Appendix C: Estimated Costs for Respirator PPE for 2024 TSCA Risk Management Economic Analyses

July 2024

Submitted to:

Economic and Policy Analysis Branch
Existing Chemicals Risk Management Division
Office of Pollution, Prevention, and Toxics
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue
Washington, DC 20460

Submitted by:

Abt Associates Inc.
6130 Executive Boulevard
Rockville, MD 20852

1. Introduction

This document presents draft estimates for the costs of a personal protective equipment (PPE) for respiratory protection. The write-up and costs estimates in this document can be dropped into 2022 and 2023 Toxic Substances Control Act (TSCA) risk management economic analyses.

EPA's cost estimates for implementing and maintaining a respiratory PPE program reflect the assumption that facilities will follow OSHA's Respiratory Protection Standard (29 CFR 1910.134 (d)(3)(i)(B)),[1] which identifies several types of respirators and their Assigned Protection Factors (APFs). The APF denotes the level of respiratory protection that a given respirator is expected to provide employees. An employer may select any respirator that has an APF equal to or greater than the applicable requirement.

Table C-1 reproduces Table 1 of the Respiratory Protection Standard (29 CFR 1910.134 (d)(3)(i)(B) (d)(3)(i)(A)) and presents each type of respirator with its expected APF.

Table C-1: Assigned Protection Factors for Respirators in OSHA Standard 29 CFR 1910.134

Type of Respirator	Quarter Mask	Half Mask	Full Facepiece	Helmet/Hood	Loose-Fitting Facepiece
Air-Purifying Respirator (APR)	5	10	50	-	-
Powered Air-Purifying Respirator (PAPR)	-	50	1,000	25/1,000[1]	25
Supplied-Air Respirator (SAR) or Airline Respirator					
• Demand mode	-	10	50		
• Continuous flow mode	-	50	1,000	25/1,000[1]	25
• Pressure-demand or other positive-pressure mode	-	50	1,000	-	-
Self-Contained Breathing Apparatus (SCBA)					
• Demand Mode	-	10	50	50	-
• Pressure-demand or other positive-pressure mode (*e.g.,* open/closed circuit)	-	-	10,000	10,000	-

[1]The employer must have evidence provided by the respirator manufacturer that testing of these respirators demonstrates performance at a level of protection of 1,000 or greater to receive an APF of 1,000. It is assumed that respirators have an APF of 1,000.

As indicated in Table C-1, above, respirators are grouped into different classes defined by the air supply system, operating mode, and the type of facepiece. The major air supply systems (as defined in 29 CFR 1910.134(b)) are:

- **Air Purifying Respirator (APR).** A respirator with an air-purifying filter, cartridge, or canister that removes specific air contaminants by passing ambient air through the air-purifying element.

[1] The Respiratory Protection Standard (29 CFR 1910.134 (d)(3)(i)(B)), promulgated by OSHA, contains requirements for program administration, procedures for respirator selection, employee training, fit testing, medical evaluation, respirator use, APFs and Maximum Use Concentrations (MUCs), as well as other provisions.

- **Atmosphere-Supplying Respirator.** A respirator that supplies breathing air from a source independent of the ambient atmosphere. Includes SAR and SCBA units.

- **Powered Air-Purifying Respirator (PAPR).** A type of air purifying respirator that uses a blower to force the ambient air through air-purifying elements to the inlet covering. The inlet covering is the portion of a respirator that forms the protective barrier between the user's respiratory tract and an air-purifying device or breathing air source.

- **Self-Contained Breathing Apparatus (SCBA).** An atmosphere-supplying respirator, where the source of breathing air is designed to be carried by the user.

- **Supplied-Air Respirator (SAR).** An atmosphere-supplying respirator, where the source of breathing air is not designed to be carried by the user.

The types of operating modes (as defined in 29 CFR 1910.134(b)) are:

- **Continuous Flow Mode.** Provides a continuous flow of breathable air to the respirator facepiece.

- **Demand Mode.** Admits breathing air to the facepiece only when a negative pressure is created inside the facepiece by inhalation.

- **Positive Pressure Mode**. The pressure inside the respirator inlet covering exceeds the ambient air pressure outside the respirator.

- **Pressure Demand Mode**. Admits breathing air to the facepiece when the positive pressure is reduced inside the facepiece by inhalation.

And the major facepiece types (as defined in 29 CFR 1910.134(b), unless otherwise noted) are:

- **Full Facepiece.** Covers from the hairline to below the chin, and typically provides eye protection as well (NIOSH 2012).

- **Half Mask.** Covers the nose, mouth, and under the chin (NIOSH 2012).

- **Helmet/Hood.** A helmet is a rigid covering that also provides head protection against impact and penetration. A hood is designed to completely cover the head and neck and may also cover portions of the shoulders and torso.

- **Loose-Fitting Facepiece.** A respiratory inlet covering that is designed to form a partial seal with the face.

- **Quarter Mask.** Covers the mouth and nose, and the lower sealing surface rests between the chin and mouth (NIOSH 2012).

Not all respirators presented in Table C-1 are suitable to include in a cost analysis. Table C-2 presents the respirators that are included and excluded from the cost analysis, with an explanation for a respirator's exclusion noted as a footnote in the table.

Table C-2: Respirators Selected for Cost Analysis

Respirator[1]		APF	Included in Analysis
APR[2]	APR Quarter Mask[3]	5	✗
	APR Half Mask	10	✓
	APR Full Facepiece	50	✓[2]
PAPR[2]	PAPR Half Mask	50	✓[2]
	PAPR Full Facepiece	1,000	✓[2]
	PAPR Helmet/Hood	1,000	✓[2]
	PAPR Loose-Fitting Facepiece	25	✓
SAR	SAR Demand Mode Half Mask[4]	10	✗
	SAR Demand Mode Full Facepiece[4]	50	✗
	SAR Continuous Flow Mode Half Mask	50	✓
	SAR Continuous Flow Mode Full Facepiece	1,000	✓
	SAR Continuous Flow Mode Helmet/Hood	1,000	✓
	SAR Continuous Flow Mode Loose-Fitting Facepiece	25	✓
	SAR Pressure-Demand or other Positive-Pressure Mode Half Mask[5]	50	✗
	SAR Pressure-Demand or other Positive-Pressure Mode Full Facepiece[5]	1,000	✗
SCBA	SCBA Demand Mode Half Mask[4]	10	✗
	SCBA Demand Mode Full Facepiece[4]	50	✗
	SCBA Demand Mode Helmet/Hood[4]	50	✗
	SCBA Pressure-Demand or other Positive-Pressure Mode Full Facepiece	10,000	✓
	SCBA Pressure-Demand or other Positive-Pressure Mode Helmet/Hood	10,000	✓

[1] APR: Air-Purifying Respirator; PAPR: Powered-Air-Purifying Respirator; SAR: Supplied-Air Respirator: SCBA: Self Contained Breathing Apparatus

[2] APR and PAPR respirators are excluded for applications where filters are not effective protection and supplied air must be used.

[3] EPA was unable to locate retailers selling quarter masks online. Given this, EPA assumes it is not widely used and excludes it from the cost analysis.

[4] The respirator is typically no longer used because demand mode creates negative pressure in the mask during inhalation, so if there is leakage, contaminated air could enter the mask and be inhaled by the wearer (U.S. DOE 1999). For this reason, the respirator should be excluded from the cost analysis.

[5] SAR respirators operated in pressure-demand and other positive-pressure modes require a high pressure air supply. A high pressure air supply is provided by a compressed air cylinder or the combination of a fixed air filtration panel and an air compressor. Both of these air supply systems are expected to be more costly than the pump needed to supply a SAR respirator operated in continuous flow mode. These respirators are excluded from the cost analysis as a result.

Section 1 presents an overview of the methodology used to estimate an average incremental respiratory PPE cost per worker. Section 2 presents the wage rates used in this analysis. Section 3 presents the written respiratory plan costs. Section 4 presents the medical evaluation costs. Section 5 presents the fit testing costs. Section 6 presents the training costs. Section 7 presents the respiratory cleaning costs. Section 8 presents the estimated useful life and unit cost estimates for PPE equipment. Section 9 presents the estimated baseline use for respirators. Section 10 presents the total initial and annually recurring respiratory protection costs. Section 11 presents the incremental costs that account for baseline PPE usage.

1. Overview of Methodology to Estimate Respiratory PPE Costs

In addition to costs for compliant respirator equipment, it is assumed that facilities will incorporate the following elements from the Respiratory Protection Standard into their PPE program, even if they would not be required to do so by a potential rule:

- Develop a written respiratory protection plan with procedures for the selection, use, cleaning, storage, and maintenance of respirators;
- Medical evaluations, to determine if an employee has an existing health condition that would inhibit safe use of a respirator;
- Fit testing, to ensure that the respirator is providing a level of protection consistent with its APF; and
- Training, to ensure that an employee understands how to properly use the equipment they are assigned.
- Cleaning respirator components as needed to ensure that it is in sanitary condition

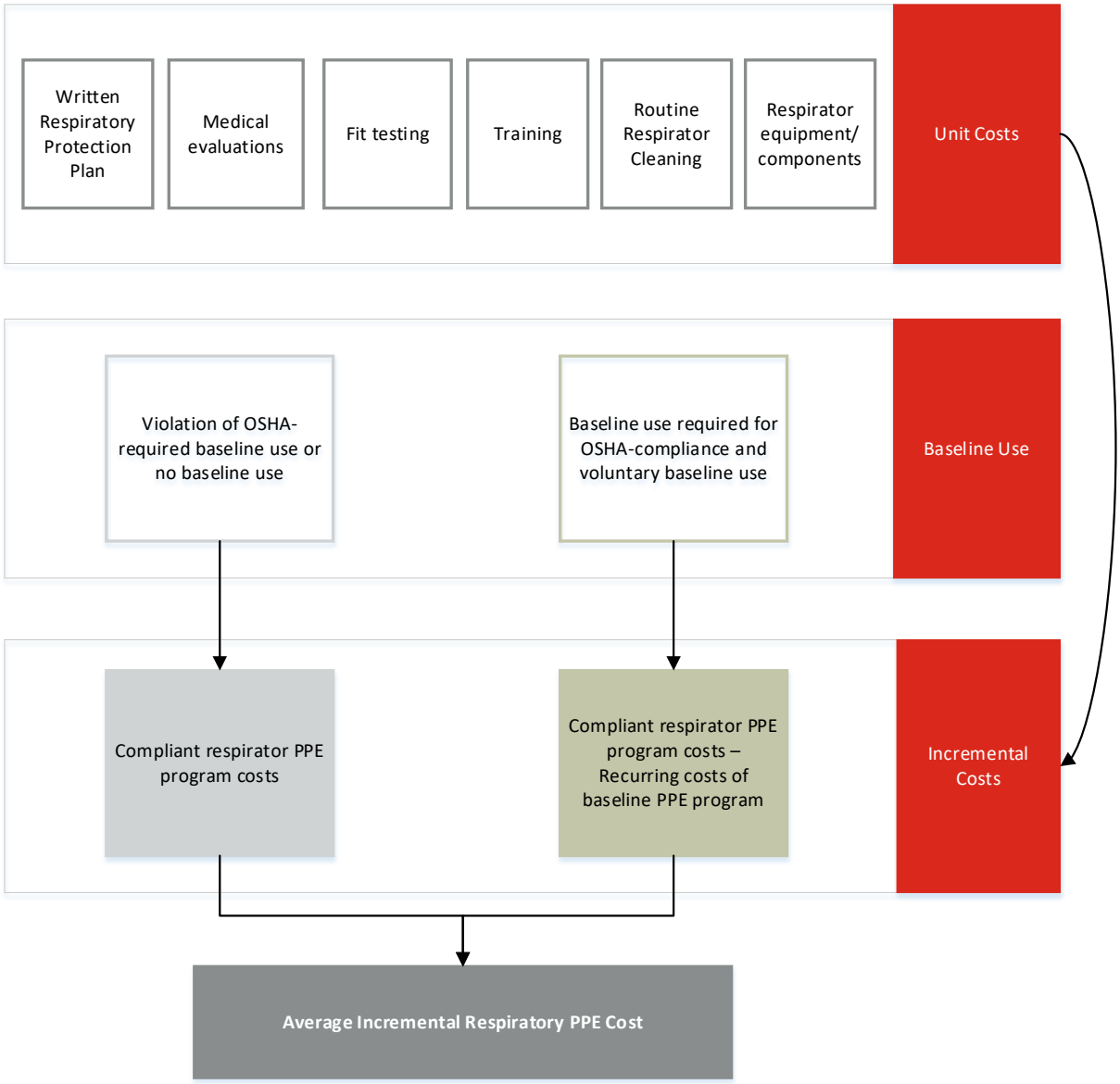
In the baseline, some establishments may already be required to provide employees with respirators under the Respiratory Protection Standard. The analysis also assumes that some establishments that are not required to provide PPE may do so anyway voluntarily ("voluntary use").

As explained further in Section 10, establishments comply with OSHA requirements by selecting an APF that provides adequate protection given the Permissible Exposure Limit (PEL) for that substance and workplace-specific exposure levels. Thus, facilities may be fully compliant with OSHA requirements in the baseline even though they provide respirators with a lower APF than what may be required under a TSCA risk management action. This analysis therefore estimates the incremental costs for facilities compliant with the OSHA-required baseline use because EPA assumes that most establishments will need to upgrade their respirator to be compliant with an EPA standard. For facilities that voluntarily provide respirators but are not required to do so by OSHA because their workplace exposure levels are below the PEL, this analysis assumes that they may need to upgrade their respirator program to comply with an EPA standard.

Thus, facilities are expected to fall into two groups, based on their baseline use of respiratory PPE: (1) no baseline use; (2) compliant with OSHA-required use or voluntary use. All costs are presented in 2021$ unless otherwise noted.

Figure C-1 presents an overview of the methodology used to estimate incremental respiratory PPE costs.

Figure C-1: Methodology to Estimate Respiratory PPE Costs



2. Industry Wage Rates

Loaded wage rates are calculated by adding fringe benefits and overhead to the wage or salary to derive a fully loaded labor cost. Loaded wage rates are calculated for several labor categories: Managerial, Professional/ Technical, Clerical, Production Workers, Industrial Hygienists, and EPA staff.

Wages and fringe benefits for each labor category (*e.g.*, managerial, professional/technical, clerical labor, and production labor were taken from the U.S. Bureau of Labor Statistics (BLS) Employer Costs for Employee Compensation (ECEC) Supplementary Tables, for December 2021 (BLS 2023d). In the BLS report, wages are represented by the "wages and salaries" cost component and fringe benefits are represented by "total benefits." Separate wage rates are estimated for different sectors, which include manufacturing, construction/mining, transportation and public utilities, wholesale trade, retail trade, and services.

The cost of fringe benefits such as paid leave and insurance, specific to each labor category, are taken from the same ECEC series. Fringe benefits as a percent of wages are calculated separately for each labor category.

An additional loading factor of 20 percent is applied to total compensation to account for overhead. This loading factor is described in *Handbook on Valuing Changes in Time Use Induced by Regulatory Requirements and Other U.S. EPA Actions* (EPA 2020a), and is reflective of multiplier values used in prior EPA RIAs and ICRs that are based on industry- and occupation-specific overhead rates affected by EPA regulations. This overhead loading factor is multiplied by the total compensation (wages plus fringe benefits). The calculated overhead costs (20% of the total compensation) are shown in Table C-3 as well as the total hourly loaded wages.

For industrial hygienists, wages were based on another BLS data series, *Occupational Employment and Wage Statistics (OEWS), May 2021 National Occupational Employment and Wage Estimates.* OEWS data were used because ECEC data were not available for very specific occupations. However, the OEWS data covers only wages, not fringe benefits. Therefore, the Industrial Hygienist fringe benefits continue to be based on ECEC data.

The wage rate for Industrial Hygienists is a weighted average of the hourly mean wage for *Occupational Health and Safety Specialists,* Standard Occupational Classification (SOC) 19-5011, and *Occupational Health and Safety Technicians,* SOC 19-5012, in Manufacturing (BLS 2023e). The wage rate for each occupation was weighted by employment for the occupation. The North American Industry Classification System (NAICS) codes for Manufacturing are 31, 32, and 33.

The wage rate for Physician's Assistant is the average of the hourly mean wage for *Physician's Assistants,* Standard Occupational Classification (SOC) 29-1071, and *Occupational Health and Safety Technicians,* SOC 29-9012, in Health Care and Social Assistance. The North American Industry Classification System (NAICS) codes for Health Care and Social Assistance is 62 (BLS 2023e).

As with other labor categories, the fringe benefits factor came from U.S. Bureau of Labor Statistics (BLS) *Employer Costs for Employee Compensation* (ECEC) Supplementary Tables, for December 2021 (BLS 2023d). Benefits for "professional and related" occupations were used, and loaded wages were calculated as for other types of labor. An additional loading factor of 20 percent of total compensation was applied to account for overhead.

Table C-3: Industry Wage Rates

EPAB Labor Category	Data Sources	Wage	Fringe Benefit	Total Compensation	Overhead, % total compensation[1]	Fully Loaded Wages
		(a)	(b)	(c) = (a) + (b)	(d)	(e) = (c) x (1 + (d))
Manufacturing						
Managerial	BLS *ECEC*, Private Manufacturing Industries, "Mgt, Business, and Financial"[2]	$54.29	$24.66	$78.95	20%	$94.74
Production Worker	BLS *ECEC*, Private Manufacturing Industries, "Office and Administrative Support"[2]	$21.79	$11.63	$33.42	20%	$40.10
Construction and Mining						
Managerial	BLS *ECEC*, Private Goods Producing Industries, "Mgt, Business, and Financial" [2]	$52.17	$22.53	$74.70	20%	$89.64
Construction/Extraction Worker	BLS *ECEC*, Private Goods Producing Industries, "Construction, extraction, farming, fishing, and forestry"[2]	$28.68	$13.71	$42.39	20%	$50.87
Transportation and Public Utilities						
Managerial	BLS *ECEC*, Trade, Transportation, and Utilities **Industries**, "Mgt, Business, and Financial"[2]	$54.12	$21.82	$75.94	20%	$91.13
Maintenance and Repair Worker	BLS *ECEC*, Private Goods Producing **Industries**, "Installation, maintenance, and repair"[2]	$31.08	$15.29	$46.37	20%	$55.64
Wholesale Trade						
Managerial	BLS *ECEC*, Private Industry Workers, "Mgt, Business, and Financial"[2]	$34.87	$12.93	$47.80	20%	$57.36
Production/	BLS *ECEC*, Wholesale Trade **Industries**, "Production, transportation, and material moving"[2]	$20.95	$9.42	$30.37	20%	$36.44
Retail Trade						

Table C-3: Industry Wage Rates

EPAB Labor Category	Data Sources	Wage	Fringe Benefit	Total Compensation	Overhead, % total compensation[1]	Fully Loaded Wages
		(a)	(b)	(c) = (a) + (b)	(d)	(e) = (c) x (1 + (d))
Managerial	BLS ECEC, Retail Trade Industries, "Mgt, Business, and Financial" [2]	$18.39	$5.59	$23.98	20%	$28.78
Production/	BLS ECEC, Retail Trade Industries, "Production, transportation, and material moving"[2]	$16.66	$6.15	$22.81	20%	$27.37
Services						
Managerial	BLS ECEC, Service Industries, "Mgt, Business, and Financial" [2]	$54.77	$24.99	$79.76	20%	$95.71
Maintenance and Repair Worker	BLS ECEC, Service Industries, "Installation, maintenance, and repair"[2]	$28.39	$13.15	$41.54	20%	$49.85
All Sectors						
Industrial Hygienist	Wage*: BLS OES Occupat. Employ. and Wage Stats.,* for Manufacturing (NAICS 31, 32, 33), average of wages for *Occup. Health/ Safety Specialists* (SOC 29-9011) and *Occup. Health/Safety Technicians* (SOC 29-9012), weighted by employment.[3,4]	$39.47	$19.96	$59.43	20%	$71.32
Physician's Assistant	OES: "Health Care and Social Assistance (Sector 62) - (29-1071) "Physicians Assistant" [3,5]	$60.23	$26.31	$86.54	20%	$103.85

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

[2]Source: Employer Costs for Employee Compensation Historical Supplementary Tables, National Compensation Survey: December 2006 – December 2020 (BLS 2023d).

[3]Source: Occupational Employment Statistics (Occupational Employment and Wages) for May 2020, (BLS 2023e).

[4] Fringe benefits are not reported in the BLS OEWS (BLS 2023e). It is therefore is assumed that fringes as a percentage of wages are 50.77%, based on the percentage for Private Manufacturing Industries, "Professional and related" in the BLS ECEC (BLS 2023d).

[5] Fringe benefits are not reported in the BLS OEWS (BLS 2023e). It is therefore is assumed that fringes as a percentage of wages are 44%, based on the percentage for Health Care and Social Assistance Industry, "Professional and related" in the BLS ECEC (BLS 2023d).

3. Written Respiratory Protection Plan

It is estimated that the development of a written respiratory protection plan will initially require 8 hours of an industrial hygienist's time and then require 2 hours annually after the first year for the industrial hygienist to update the plan (OSHA 2016).[2] The estimated costs by industry sector are presented below in Table C-4. Note that these costs are a per establishment costs, whereas all other costs presented in this respirator protection cost analysis are estimated on a per worker basis.

Table C-4: Per Establishment Costs for Written Respiratory Protection Program

Sector	Initial Costs for Plan Development (8 hours of Industrial Hygienist Wage Rate of $68.50)[1]	Annual Costs for Updating Plan (2 hours of Industrial Hygienist Wage Rate of $68.50) [1]	Percent of Establishments Without a Baseline Plan[2]	Incremental Costs	
				Initial	Recurring
Manufacturing	$570.56	$142.64	72%	$409.24	$102.31
Construction			78%	$446.15	$111.54
Mining			66%	$375.83	$93.96
Transportation and Public Utilities			88%	$503.20	$125.80
Wholesale Trade			85%	$486.07	$121.52
Retail Trade			96%	$548.81	$137.20
Services			95%	$540.76	$135.19

[1]See Table C-3 (BLS 2023a, BLS 2023c).

[2]See Table C-14 below (BLS 2003, U.S. Census Bureau 2001).

[2] OSHA (2016) assumed the plan would be developed by a human resources manager, but this analysis uses the industrial hygienist wage to estimate the cost of the labor burden.

4. Medical Evaluation Costs

All employees must receive a medical evaluation before they are required to wear a respirator. The employer identifies a physician or other licensed health care professional to perform an initial medical evaluation using a medical questionnaire or a medical examination that gathers the same information as the questionnaire. Many respirator distributors are now offering medical questionnaires online. For example, 3M offers the services for $31 per employee and estimates it will take an employee about 15 minutes to complete (3M 2019). The cost to the employer for this component of the medical evaluation includes the cost of the medical questionnaire service ($31), plus the loaded wage of an employee for 15 minutes to complete the questionnaire.

Any employee failing the initial medical evaluation must receive a follow-up examination. It is estimated that 23 percent of employees fail the initial medical evaluation (OSHA 2010). The total cost of the follow-up medical examination incorporates the cost of the employee's time (time spent traveling, waiting, and being examined) and the cost of the examination. The cost of the employee's time is estimated by multiplying their loaded wage rate by travel time, wait time, and estimated duration of the follow-up medical examination. The cost of the follow-up medical examination is equal to $201, estimated as the cost presented in OSHA (2010) and inflating the value from 1994 to 2021 dollars using the CPI for medical care services (BLS 2023b)

Table C-5 presents the estimated per-employee medical evaluation costs. The full medical evaluation costs are included as initial costs. To account for new employees and/or employees that need a new medical evaluation, annual recurring costs are estimated as one fifth of the initial costs.

Table C-5: Medical Evaluation Costs per Employee

Cost Input	Cost Per Hour	Number of Hours Per Employee		Cost Per Employee	
		Initial	Recurring	Initial	Recurring
Questionnaire and Examination					
Online Medical History Questionnaire Services	-	-	-	$32.00	$6.40
Cost of Medical Exam[1]	-	-	-	$48.30	$9.66
Employee Time for Questionnaire, by Industry					
Manufacturing	$40.10	0.25	0.05	$10.03	$2.01
Construction	$50.87	0.25	0.05	$12.72	$2.54
Mining	$50.87	0.25	0.05	$12.72	$2.54
Transportation and Public Utilities	$55.64	0.25	0.05	$13.91	$2.78
Wholesale Trade	$36.44	0.25	0.05	$9.11	$1.82
Retail Trade	$27.37	0.25	0.05	$6.84	$1.37
Services	$49.85	0.25	0.05	$12.46	$2.49
Employee Time for Exam, by Industry[2]					
Manufacturing	$40.10	0.46	0.092	$18.45	$3.69
Construction	$50.87	0.46	0.092	$23.40	$4.68
Mining	$50.87	0.46	0.092	$23.40	$4.68
Transportation and Public Utilities	$55.64	0.46	0.092	$25.59	$5.12
Wholesale Trade	$36.44	0.46	0.092	$16.76	$3.35
Retail Trade	$27.37	0.46	0.092	$12.59	$2.52
Services	$49.85	0.46	0.092	$22.93	$4.59
Total Medical Evaluation Costs Per Employee, by Industry					
Manufacturing				**$108.77**	**$21.75**
Construction				**$116.42**	**$23.28**
Mining				**$116.42**	**$23.28**
Transportation and Public Utilities				**$119.80**	**$23.96**
Wholesale Trade				**$106.17**	**$21.23**
Retail Trade				**$99.73**	**$19.95**
Services				**$115.69**	**$23.14**

[1] The cost per employee is estimated by multiplying the cost of a medical examination ($201) by the 23 percent of employees that fail the initial medical evaluation (OSHA 2010)

[2] 23 percent of employees that fail the initial medical evaluation and incur a 2 hour labor burden, 23%*2 = 0.46 hours on average per employee (OSHA 2010).

5. Fit Testing

Before an employee can wear a negative or positive pressure tight-fitting mask/facepiece respirator, they must be fit tested with the same make, model, style, and size of respirator that will be used. The employer shall ensure that employees pass an appropriate qualitative fit test or quantitative fit test.

Qualitative fit tests may only be used to fit test negative pressure APRs that must achieve a fit factor of 100 or less (29 CFR 1910.134(f)(6)).[3] They involve a chemical test kit that uses an employee's sense of smell, taste, or reaction to an irritant to detect leakage into the mask/facepiece. There are four qualitative fit test methods accepted by OSHA (OSHA 2015).

- Saccharin, which leaves a sweet taste in your mouth;
- Isoamyl acetate, which smells like bananas;
- Bitrex, which leaves a bitter taste in your mouth; and
- Irritant smoke (Stannic Chloride), which can cause coughing.

It is assumed that a manager performs the qualitative fit test and that the test takes an hour to complete (ERG 2003).

Quantitative fit testing uses a machine to measure the actual amount of leakage into the facepiece and does not rely on the employee's sense of taste, smell, or irritation to detect leakage. The respirators used during this type of fit testing have a probe attached to the facepiece that is connected to the machine by a hose (OSHA 2015). There are three quantitative fit test methods accepted by OSHA (OSHA 2015):

1. Generated aerosol;
2. Ambient aerosol; and
3. Controlled Negative Pressure.

Quantitative fit tests are more expensive than qualitative fit tests because they take longer to perform (two hours instead of one), but may produce better results. They are typically performed by an industrial hygienist.[4] It is assumed that each employee receiving a quantitative fit test will require one hour of the industrial hygienist's time and two hours of the employee's (ERG 2003).

Table C-6 presents the qualitative per-employee fit testing costs. Table C-7 presents the quantitative per-employee fit testing costs.

[3] Fit factor is a quantitative estimate of the fit of the respirator, and typically estimates the ratio of the concentration of a substance outside of the respirator to its concentration inside the respirator.

[4] Quantitative fit tests can also be performed by a certified supervisor, but this scenario is not considered.

Table C-6: Qualitative Fit Testing Costs per Employee

Sector	Cost Input	Cost Per Hour	Number of Hours Per Employee	Cost Per Employee
Manufacturing	Cost of Manager[1]	$94.74	0.25	$23.69
	Cost of Employee's Time	$40.10	1.00	$40.10
	Fit-test Materials[2]			$0.78
	Total Cost			**$64.57**
Construction	Cost of Manager[1]	$89.64	0.25	$22.41
	Cost of Employee's Time	$50.87	1.00	$50.87
	Fit-test Materials[2]			$0.78
	Total Cost			**$74.06**
Mining	Cost of Manager[1]	$89.64	0.25	$22.41
	Cost of Employee's Time	$50.87	1.00	$50.87
	Fit-test Materials[2]			$0.78
	Total Cost			**$74.06**
Transportation and Public Utilities	Cost of Manager[1]	$91.13	0.25	$22.78
	Cost of Employee's Time	$55.64	1.00	$55.64
	Fit-test Materials[2]			$0.78
	Total Cost			**$79.20**
Wholesale Trade	Cost of Manager[1]	$57.36	0.25	$14.34
	Cost of Employee's Time	$36.44	1.00	$36.44
	Fit-test Materials[2]			$0.78
	Total Cost			**$51.56**
Retail Trade	Cost of Manager[1]	$28.78	0.25	$7.20
	Cost of Employee's Time	$27.37	1.00	$27.37
	Fit-test Materials[2]			$0.78
	Total Cost			**$35.35**
Services	Cost of Manager[1]	$95.71	0.25	$23.93
	Cost of Employee's Time	$49.85	1.00	$49.85
	Fit-test Materials[2]			$0.78
	Total Cost			**$74.56**

[1] The number of hours per employee for a Manager to perform a qualitative fit test is 15 minutes rather than 1 hour because the qualitative fit test is assumed to be conducted in groups of four (ERG 2003)

[2] Cost estimate is an average of four online retailers (www.airgas.com, www.zefon.com, www.asasupplies.com, www.premiersafety.com).

[3] The number of hours per employee for an Industrial Hygienist to perform a quantitative fit test is 1 hour rather than 2 because it is assumed that an Industrial Hygienist can perform the fit test on two employees at a time (ERG 2003)

Table C-7: Quantitative Fit Testing Costs per Employee

Sector	Cost Input	Cost Per Hour	Number of Hours Per Employee	Cost Per Employee
Manufacturing	Cost of Industrial Hygienist's Time[3]	$71.32	1.00	$71.32
	Cost of Employee's Time	$40.10	2.00	$80.20
	Total Cost			**$151.52**
Construction	Cost of Industrial Hygienist's Time[3]	$71.32	1.00	$71.32
	Cost of Employee's Time	$50.87	2.00	$101.74
	Total Cost			**$173.06**
Mining	Cost of Industrial Hygienist's Time[3]	$71.32	1.00	$71.32
	Cost of Employee's Time	$50.87	2.00	$101.74
	Total Cost			**$173.06**
Transportation and Public Utilities	Cost of Industrial Hygienist's Time[3]	$71.32	1.00	$71.32
	Cost of Employee's Time	$55.64	2.00	$111.28
	Total Cost			**$182.60**
Wholesale Trade	Cost of Industrial Hygienist's Time[3]	$71.32	1.00	$71.32
	Cost of Employee's Time	$36.44	2.00	$72.88
	Total Cost			**$144.20**
Retail Trade	Cost of Industrial Hygienist's Time[3]	$71.32	1.00	$71.32
	Cost of Employee's Time	$27.37	2.00	$54.74
	Total Cost			**$126.06**
Services	Cost of Industrial Hygienist's Time[3]	$71.32	1.00	$71.32
	Cost of Employee's Time	$49.85	2.00	$99.70
	Total Cost			**$171.02**

[1] The number of hours per employee for a Manager to perform a qualitative fit test is 15 minutes rather than 1 hour because the qualitative fit test is assumed to be conducted in groups of four (ERG 2003)

[2] Cost estimate is an average of four online retailers.

[3] The number of hours per employee for an Industrial Hygienist to perform a quantitative fit test is 1 hour rather than 2 because it is assumed that an Industrial Hygienist can perform the fit test on two employees at a time (ERG 2003)

6. Training

After an employee is properly fitted for a respirator, they will receive training to ensure proper use of the equipment. Table C-8 presents the estimated hourly employee training costs.

Table C-8: Annual Training Costs: APR

	Employee Type	Price/Hour	Number of Hours Per Employee	Cost/Employee
Manufacturing	Worker	$40.10	2	$80.20
	Manager[1]	$94.74	0.5	$47.37
	Total Cost			**$127.57**
Construction	Worker	$50.87	2	$101.74
	Manager[1]	$89.64	0.5	$44.82
	Total Cost			**$146.56**
Mining	Worker	$50.87	2	$101.74
	Manager[1]	$89.64	0.5	$44.82
	Total Cost			**$146.56**
Transportation and Public Utilities	Worker	$55.64	2	$111.28
	Manager[1]	$91.13	0.5	$45.57
	Total Cost			**$156.85**
Wholesale Trade	Worker	$36.44	2	$72.88
	Manager[1]	$57.36	0.5	$28.68
	Total Cost			**$101.56**
Retail Trade	Worker	$27.37	2	$54.74
	Manager[1]	$28.78	0.5	$14.39
	Total Cost			**$69.13**
Services	Worker	$49.85	2	$99.70
	Manager[1]	$95.71	0.5	$47.86
	Total Cost			**$147.56**

[1] The number of hours per employee for a Manager to conduct training is ¼ of the worker's time because training is assumed to be conducted in groups of four (ERG 2003)

The duration of training varies with the complexity of the respirator. ERG (2003) estimates that APR systems require two hours of training per year, PAPR and SAR systems both require 4 hours of training per year, and SCBA systems require 8 hours of training per year. Table C-9 presents the estimated annual training costs per employee for PAPR and SAR systems. Table C-10 presents the estimated annual training costs per employee for SCBA systems.

Table C-9: Annual Training Costs: PAPR/SAR

	Employee Type	Price/Hour	Number of Hours	Cost/Employee
Manufacturing	Worker	$40.10	4	$160.40
	Manager[1]	$94.74	1	$94.74
	Total Cost			**$255.14**
Construction	Worker	$50.87	4	$203.48
	Manager[1]	$89.64	1	$89.64
	Total Cost			**$293.12**
Mining	Worker	$50.87	4	$203.48
	Manager[1]	$89.64	1	$89.64
	Total Cost			**$293.12**
Transportation and Public Utilities	Worker	$55.64	4	$222.56
	Manager[1]	$91.13	1	$91.13
	Total Cost			**$313.69**
Wholesale Trade	Worker	$36.44	4	$145.76
	Manager[1]	$57.36	1	$57.36
	Total Cost			**$203.12**
Retail Trade	Worker	$27.37	4	$109.48
	Manager[1]	$28.78	1	$28.78
	Total Cost			**$138.26**
Services	Worker	$49.85	4	$199.40
	Manager[1]	$95.71	1	$95.71
	Total Cost			**$295.11**

[1] The number of hours per employee for a Manager to conduct training is ¼ of the worker's time because training is assumed to be conducted in groups of four (ERG 2003)

Table C-10: Annual Training Costs: SCBA

	Employee Type	Price/Hour	Number of Hours	Cost/Employee
Manufacturing	Worker	$40.10	8	$320.80
	Manager[1]	$94.74	2	$189.48
	Total Cost			**$510.28**
Construction	Worker	$50.87	8	$406.96
	Manager[1]	$89.64	2	$179.28
	Total Cost			**$586.24**
Mining	Worker	$50.87	8	$406.96
	Manager[1]	$89.64	2	$179.28
	Total Cost			**$586.24**
Transportation and Public Utilities	Worker	$55.64	8	$445.12
	Manager[1]	$91.13	2	$182.26
	Total Cost			**$627.38**
Wholesale Trade	Worker	$36.44	8	$291.52
	Manager[1]	$57.36	2	$114.72
	Total Cost			**$406.24**
Retail Trade	Worker	$27.37	8	$218.96
	Manager[1]	$28.78	2	$57.56
	Total Cost			**$276.52**
Services	Worker	$49.85	8	$398.80
	Manager[1]	$95.71	2	$191.42
	Total Cost			**$590.22**

[1] The number of hours per employee for a Manager to conduct training is ¼ of the worker's time because training is assumed to be conducted in groups of four (ERG 2003)

7. Respirator Cleaning and Maintenance Costs

It is estimated that each worker will need clean their respirator every other shift, or 125 times per year, requiring 5 minutes of labor per cleaning (OSHA 2016). Thus, the estimated annual labor burden for cleaning is 10.42 hours per worker. The estimated costs by industry sector are presented below in Table C-11. EPA assumes that this labor burden also accounts for the time required for any regular maintenance of the respirators that is needed, such as changing filters.

Table C-11: Annual Cleaning Costs Per Worker

Sector	Worker Labor Cost Per Hour of Training	Annual Cleaning Labor Hours	Annual Cost
Manufacturing	$40.10	10.42	$417.71
Construction	$50.87	10.42	$529.90
Mining	$50.87	10.42	$529.90
Transportation and Public Utilities	$55.64	10.42	$579.58
Wholesale Trade	$36.44	10.42	$379.58
Retail Trade	$27.37	10.42	$285.10
Services	$49.85	10.42	$519.27

8. Useful Life and Annualized Unit Cost Estimates

Useful life is equal to the number of years until a respirator or respirator component needs to be replaced, as well as the number of years until a medical evaluation, fit testing, or training is required. The annual replacement rate of a respirator or respirator component, or the annual reoccurrence of other PPE program elements, is therefore equal to 1 divided by the useful life. Table C-12 presents the useful lives of respirators, respirator components, training, and fit testing. Respirator useful lives are presented as those of the individual respirator system components (*e.g.,* mask, pump, breathing tube, etc.) or as the useful life of a full respiratory system or system components kit (if the components in the kit have similar useful lives). Individual respirator components are listed if they have different useful lives. The table also includes the sources and assumptions underlying the useful life estimates.

The useful life for some components depends on a variety of factors, making it difficult to identify a representative estimate. In these cases, assumptions are made about the component's useful life using available literature. For example, the filter cartridge replacement rate varies with a multitude of factors, including humidity, temperature, and atmospheric pressure. The analysis assumes a cartridge replacement rate of 50 times per year for a PAPR and 100 times per year for an APR, consistent with the rates used in ERG (2003).[5]

Note that useful life expectancies and costs are estimates and may vary by industry, facility, and or/geographic location. Therefore, estimated costs are expected to represent a typical facility – actual costs for a specific facility may be higher or lower.

[5] EPA also reviewed the cartridge replacement frequency estimations predicted by 3M's online software application (3M 2015). The range of expected lives predicted by the 3M replacement frequency estimator software varies greatly. For example, the NIOSH-approved GVP 401 cartridges have an estimated service life of 127 minutes in an environment of >95% humidity and 86 degrees Fahrenheit. However, the useful life jumps to 197 hours when used in an environment of <65% humidity and 32 degrees Fahrenheit. The 3M software confirms that replacement rate estimates are highly dependent on factors that vary nationally, and that it is up to each facility to replace cartridges as required by their environmental parameters. The analysis also used the 3M software to confirm that the replacement rate estimates from ERG (2003) of 50 times per year for PAPR and 100 times per year for APR fall within the predicted range and are thus reasonable estimates.

Table C-12: Respirator PPE Useful Life

Respirator System	Component	Useful Life (years)	Description
APF Factor 10			
APR, Half Mask	Half Mask, APR	2	Estimate based on the equipment service life of an APR, full facepiece respirator (ERG 2003)
	Cartridge Filters, APR	0.01	Assume APR cartridges are replaced at a rate of 100 per year (ERG 2003)
	Training	1	ERG (2003)
	Qualitative Fit Testing	1	29 CFR 1910.134(f)(2)
APF Factor 25			
PAPR, Loose-Fitting Facepiece	Loose-Fitting Facepiece, PAPR	3	ERG (2003)
	Cartridge Filters, PAPR	0.02	Assume PAPR cartridges are replaced at a rate of 50 per year (ERG 2003)
	PAPR System	3	OSHA (1996); ERG (2003)
	Breathing Tube	3	Assume breathing tubes have the same useful life as a mask or facepiece, since facepieces are regularly sold with breathing tubes.
	Training	1	ERG (2003)
SAR, Continuous Flow Mode, Loose-Fitting Facepiece	Loose-Fitting Facepiece (PAPR)	3	ERG (2003)
	Breathing Tube	3	Assume breathing tubes have the same useful life as a masks or facepieces, since facepieces are regularly sold with breathing tubes.
	Pump	7	Pumps are assumed to have a useful life of 7 years for all industries. The useful life is estimated by considering a range of daily run times for 260 days per year under the assumption that the pump has a service life of 10,000 hours (Northern Safety & Industrial 2016) and not more than 10 years.
	Pump Installation	7	Assume every time a new pump is purchased, it will need to be installed in a clean air environment. Assume $50 worth of labor and materials used for installation.
	Pump Inlet Filter	0.48	Assume pump inlet filters have a 500 hour life span (MST Inc. 2001). Employees assumed to work 260 days per year. The replacement rate is calculated with the assumption of 4 hours of use per day (1040 hours per year).
	Pump Outlet Filter	0.19	Assume pump outlet filters have a 200 hour life span (MST Inc. 2001). Employees assumed to work 260 days per year. The replacement rate is calculated with the assumption of 4 hours of use per day, and 0.19 is rounded to 0.20 for analysis
APF Factor 50			
APR, Full Facepiece	Full Facepiece, APR	2	ERG (2003)
	Cartridge Filters, APR	0.01	Assume APR cartridges are replaced at a rate of 100 per year (ERG 2003)
	Training	1	ERG (2003)
	Qualitative Fit Testing	1	29 CFR 1910.134(f)(2)
PAPR, Half Mask	Half Mask	3	ERG (2003)

Table C-12: Respirator PPE Useful Life

Respirator System	Component	Useful Life (years)	Description
	Cartridge Filters (PAPR)	0.02	Assume PAPR cartridges are replaced at a rate of 50 per year (ERG 2003)
	PAPR System Components Kit	3	OSHA (1996); ERG (2003)
	Breathing Tube	3	Assume breathing tubes have the same useful life as a masks or facepieces, since facepieces are regularly sold with breathing tubes.
	Training	1	ERG (2003)
	Quantitative Fit Testing	1	29 CFR 1910.134(f)(2)
SAR, Continuous Flow Mode, Half Mask	Half Mask	3	ERG (2003)
	Breathing Tube and Airline Hose	3	Assume breathing tubes have the same useful life as a mask or facepiece, since facepieces are regularly sold with breathing tubes. Airline hose assumed to be replaced with breathing tube.
	Pump (1/4 HP)	7	Pumps are assumed to have a useful life of 7 years for all industries. The useful life is estimated by considering a range of daily run times for 260 days per year under the assumption that the pump has a service life of 10,000 hours (Northern Safety & Industrial 2016) and not more than 10 years.
	Pump Installation	7	Assume every time a new pump is purchased, it will need to be installed in a clean air environment. Assume $50 worth of labor and materials used for installation.
	Pump Inlet Filter	0.48	A replacement rate of about once every two years (MST Inc. 2001)
	Pump Outlet Filter	0.19	Assume pump outlet filters have a 200 hour life span (MST Inc. 2001). Employees assumed to work 260 days per year. The replacement rate is calculated with the assumption of 4 hours of use per day, and 0.19 is rounded to 0.20 for analysis
	Training	1	ERG (2003)
	Quantitative Fit Testing	1	29 CFR 1910.134(f)(2)
APF Factor 1,000			
PAPR, Full Facepiece	Full Facepiece	3	ERG (2003)
	PAPR System	3	OSHA (1996); ERG (2003)
	Breathing Tube	3	Assume breathing tubes have the same useful life as a mask or facepiece because they are regularly sold with breathing tubes.
	Cartridge Filters (PAPR)	0.02	Assume PAPR cartridges are replaced at a rate of 50 per year (ERG 2003)
	Training	1	ERG (2003)
	Quantitative Fit Testing	1	29 CFR 1910.134(f)(2)
PAPR Helmet/Hood	Hood	3	OSHA (1996); ERG (2003)
	PAPR System Components Kit	3	OSHA (1996); ERG (2003)
	Breathing Tube	3	Assume breathing tubes have the same useful life as a mask or facepiece because they are regularly sold with breathing tubes.

Table C-12: Respirator PPE Useful Life

Respirator System	Component	Useful Life (years)	Description
	Cartridge Filters (PAPR)	0.02	Assume PAPR cartridges are replaced at a rate of 50 per year (ERG 2003)
	Training	1	ERG (2003)
	Quantitative Fit Testing	1	29 CFR 1910.134(f)(2)
SAR, Continuous Flow Mode, Full Facepiece	Full Facepiece	3	ERG (2003)
	Pump (1/4 HP)	7	Pumps are assumed to have a useful life of 7 years for all industries. The useful life is estimated by considering a range of daily run times for 260 days per year under the assumption that the pump has a service life of 10,000 hours (Northern Safety & Industrial 2016) and not more than 10 years.
	Breathing Tube and Airline Hose	3	Assume breathing tubes have the same useful life as a mask or facepiece because they are regularly sold with breathing tubes. Airline hose assumed to be replaced with breathing tube.
	Pump Installation	7	Assume that every time a new pump is purchased, it will need to be installed in a clean air environment. Assume $50 worth of labor and materials used for installation.
	Pump Inlet Filter	0.48	A replacement rate of about once every two years (MST Inc. 2001)
	Pump Outlet Filter	0.19	Assume pump outlet filters have a 200 hour life span (MST Inc. 2001). Employees assumed to work 260 days per year. The replacement rate is calculated with the assumption of 4 hours of use per day, and 0.19 is rounded to 0.2
	Training	1	ERG (2003)
	Quantitative Fit Testing	1	29 CFR 1910.134(f)(2)
SAR, Continuous Flow Mode, Helmet/Hood	Hood	3	OSHA (1996); ERG (2003)
	Pump (3/4 HP)	7	Pumps are assumed to have a useful life of 7 years for all industries. The useful life is estimated by considering a range of daily run times for 260 days per year under the assumption that the pump has a service life of 10,000 hours (Northern Safety & Industrial 2016) and not more than 10 years.
	Breathing Tube and Airline Hose	3	Assume breathing tubes have the same useful life as a mask or facepiece because they are regularly sold with breathing tubes. Airline hose assumed to be replaced with breathing tube.
	Pump Installation	7	Assume that every time a new pump is purchased, it will need to be installed in a clean air environment. Assume $50 worth of labor and materials used for installation.
	Pump Inlet Filter	0.48	A replacement rate of about once every two years (MST Inc. 2001)
	Pump Outlet Filter	0.19	Assume pump outlet filters have a 200 hour life span (MST Inc. 2001). Employees assumed to work 260 days per year. The replacement rate is calculated with the assumption of 4 hours of use per day, and 0.19 is rounded to 0.2
	Training	1	ERG (2003)
	Quantitative Fit Testing	1	29 CFR 1910.134(f)(2)
APF Factor 10,000			

Table C-12: Respirator PPE Useful Life

Respirator System	Component	Useful Life (years)	Description
SCBA, Positive Pressure Mode, Full Facepiece	Positive Pressure SCBA System (includes full facepiece)	3	ERG (2003)
	Air Compressor	16	Estimated useful life for air compressor is 20 years with preventative maintenance, 16 years without preventative maintenance. Assume preventative maintenance not done. Assume an industrial air compressor ($27,021.80) will serve about 5 employees, recharging their SCBA cylinders. ($27,021.800/5 = $5,404.36) As an alternative to filling SCBA cylinders on site with an air compressor, a cylinder recharge system may be used. Costs for this service are not currently developed (Koo 2015).
	Training	1	ERG (2003)
	Quantitative Fit Testing	1	29 CFR 1910.134(f)(2)
SCBA, Positive Pressure Mode, Helmet/Hood	Positive Pressure SCBA System (includes hood)	3	ERG (2003)
	Air Compressor	16	Estimated useful life for air compressor is 20 years with preventative maintenance, 16 years without preventative maintenance. Assume preventative maintenance not done. Assume an industrial air compressor ($27,021.80) will serve about 5 employees, recharging their SCBA cylinders. ($27,021.800/5 = $5,404.36). As an alternative to filling SCBA cylinders on site with an air compressor, a cylinder recharge system may be used. Costs for this service are not currently developed (Koo 2015).
	Training	1	ERG (2003)
	Quantitative Fit Testing	1	29 CFR 1910.134(f)(2)
APR: Air-Purifying Respirators; PAPR: Powered Air-Purifying Respirator; SAR: Supplied-Air Respirator; SCBA: Self-Contained Breathing Apparatus			

Table C-13 presents annual unit costs estimates for respirators and respirator system components. Average annual recurring costs are estimated as the unit cost divided by the useful life of each component.

Respirators are organized by their corresponding APF. Unit cost estimates for individual respirator system components and kits are based on price data collected from retailer websites. Price data are averaged for component and kit unit cost estimates that incorporate the price of more than one product brand.

Table C-13: Annual PPE Equipment Unit Costs per Worker, by Respirator System

Respirator System	Component	Unit Cost	Useful Life (Years)	Annual Unit Costs	
				Initial	Recurring
APF Factor 10					
APR, Half Mask	Half Mask, (APR)	$22.45	2	$22	$11
	Cartridge Filters (APR)	$20.32	0.01	$2,032	$2,032
			Total	**$2,054**	**$2,043**
APF Factor 25					
PAPR, Loose-Fitting Facepiece	Loose-Fitting Facepiece (PAPR)	$59.03	3	$59	$20
	Cartridge Filters (PAPR)	$12.91	0.02	$646	$646
	PAPR System	$1,175.01	3	$1,175	$392
	Breathing Tube	$60.41	3	$60	$20
			Total	**$1,940**	**$1,077**
SAR, Continuous Flow Mode, Loose-Fitting Facepiece	Loose-Fitting Facepiece (PAPR)	$59.03	3	$59	$20
	Breathing Tube	$164.32	3	$164	$55
	Pump	$1,018.46	7	$1,018	$145
	Pump Installation	$55.74	7	$56	$8
	Pump Inlet Filter	$8.68	0.48	$18	$18
	Pump Outlet Filter	$14.67	0.19	$77	$77
			Total	**$1,393**	**$323**
APF Factor 50					
APR, Full Facepiece	Full Facepiece (APR)	$246.28	2	$246	$123
	Cartridge Filters (APR)	$20.32	0.01	$2,032	$2,032
			Total	**$2,278**	**$2,155**
PAPR, Half Mask	Half Mask	$22.45	3	$22	$7
	Cartridge Filters (PAPR)	$12.91	0.02	$646	$646
	PAPR System Components Kit	$1,175.01	3	$1,175	$392
	Breathing Tube and Airline Hose	$60.41	3	$60	$20
			Total	**$1,903**	**$1,065**

Table C-13: Annual PPE Equipment Unit Costs per Worker, by Respirator System

Respirator System	Component	Unit Cost	Useful Life (Years)	Annual Unit Costs	
				Initial	Recurring
SAR, Continuous Flow Mode, Half Mask	Half Mask	$22.45	3	$22	$7
	Breathing Tube	$164.32	3	$164	$55
	Pump	$1,018.46	7	$1,018	$145
	Pump Installation	$55.74	7	$56	$8
	Pump Inlet Filter	$8.68	0.48	$18	$18
	Pump Outlet Filter	$14.67	0.19	$77	$77
			Total	**$1,356**	**$311**
APF Factor 1,000					
PAPR, Full Facepiece	Full Facepiece	$202.48	3	$202	$67
	PAPR System	$1,175.01	3	$1,175	$392
	Breathing Tube	$60.41	3	$60	$20
	Cartridge Filters (PAPR)	$12.91	0.02	$646	$646
			Total	**$2,083**	**$1,125**
PAPR, Helmet/Hood	Hood	$100.14	3	$100	$33
	PAPR System Components Kit	$1,175.01	3	$1,175	$392
	Breathing Tube	$60.41	3	$60	$20
	Cartridge Filters (PAPR)	$12.91	0.02	$646	$646
			Total	**$1,981**	**$1,091**
SAR, Continuous Flow Mode, Full Facepiece	Full Facepiece	$202.48	3	$202	$67
	Pump (1/4 HP)	$1,018.46	7	$1,018	$145
	Breathing Tube and Airline Hose	$164.32	3	$164	$55
	Pump Installation	$55.74	7	$56	$8
	Pump Inlet Filter	$8.68	0.48	$18	$18
	Pump Outlet Filter	$14.67	0.19	$77	$77
			Total	**$1,536**	**$371**
SAR, Continuous Flow Mode, Helmet/Hood	Hood	$100.14	3	$100	$33
	Pump (3/4 HP)	$1,101.11	7	$1,101	$157
	Breathing Tube and Airline Hose	$164.32	3	$164	$55
	Pump Installation	$55.74	7	$56	$8
	Pump Inlet Filter	$13.07	0.48	$27	$27
	Pump Outlet Filter	$14.67	0.19	$77	$77
			Total	**$1,526**	**$358**

Table C-13: Annual PPE Equipment Unit Costs per Worker, by Respirator System

Respirator System	Component	Unit Cost	Useful Life (Years)	Annual Unit Costs	
				Initial	Recurring
APF Factor 10,000					
SCBA, Positive-pressure Mode, Full Facepiece	Positive-pressure SCBA System (includes full facepiece):	$2,535.81	3	$2,536	$845
	Air Compressor	$6,024.97	16	$6,025	$377
			Total	**$8,561**	**$1,222**
SCBA, Positive-pressure Mode, Helmet/Hood	Positive-pressure SCBA system (includes hood)	$2,775.05	3	$2,775	$925
	Air Compressor	$6,024.97	16	$6,025	$377
			Total	**$8,800**	**$1,302**

9. Baseline Respirator PPE Use

Incremental costs of complying with a respirator PPE requirement are estimated by incorporating the baseline respirator use among affected facilities. The Respiratory Protection Rule specifies that employees exposed to harmful substances must wear respiratory protection if workplace exposure levels are above the specified Permissible Exposure Limit (PEL) for that substance. The suitability of an APF for a workplace is determined by the Maximum Use Concentration (MUC), or the maximum concentration of a substance that an employee will be protected against while wearing a respirator of a given APF. The MUC is calculated by multiplying the APF of a respirator by the exposure limit of a substance (29 CFR 1910.134 (d)(3)(i)(B)).

For example, given a PEL of 100 ppm, a worker can be expected to be protected from concentrations of up to 1,000 ppm while wearing an APF 10 respirator. The APF required for compliance with OSHA's Respiratory Protection Rule is therefore determined by dividing the MUC of a workplace by the PEL. For example, if exposure of a regulated substance is 10,000 ppm, facilities will need to provide workers with a respirator of an APF of 100 to be compliant with the rule.

It is worth noting that a number of factors are taken into account when selecting a respirator, including cost, comfort, compatibility with the facility layout, and mobility requirements of the job. Thus, it is likely that respirator selection is not based solely on required APF or cost alone and that facilities may provide respirators with APFs above what is required.

This analysis uses the Bureau of Labor Statistic's 2001 Respirator Usage in Private Sector Firms (RUPS) survey to estimate the percentage of facilities that use each type of respirator in the baseline (BLS 2003). The RUPS was conducted jointly by the Bureau of Labor Statistics (BLS) and the National Institute of Occupational Safety and Health (NIOSH). The survey was conducted between August 2000 and January 2001, and collected data on the number of private sector establishments that use respirators, as well as the types of respirators they use. The survey was sent to a sample 40,002 establishments (75.5 percent response rate) that is representative of all private sector establishments.

For each industry sector, Table C-14 presents the number and percent of establishments using each type of respirator and the percent of establishments associated with each APF. Note that because the mode used by supplied air or self-contained breathing apparatus systems (continuous flow or pressure demand) is not specified in the survey, it is assumed that establishments are evenly divided between the two modes for each respirator type.

Table C-14: Baseline Respirator Use, by APF

Sector	APF	Respirator Type	Number of Establish-ments	Percent of Establishments Using Respirators	
				Type	APF
Manufacturing	10	APR, Half Mask	28,345	38.58%	38.58%
	25	PAPR, Loose-Fitting Facepiece	511	0.70%	0.70%
		SAR, Continuous Flow Loose-Fitting Facepiece	-	-	
	50	APR, Full Facepiece	15,091	20.54%	26.45%
		PAPR, Half Mask	2,372	3.23%	
		SAR, Continuous Flow Half Mask	1,971	2.68%	
	1,000	PAPR, Full Facepiece	3,398	4.62%	27.59%
		PAPR, Helmet/Hood	5,647	7.69%	
		SAR, Continuous Flow Full Facepiece	2,729	3.71%	

Table C-14: Baseline Respirator Use, by APF

Sector	APF	Respirator Type	Number of Establish-ments	Percent of Establishments Using Respirators	
				Type	APF
		SAR, Continuous Flow Helmet/Hood	8,498	11.57%	
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	2,457	3.34%	6.68%
		SCBA, Positive-pressure Mode, Helmet/Hood	2,457	3.34%	
Construction	10	APR, Half Mask	26,008	37.38%	37.38%
	25	PAPR, Loose-Fitting Facepiece	2,822	4.06%	4.06%
		SAR, Continuous Flow Loose-Fitting Facepiece	-	-	
	50	APR, Full Facepiece	12,834	18.44%	28.78%
		PAPR, Half Mask	5,012	7.20%	
		SAR, Continuous Flow Half Mask	2,184	3.14%	
	1,000	PAPR, Full Facepiece	3,148	4.52%	24.48%
		PAPR, Helmet/Hood	3,164	4.55%	
		SAR, Continuous Flow Full Facepiece	4,020	5.78%	
		SAR, Continuous Flow Helmet/Hood	6,698	9.63%	
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	1,848	2.66%	5.32%
		SCBA, Positive-pressure Mode, Helmet/Hood	1,848	2.66%	
Mining	10	APR, Half Mask	2,052	47.10%	47.10%
	25	PAPR, Loose-Fitting Facepiece	0	0.00%	0.00%
		SAR, Continuous Flow Loose-Fitting Facepiece	-	-	
	50	APR, Full Facepiece	727	16.69%	23.30%
		PAPR, Half Mask	241	5.53%	
		SAR, Continuous Flow Half Mask	47	1.08%	
	1,000	PAPR, Full Facepiece	265	6.08%	20.97%
		PAPR, Helmet/Hood	150	3.44%	
		SAR, Continuous Flow Full Facepiece	137	3.15%	
		SAR, Continuous Flow Helmet/Hood	362	8.30%	
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	188	4.32%	8.64%
		SCBA, Positive-pressure Mode, Helmet/Hood	188	4.32%	
Transportation and Public Utilities	10	APR, Half Mask	4,760	30.19%	30.19%
	25	PAPR, Loose-Fitting Facepiece	124	0.79%	0.79%
		SAR, Continuous Flow Loose-Fitting Facepiece	-	-	
	50	APR, Full Facepiece	2,556	16.21%	21.68%
		PAPR, Half Mask	341	2.16%	
		SAR, Continuous Flow Half Mask	522	3.31%	
	1,000	PAPR, Full Facepiece	810	5.14%	29.79%
		PAPR, Helmet/Hood	796	5.05%	
		SAR, Continuous Flow Full Facepiece	1,373	8.71%	
		SAR, Continuous Flow Helmet/Hood	1,716	10.89%	

Table C-14: Baseline Respirator Use, by APF

Sector	APF	Respirator Type	Number of Establish-ments	Percent of Establishments Using Respirators	
				Type	APF
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	1,384	8.78%	17.56%
		SCBA, Positive-pressure Mode, Helmet/Hood	1,384	8.78%	
Wholesale Trade	10	APR, Half Mask	15,096	38.42%	38.42%
	25	PAPR, Loose-Fitting Facepiece	1,254	3.19%	3.19%
		SAR, Continuous Flow Loose-Fitting Facepiece	-	-	
	50	APR, Full Facepiece	8,637	21.98%	25.90%
		PAPR, Half Mask	814	2.07%	
		SAR, Continuous Flow Half Mask	726	1.85%	
	1,000	PAPR, Full Facepiece	1,979	5.04%	21.40%
		PAPR, Helmet/Hood	2,371	6.03%	
		SAR, Continuous Flow Full Facepiece	1,007	2.56%	
		SAR, Continuous Flow Helmet/Hood	3,055	7.77%	
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	2,178	5.54%	11.08%
		SCBA, Positive-pressure Mode, Helmet/Hood	2,178	5.54%	
Retail Trade	10	APR, Half Mask	10,556	43.46%	43.46%
	25	PAPR, Loose-Fitting Facepiece	2,188	9.01%	9.01%
		SAR, Continuous Flow Loose-Fitting Facepiece	-	-	
	50	APR, Full Facepiece	4,289	17.66%	31.35%
		PAPR, Half Mask	2,270	9.35%	
		SAR, Continuous Flow Half Mask	1,053	4.34%	
	1,000	PAPR, Full Facepiece	800	3.29%	11.65%
		PAPR, Helmet/Hood	630	2.59%	
		SAR, Continuous Flow Full Facepiece	684	2.81%	
		SAR, Continuous Flow Helmet/Hood	720	2.96%	
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	550	2.26%	4.52%
		SCBA, Positive-pressure Mode, Helmet/Hood	550	2.26%	
Services	10	APR, Half Mask	45,508	51.85%	51.85%
	25	PAPR, Loose-Fitting Facepiece	833	0.95%	0.95%
		SAR, Continuous Flow Loose-Fitting Facepiece	-	-	
	50	APR, Full Facepiece	15,753	17.95%	24.68%
		PAPR, Half Mask	2,110	2.40%	
		SAR, Continuous Flow Half Mask	3,800	4.33%	
	1,000	PAPR, Full Facepiece	7,362	8.39%	17.46%
		PAPR, Helmet/Hood	3,157	3.60%	
		SAR, Continuous Flow Full Facepiece	2,410	2.75%	
		SAR, Continuous Flow Helmet/Hood	2,386	2.72%	
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	2,229	2.54%	5.08%

Table C-14: Baseline Respirator Use, by APF

Sector	APF	Respirator Type	Number of Establish-ments	Percent of Establishments Using Respirators	
				Type	APF
		SCBA, Positive-pressure Mode, Helmet/Hood	2,229	2.54%	
Source: BLS (2003)					

Baseline use of PPE in each industry was estimated using the 2001 RUPS survey data (BLS 2003) estimates for the number of establishments using PPE and the 2001 Census County Business Patterns data (U.S. Census Bureau 2001) to estimate the total number of establishments by industry (see Table C-15).

Table C-15: Percent of Baseline PPE Use by Industry

Industry	Percent of Establishments with Baseline PPE Use
Manufacturing	28%
Construction	22%
Mining	34%
Transportation and Public Utilities	12%
Wholesale trade	15%
Retail trade	4%
Service	5%
Sources: (BLS 2003) and (U.S. Census Bureau 2001)	

10. Total Annual Respiratory Program Costs

Table C-16 presents the total initial costs of a PPE program, by respirator system. Table C-17 presents the total annual recurring costs of a PPE program, by respirator system. Both tables cover all seven industry sectors included in the analysis.

Table C-16: Total Initial PPE Costs

Sector	APF	Respirator System	Respirator Program Costs	Equipment Costs	Medical Evaluation Costs	Fit Test Costs	Training Costs	Cleaning Costs	Total Costs
Manufacturing	10	APR, Half Mask	$115	$2,054	$109	$0	$0	$0	$2,279
	25	PAPR, Loose-Fitting Facepiece	$115	$1,940	$109	$0	$0	$0	$2,164
	25	SAR, Loose-Fitting Facepiece	$115	$1,393	$109	$0	$0	$0	$1,617
	50	APR, Full Facepiece	$115	$2,278	$109	$0	$0	$0	$2,502
	50	PAPR, Half Mask	$115	$1,903	$109	$0	$0	$0	$2,128
	50	SAR, Continuous Flow Half Mask	$115	$1,356	$109	$0	$0	$0	$1,580
	1,000	PAPR, Full Facepiece	$115	$2,083	$109	$0	$0	$0	$2,308
	1,000	PAPR, Helmet/Hood	$115	$1,981	$109	$0	$0	$0	$2,205
	1,000	SAR, Continuous Flow Full Facepiece	$115	$1,536	$109	$0	$0	$0	$1,760
	1,000	SAR, Continuous Flow Helmet/Hood	$115	$1,526	$109	$0	$0	$0	$1,750
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	$115	$8,561	$109	$0	$0	$0	$8,785
	10,000	SCBA, Positive-pressure Mode, Helmet/Hood	$115	$8,800	$109	$0	$0	$0	$9,024
Construction	10	APR, Half Mask	$126	$2,054	$116	$0	$0	$0	$2,297
	25	PAPR, Loose-Fitting Facepiece	$126	$1,940	$116	$0	$0	$0	$2,182
	25	SAR, Loose-Fitting Facepiece	$126	$1,393	$116	$0	$0	$0	$1,635
	50	APR, Full Facepiece	$126	$2,278	$116	$0	$0	$0	$2,520
	50	PAPR, Half Mask	$126	$1,903	$116	$0	$0	$0	$2,146
	50	SAR, Continuous Flow Half Mask	$126	$1,356	$116	$0	$0	$0	$1,598
	1,000	PAPR, Full Facepiece	$126	$2,083	$116	$0	$0	$0	$2,326
	1,000	PAPR, Helmet/Hood	$126	$1,981	$116	$0	$0	$0	$2,223
	1,000	SAR, Continuous Flow Full Facepiece	$126	$1,536	$116	$0	$0	$0	$1,779

Table C-16: Total Initial PPE Costs

Sector	APF	Respirator System	Respirator Program Costs	Equipment Costs	Medical Evaluation Costs	Fit Test Costs	Training Costs	Cleaning Costs	Total Costs
	1,000	SAR, Continuous Flow Helmet/Hood	$126	$1,526	$116	$0	$0	$0	$1,768
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	$126	$8,561	$116	$0	$0	$0	$8,803
	10,000	SCBA, Positive-pressure Mode, Helmet/Hood	$126	$8,800	$116	$0	$0	$0	$9,042
Mining	10	APR, Half Mask	$106	$2,054	$116	$0	$0	$0	$2,277
	25	PAPR, Loose-Fitting Facepiece	$106	$1,940	$116	$0	$0	$0	$2,162
	25	SAR, Loose-Fitting Facepiece	$106	$1,393	$116	$0	$0	$0	$1,615
	50	APR, Full Facepiece	$106	$2,278	$116	$0	$0	$0	$2,501
	50	PAPR, Half Mask	$106	$1,903	$116	$0	$0	$0	$2,126
	50	SAR, Continuous Flow Half Mask	$106	$1,356	$116	$0	$0	$0	$1,579
	1,000	PAPR, Full Facepiece	$106	$2,083	$116	$0	$0	$0	$2,306
	1,000	PAPR, Helmet/Hood	$106	$1,981	$116	$0	$0	$0	$2,203
	1,000	SAR, Continuous Flow Full Facepiece	$106	$1,536	$116	$0	$0	$0	$1,759
	1,000	SAR, Continuous Flow Helmet/Hood	$106	$1,526	$116	$0	$0	$0	$1,748
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	$106	$8,561	$116	$0	$0	$0	$8,783
	10,000	SCBA, Positive-pressure Mode, Helmet/Hood	$106	$8,800	$116	$0	$0	$0	$9,022
Transportation and Public Utilities	10	APR, Half Mask	$142	$2,054	$120	$0	$0	$0	$2,316
	25	PAPR, Loose-Fitting Facepiece	$142	$1,940	$120	$0	$0	$0	$2,202
	25	SAR, Loose-Fitting Facepiece	$142	$1,393	$120	$0	$0	$0	$1,655
	50	APR, Full Facepiece	$142	$2,278	$120	$0	$0	$0	$2,540
	50	PAPR, Half Mask	$142	$1,903	$120	$0	$0	$0	$2,165
	50	SAR, Continuous Flow Half Mask	$142	$1,356	$120	$0	$0	$0	$1,618
	1,000	PAPR, Full Facepiece	$142	$2,083	$120	$0	$0	$0	$2,345

Table C-16: Total Initial PPE Costs

Sector	APF	Respirator System	Respirator Program Costs	Equipment Costs	Medical Evaluation Costs	Fit Test Costs	Training Costs	Cleaning Costs	Total Costs
	1,000	PAPR, Helmet/Hood	$142	$1,981	$120	$0	$0	$0	$2,243
	1,000	SAR, Continuous Flow Full Facepiece	$142	$1,536	$120	$0	$0	$0	$1,798
	1,000	SAR, Continuous Flow Helmet/Hood	$142	$1,526	$120	$0	$0	$0	$1,787
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	$142	$8,561	$120	$0	$0	$0	$8,822
	10,000	SCBA, Positive-pressure Mode, Helmet/Hood	$142	$8,800	$120	$0	$0	$0	$9,062
Wholesale Trade	10	APR, Half Mask	$137	$2,054	$106	$0	$0	$0	$2,298
	25	PAPR, Loose-Fitting Facepiece	$137	$1,940	$106	$0	$0	$0	$2,183
	25	SAR, Loose-Fitting Facepiece	$137	$1,393	$106	$0	$0	$0	$1,636
	50	APR, Full Facepiece	$137	$2,278	$106	$0	$0	$0	$2,521
	50	PAPR, Half Mask	$137	$1,903	$106	$0	$0	$0	$2,147
	50	SAR, Continuous Flow Half Mask	$137	$1,356	$106	$0	$0	$0	$1,599
	1,000	PAPR, Full Facepiece	$137	$2,083	$106	$0	$0	$0	$2,327
	1,000	PAPR, Helmet/Hood	$137	$1,981	$106	$0	$0	$0	$2,224
	1,000	SAR, Continuous Flow Full Facepiece	$137	$1,536	$106	$0	$0	$0	$1,780
	1,000	SAR, Continuous Flow Helmet/Hood	$137	$1,526	$106	$0	$0	$0	$1,769
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	$137	$8,561	$106	$0	$0	$0	$8,804
	10,000	SCBA, Positive-pressure Mode, Helmet/Hood	$137	$8,800	$106	$0	$0	$0	$9,043
Retail Trade	10	APR, Half Mask	$155	$2,054	$100	$0	$0	$0	$2,309
	25	PAPR, Loose-Fitting Facepiece	$155	$1,940	$100	$0	$0	$0	$2,194
	25	SAR, Loose-Fitting Facepiece	$155	$1,393	$100	$0	$0	$0	$1,647
	50	APR, Full Facepiece	$155	$2,278	$100	$0	$0	$0	$2,533
	50	PAPR, Half Mask	$155	$1,903	$100	$0	$0	$0	$2,158

Table C-16: Total Initial PPE Costs

Sector	APF	Respirator System	Respirator Program Costs	Equipment Costs	Medical Evaluation Costs	Fit Test Costs	Training Costs	Cleaning Costs	Total Costs
	50	SAR, Continuous Flow Half Mask	$155	$1,356	$100	$0	$0	$0	$1,611
	1,000	PAPR, Full Facepiece	$155	$2,083	$100	$0	$0	$0	$2,338
	1,000	PAPR, Helmet/Hood	$155	$1,981	$100	$0	$0	$0	$2,236
	1,000	SAR, Continuous Flow Full Facepiece	$155	$1,536	$100	$0	$0	$0	$1,791
	1,000	SAR, Continuous Flow Helmet/Hood	$155	$1,526	$100	$0	$0	$0	$1,780
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	$155	$8,561	$100	$0	$0	$0	$8,815
	10,000	SCBA, Positive-pressure Mode, Helmet/Hood	$155	$8,800	$100	$0	$0	$0	$9,054
Services	10	APR, Half Mask	$152	$2,054	$116	$0	$0	$0	$2,323
	25	PAPR, Loose-Fitting Facepiece	$152	$1,940	$116	$0	$0	$0	$2,208
	25	SAR, Loose-Fitting Facepiece	$152	$1,393	$116	$0	$0	$0	$1,661
	50	APR, Full Facepiece	$152	$2,278	$116	$0	$0	$0	$2,546
	50	PAPR, Half Mask	$152	$1,903	$116	$0	$0	$0	$2,172
	50	SAR, Continuous Flow Half Mask	$152	$1,356	$116	$0	$0	$0	$1,624
	1,000	PAPR, Full Facepiece	$152	$2,083	$116	$0	$0	$0	$2,352
	1,000	PAPR, Helmet/Hood	$152	$1,981	$116	$0	$0	$0	$2,249
	1,000	SAR, Continuous Flow Full Facepiece	$152	$1,536	$116	$0	$0	$0	$1,804
	1,000	SAR, Continuous Flow Helmet/Hood	$152	$1,526	$116	$0	$0	$0	$1,794
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	$152	$8,561	$116	$0	$0	$0	$8,829
	10,000	SCBA, Positive-pressure Mode, Helmet/Hood	$152	$8,800	$116	$0	$0	$0	$9,068

Table C-17: Total Annual Recurring PPE Costs

Sector	APF	Respirator System	Respirator Program Costs	Equipment Costs	Medical Evaluation Costs	Fit Test Costs	Training Costs	Cleaning Costs	Total Costs
Manufacturing	10	APR, Half Mask	$121	$2,043	$22	$65	$128	$418	$2,795
	25	PAPR, Loose-Fitting Facepiece	$121	$1,077	$22	$0	$255	$418	$1,892
	25	SAR, Loose-Fitting Facepiece	$121	$323	$22	$0	$255	$418	$1,138
	50	APR, Full Facepiece	$121	$2,155	$22	$65	$128	$418	$2,907
	50	PAPR, Half Mask	$121	$1,065	$22	$152	$255	$418	$2,031
	50	SAR, Continuous Flow Half Mask	$121	$311	$22	$152	$255	$418	$1,278
	1,000	PAPR, Full Facepiece	$121	$1,125	$22	$152	$255	$418	$2,091
	1,000	PAPR, Helmet/Hood	$121	$1,091	$22	$152	$255	$418	$2,057
	1,000	SAR, Continuous Flow Full Facepiece	$121	$371	$22	$152	$255	$418	$1,338
	1,000	SAR, Continuous Flow Helmet/Hood	$121	$358	$22	$152	$255	$418	$1,325
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	$121	$1,222	$22	$152	$510	$418	$2,444
	10,000	SCBA, Positive-pressure Mode, Helmet/Hood	$121	$1,302	$22	$152	$510	$418	$2,523
Construction	10	APR, Half Mask	$131	$2,043	$23	$74	$147	$530	$2,948
	25	PAPR, Loose-Fitting Facepiece	$131	$1,077	$23	$0	$293	$530	$2,055
	25	SAR, Loose-Fitting Facepiece	$131	$323	$23	$0	$293	$530	$1,301
	50	APR, Full Facepiece	$131	$2,155	$23	$74	$147	$530	$3,060
	50	PAPR, Half Mask	$131	$1,065	$23	$173	$293	$530	$2,216
	50	SAR, Continuous Flow Half Mask	$131	$311	$23	$173	$293	$530	$1,462
	1,000	PAPR, Full Facepiece	$131	$1,125	$23	$173	$293	$530	$2,276
	1,000	PAPR, Helmet/Hood	$131	$1,091	$23	$173	$293	$530	$2,241
	1,000	SAR, Continuous Flow Full Facepiece	$131	$371	$23	$173	$293	$530	$1,522
	1,000	SAR, Continuous Flow Helmet/Hood	$131	$358	$23	$173	$293	$530	$1,509

Table C-17: Total Annual Recurring PPE Costs

Sector	APF	Respirator System	Respirator Program Costs	Equipment Costs	Medical Evaluation Costs	Fit Test Costs	Training Costs	Cleaning Costs	Total Costs
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	$131	$1,222	$23	$173	$586	$530	$2,666
	10,000	SCBA, Positive-pressure Mode, Helmet/Hood	$131	$1,302	$23	$173	$586	$530	$2,745
Mining	10	APR, Half Mask	$111	$2,043	$23	$74	$147	$530	$2,928
	25	PAPR, Loose-Fitting Facepiece	$111	$1,077	$23	$0	$293	$530	$2,034
	25	SAR, Loose-Fitting Facepiece	$111	$323	$23	$0	$293	$530	$1,280
	50	APR, Full Facepiece	$111	$2,155	$23	$74	$147	$530	$3,040
	50	PAPR, Half Mask	$111	$1,065	$23	$173	$293	$530	$2,195
	50	SAR, Continuous Flow Half Mask	$111	$311	$23	$173	$293	$530	$1,441
	1,000	PAPR, Full Facepiece	$111	$1,125	$23	$173	$293	$530	$2,255
	1,000	PAPR, Helmet/Hood	$111	$1,091	$23	$173	$293	$530	$2,221
	1,000	SAR, Continuous Flow Full Facepiece	$111	$371	$23	$173	$293	$530	$1,501
	1,000	SAR, Continuous Flow Helmet/Hood	$111	$358	$23	$173	$293	$530	$1,488
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	$111	$1,222	$23	$173	$586	$530	$2,645
	10,000	SCBA, Positive-pressure Mode, Helmet/Hood	$111	$1,302	$23	$173	$586	$530	$2,725
Transportation and Public Utilities	10	APR, Half Mask	$148	$2,043	$24	$79	$157	$580	$3,031
	25	PAPR, Loose-Fitting Facepiece	$148	$1,077	$24	$0	$314	$580	$2,142
	25	SAR, Loose-Fitting Facepiece	$148	$323	$24	$0	$314	$580	$1,389
	50	APR, Full Facepiece	$148	$2,155	$24	$79	$157	$580	$3,143
	50	PAPR, Half Mask	$148	$1,065	$24	$183	$314	$580	$2,313
	50	SAR, Continuous Flow Half Mask	$148	$311	$24	$183	$314	$580	$1,559
	1,000	PAPR, Full Facepiece	$148	$1,125	$24	$183	$314	$580	$2,373
	1,000	PAPR, Helmet/Hood	$148	$1,091	$24	$183	$314	$580	$2,339

Table C-17: Total Annual Recurring PPE Costs

Sector	APF	Respirator System	Respirator Program Costs	Equipment Costs	Medical Evaluation Costs	Fit Test Costs	Training Costs	Cleaning Costs	Total Costs
	1,000	SAR, Continuous Flow Full Facepiece	$148	$371	$24	$183	$314	$580	$1,619
	1,000	SAR, Continuous Flow Helmet/Hood	$148	$358	$24	$183	$314	$580	$1,606
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	$148	$1,222	$24	$183	$627	$580	$2,784
	10,000	SCBA, Positive-pressure Mode, Helmet/Hood	$148	$1,302	$24	$183	$627	$580	$2,863
Wholesale Trade	10	APR, Half Mask	$143	$2,043	$21	$52	$102	$380	$2,740
	25	PAPR, Loose-Fitting Facepiece	$143	$1,077	$21	$0	$203	$380	$1,824
	25	SAR, Loose-Fitting Facepiece	$143	$323	$21	$0	$203	$380	$1,070
	50	APR, Full Facepiece	$143	$2,155	$21	$52	$102	$380	$2,852
	50	PAPR, Half Mask	$143	$1,065	$21	$144	$203	$380	$1,956
	50	SAR, Continuous Flow Half Mask	$143	$311	$21	$144	$203	$380	$1,202
	1,000	PAPR, Full Facepiece	$143	$1,125	$21	$144	$203	$380	$2,016
	1,000	PAPR, Helmet/Hood	$143	$1,091	$21	$144	$203	$380	$1,982
	1,000	SAR, Continuous Flow Full Facepiece	$143	$371	$21	$144	$203	$380	$1,262
	1,000	SAR, Continuous Flow Helmet/Hood	$143	$358	$21	$144	$203	$380	$1,249
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	$143	$1,222	$21	$144	$406	$380	$2,316
	10,000	SCBA, Positive-pressure Mode, Helmet/Hood	$143	$1,302	$21	$144	$406	$380	$2,396
Retail Trade	10	APR, Half Mask	$162	$2,043	$20	$35	$69	$285	$2,614
	25	PAPR, Loose-Fitting Facepiece	$162	$1,077	$20	$0	$138	$285	$1,682
	25	SAR, Loose-Fitting Facepiece	$162	$323	$20	$0	$138	$285	$928
	50	APR, Full Facepiece	$162	$2,155	$20	$35	$69	$285	$2,726
	50	PAPR, Half Mask	$162	$1,065	$20	$126	$138	$285	$1,796

Table C-17: Total Annual Recurring PPE Costs

Sector	APF	Respirator System	Respirator Program Costs	Equipment Costs	Medical Evaluation Costs	Fit Test Costs	Training Costs	Cleaning Costs	Total Costs
	50	SAR, Continuous Flow Half Mask	$162	$311	$20	$126	$138	$285	$1,042
	1,000	PAPR, Full Facepiece	$162	$1,125	$20	$126	$138	$285	$1,856
	1,000	PAPR, Helmet/Hood	$162	$1,091	$20	$126	$138	$285	$1,822
	1,000	SAR, Continuous Flow Full Facepiece	$162	$371	$20	$126	$138	$285	$1,102
	1,000	SAR, Continuous Flow Helmet/Hood	$162	$358	$20	$126	$138	$285	$1,089
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	$162	$1,222	$20	$126	$277	$285	$2,091
	10,000	SCBA, Positive-pressure Mode, Helmet/Hood	$162	$1,302	$20	$126	$277	$285	$2,171
Services	10	APR, Half Mask	$159	$2,043	$23	$75	$148	$519	$2,967
	25	PAPR, Loose-Fitting Facepiece	$159	$1,077	$23	$0	$295	$519	$2,074
	25	SAR, Loose-Fitting Facepiece	$159	$323	$23	$0	$295	$519	$1,320
	50	APR, Full Facepiece	$159	$2,155	$23	$75	$148	$519	$3,079
	50	PAPR, Half Mask	$159	$1,065	$23	$171	$295	$519	$2,233
	50	SAR, Continuous Flow Half Mask	$159	$311	$23	$171	$295	$519	$1,479
	1,000	PAPR, Full Facepiece	$159	$1,125	$23	$171	$295	$519	$2,293
	1,000	PAPR, Helmet/Hood	$159	$1,091	$23	$171	$295	$519	$2,259
	1,000	SAR, Continuous Flow Full Facepiece	$159	$371	$23	$171	$295	$519	$1,539
	1,000	SAR, Continuous Flow Helmet/Hood	$159	$358	$23	$171	$295	$519	$1,526
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	$159	$1,222	$23	$171	$590	$519	$2,685
	10,000	SCBA, Positive-pressure Mode, Helmet/Hood	$159	$1,302	$23	$171	$590	$519	$2,765

11. Annual Incremental Respirator PPE Costs

Facilities that do not provide PPE in the baseline are assumed to incur the total costs for implementing a respirator program with the APF level required under TSCA. These costs are estimated as the weighted average of the costs presented in Table C-16 and Table C-17 for each given APF and industry sector, using the percentages presented in Table C-14 to weight the different respirator systems with the same APF.

Facilities with a baseline respirator program are assumed to incur incremental costs if they are required to switch to respirators with a higher APF or to switch from purified air respirators to supplied air respirators. Facilities that are already using respirators compliant with the TSCA requirements are not assumed to incur any costs. Estimated baseline respirator costs for facilities that must switch to compliant respirators is estimated as the weighted average of the costs of respirators that can no longer be used, using the percentages presented in Table C-14 to weight the costs of the different respirator systems. Respirators that can no longer be used include those with APFs below the requirements or respirators that use purified air when supplied air respirators are required.

Note that the costs of using higher APF respirators are sometimes lower than costs of using lower APF respirators. This is generally the case when comparing purified air respirators with supplied air respirators because the filters used in purified air respirators are relatively expensive. These purified air respirators are still often preferred, despite their higher costs, because they are more comfortable to wear (with a supplied air respirator the workers are either carrying a relatively heavy tank or are tethered to the hose that is supplying the air). However, when the estimated costs of compliant respirators are lower than the cost of the baseline respirators, the incremental costs of the compliant respirators are assumed to be zero (rather than assuming a cost savings).

Table C-18 presents the initial incremental PPE costs for purified or supplied air. Table C-19 presents the annual incremental recurring PPE costs of purified or supplied air. Table C-20 presents the initial incremental PPE costs for supplied air only. Table C-21 presents the annual incremental recurring PPE costs for supplied air only. All four tables cover the seven industry sectors included in the analysis.

Table C-18: Incremental PPE Costs, Purified or Supplied Air, Initial Costs

Sector	APF	Baseline Percentage of No Use	Baseline No Use Cost	Baseline Use Cost	Average Incremental APF Cost
Manufacturing	10	72%	$2,279	$0	$1,634
	25		$2,164	$0	$1,552
	50		$2,363	$52	$1,710
	1,000		$1,972	$0	$1,414
	10,000		$8,905	$6,246	$8,153
Construction	10	78%	$2,297	$0	$1,796
	25		$2,182	$0	$1,706
	50		$2,326	$24	$1,824
	1,000		$1,958	$0	$1,531
	10,000		$8,923	$6,353	$8,362
Mining	10	66%	$2,277	$0	$1,500
	25		$2,162	$0	$1,424
	50		$2,369	$62	$1,581
	1,000		$1,986	$0	$1,308
	10,000		$8,903	$6,093	$7,944
Transportation and Public Utilities	10	88%	$2,316	$0	$2,043
	25		$2,202	$0	$1,942
	50		$2,362	$29	$2,086
	1,000		$1,964	$0	$1,732
	10,000		$8,942	$5,558	$8,543
Wholesale Trade	10	85%	$2,298	$0	$1,957
	25		$2,183	$0	$1,860
	50		$2,426	$84	$2,079
	1,000		$2,030	$0	$1,729
	10,000		$8,924	$5,920	$8,479
Retail Trade	10	96%	$2,309	$0	$2,221
	25		$2,194	$0	$2,111
	50		$2,293	$3	$2,206
	1,000		$2,041	$0	$1,964
	10,000		$8,935	$6,373	$8,837
Services	10	95%	$2,323	$0	$2,201
	25		$2,208	$0	$2,093
	50		$2,348	$19	$2,227
	1,000		$2,157	$0	$2,045
	10,000		$8,949	$6,313	$8,811

Table C-19: Incremental PPE Costs, Purified or Supplied Air, Recurring Costs

Sector	APF	Baseline Percentage of No Use	Baseline No Use Cost	Baseline Use Cost	Average Incremental APF Cost
Manufacturing	10	72%	$2,795	$0	$2,005
	25		$1,892	$0	$1,357
	50		$2,635	$0	$1,890
	1,000		$1,659	$0	$1,190
	10,000		$2,483	$71	$1,801
Construction	10	78%	$2,948	$0	$2,305
	25		$2,055	$0	$1,607
	50		$2,675	$0	$2,091
	1,000		$1,790	$0	$1,399
	10,000		$2,706	$169	$2,152
Mining	10	66%	$2,928	$0	$1,928
	25		$2,034	$0	$1,340
	50		$2,765	$0	$1,821
	1,000		$1,832	$0	$1,207
	10,000		$2,685	$46	$1,784
Transportation and Public Utilities	10	88%	$3,031	$0	$2,673
	25		$2,142	$0	$1,890
	50		$2,818	$0	$2,486
	1,000		$1,866	$0	$1,646
	10,000		$2,823	$229	$2,517
Wholesale Trade	10	85%	$2,740	$0	$2,335
	25		$1,824	$0	$1,554
	50		$2,663	$0	$2,268
	1,000		$1,638	$0	$1,395
	10,000		$2,356	$0	$2,007
Retail Trade	10	96%	$2,614	$0	$2,515
	25		$1,682	$0	$1,618
	50		$2,216	$0	$2,131
	1,000		$1,472	$0	$1,415
	10,000		$2,131	$0	$2,050
Services	10	95%	$2,967	$0	$2,812
	25		$2,074	$0	$1,965
	50		$2,716	$0	$2,574
	1,000		$2,047	$0	$1,940
	10,000		$2,725	$1	$2,582

Table C-20: Incremental PPE Costs, Supplied Air Only, Initial Costs

Sector	APF	Baseline Percentage of No Use	Baseline No Use Cost	Baseline Use Cost	Average Incremental APF Cost
Manufacturing	25	72%	$1,617	$0	$1,160
	50		$1,580	$0	$1,134
	1,000		$1,752	$0	$1,257
	10,000		$8,905	$6,694	$8,279
Construction	25	78%	$1,635	$0	$1,279
	50		$1,598	$0	$1,250
	1,000		$1,772	$0	$1,386
	10,000		$8,923	$6,709	$8,440
Mining	25	66%	$1,615	$0	$1,064
	50		$1,579	$0	$1,040
	1,000		$1,751	$0	$1,153
	10,000		$8,903	$6,669	$8,140
Transportation and Public Utilities	25	88%	$1,655	$0	$1,459
	50		$1,618	$0	$1,427
	1,000		$1,792	$0	$1,581
	10,000		$8,942	$6,742	$8,682
Wholesale Trade	25	85%	$1,636	$0	$1,394
	50		$1,599	$0	$1,363
	1,000		$1,772	$0	$1,509
	10,000		$8,924	$6,657	$8,588
Retail Trade	25	96%	$1,647	$0	$1,585
	50		$1,611	$0	$1,549
	1,000		$1,785	$0	$1,717
	10,000		$8,935	$6,675	$8,849
Services	25	95%	$1,661	$0	$1,574
	50		$1,624	$0	$1,540
	1,000		$1,799	$0	$1,705
	10,000		$8,949	$6,651	$8,829

Table C-21: Incremental PPE Costs, Supplied Air Only, Recurring Costs

Sector	APF	Baseline Percentage of No Use	Baseline No Use Cost	Baseline Use Cost	Average Incremental APF Cost
Manufacturing	25	72%	$1,138	$0	$816
	50		$1,278	$0	$916
	1,000		$1,328	$0	$952
	10,000		$2,483	$76	$1,803
Construction	25	78%	$1,301	$0	$1,017
	50		$1,462	$0	$1,143
	1,000		$1,514	$0	$1,184
	10,000		$2,706	$178	$2,154
Mining	25	66%	$1,280	$0	$843
	50		$1,441	$0	$949
	1,000		$1,492	$0	$982
	10,000		$2,685	$50	$1,786
Transportation and Public Utilities	25	88%	$1,389	$0	$1,225
	50		$1,559	$0	$1,375
	1,000		$1,612	$0	$1,421
	10,000		$2,823	$278	$2,523
Wholesale Trade	25	85%	$1,070	$0	$912
	50		$1,202	$0	$1,024
	1,000		$1,252	$0	$1,067
	10,000		$2,356	$0	$2,007
Retail Trade	25	96%	$928	$0	$893
	50		$1,042	$0	$1,002
	1,000		$1,095	$0	$1,054
	10,000		$2,131	$0	$2,050
Services	25	95%	$1,320	$0	$1,251
	50		$1,479	$0	$1,402
	1,000		$1,532	$0	$1,452
	10,000		$2,725	$1	$2,582

As noted previously, when the estimated costs of compliant respirators are lower than the cost of the baseline respirators, the incremental costs of the compliant respirators are assumed to be zero (see Table C-18 to Table C-21). We present alternative incremental cost estimates in Table C-22 through Table C-25, which include all costs savings from switching to higher APF respirators in the incremental cost estimates.

Table C-22: Alternative Incremental PPE Costs (includes cost savings where more protective PPE has lower costs), Purified or Supplied Air, Initial Costs

Sector	APF	Baseline Percentage of No Use	Baseline No Use Cost	Baseline Use Cost	Average Incremental APF Cost
Manufacturing	10	72%	$2,279	$0	$1,634
	25		$2,164	($112)	$1,520
	50		$2,363	$52	$1,710
	1,000		$1,972	($239)	$1,346
	10,000		$8,905	$6,246	$8,153
Construction	10	78%	$2,297	$0	$1,796
	25		$2,182	($103)	$1,684
	50		$2,326	$24	$1,824
	1,000		$1,958	($255)	$1,475
	10,000		$8,923	$6,353	$8,362
Mining	10	66%	$2,277	$0	$1,500
	25		$2,162	($115)	$1,385
	50		$2,369	$62	$1,581
	1,000		$1,986	($248)	$1,224
	10,000		$8,903	$6,093	$7,944
Transportation and Public Utilities	10	88%	$2,316	$0	$2,043
	25		$2,202	($112)	$1,929
	50		$2,362	$29	$2,086
	1,000		$1,964	($236)	$1,704
	10,000		$8,942	$5,558	$8,543
Wholesale Trade	10	85%	$2,298	$0	$1,957
	25		$2,183	($106)	$1,844
	50		$2,426	$84	$2,079
	1,000		$2,030	($237)	$1,694
	10,000		$8,924	$5,920	$8,479
Retail Trade	10	96%	$2,309	$0	$2,221
	25		$2,194	($95)	$2,107
	50		$2,293	$3	$2,206
	1,000		$2,041	($219)	$1,955
	10,000		$8,935	$6,373	$8,837
Services	10	95%	$2,323	$0	$2,201
	25		$2,208	($112)	$2,087
	50		$2,348	$19	$2,227
	1,000		$2,157	($140)	$2,037
	10,000		$8,949	$6,313	$8,811

Table C-23: Alternative Incremental PPE Costs (includes cost savings where more protective PPE has lower costs), Purified or Supplied Air, Recurring Costs

Sector	APF	Baseline Percentage of No Use	Baseline No Use Cost	Baseline Use Cost	Average Incremental APF Cost
Manufacturing	10	72%	$2,795	$0	$2,005
	25		$1,892	($887)	$1,106
	50		$2,635	($86)	$1,866
	1,000		$1,659	($748)	$978
	10,000		$2,483	$71	$1,801
Construction	10	78%	$2,948	$0	$2,305
	25		$2,055	($806)	$1,431
	50		$2,675	($110)	$2,067
	1,000		$1,790	($738)	$1,238
	10,000		$2,706	$169	$2,152
Mining	10	66%	$2,928	$0	$1,928
	25		$2,034	($894)	$1,035
	50		$2,765	($109)	$1,784
	1,000		$1,832	($802)	$933
	10,000		$2,685	$46	$1,784
Transportation and Public Utilities	10	88%	$3,031	$0	$2,673
	25		$2,142	($866)	$1,787
	50		$2,818	($112)	$2,473
	1,000		$1,866	($679)	$1,566
	10,000		$2,823	$229	$2,517
Wholesale Trade	10	85%	$2,740	$0	$2,335
	25		$1,824	($846)	$1,429
	50		$2,663	($5)	$2,268
	1,000		$1,638	($782)	$1,280
	10,000		$2,356	($56)	$1,999
Retail Trade	10	96%	$2,614	$0	$2,515
	25		$1,682	($772)	$1,588
	50		$2,216	($149)	$2,125
	1,000		$1,472	($784)	$1,386
	10,000		$2,131	($119)	$2,045
Services	10	95%	$2,967	$0	$2,812
	25		$2,074	($877)	$1,920
	50		$2,716	($160)	$2,566
	1,000		$2,047	($676)	$1,905
	10,000		$2,725	$1	$2,582

Table C-24: Alternative Incremental PPE Costs (includes cost savings where more protective PPE has lower costs), Supplied Air Only, Initial Costs

Sector	APF	Baseline Percentage of No Use	Baseline No Use Cost	Baseline Use Cost	Average Incremental APF Cost
Manufacturing	25	72%	$1,617	($709)	$959
	50		$1,580	($746)	$923
	1,000		$1,752	($548)	$1,102
	10,000		$8,905	$6,694	$8,279
Construction	25	78%	$1,635	($693)	$1,127
	50		$1,598	($729)	$1,091
	1,000		$1,772	($527)	$1,271
	10,000		$8,923	$6,709	$8,440
Mining	25	66%	$1,615	($697)	$826
	50		$1,579	($734)	$789
	1,000		$1,751	($552)	$965
	10,000		$8,903	$6,669	$8,140
Transportation and Public Utilities	25	88%	$1,655	($712)	$1,375
	50		$1,618	($748)	$1,339
	1,000		$1,792	($535)	$1,517
	10,000		$8,942	$6,742	$8,682
Wholesale Trade	25	85%	$1,636	($713)	$1,288
	50		$1,599	($750)	$1,252
	1,000		$1,772	($560)	$1,426
	10,000		$8,924	$6,657	$8,588
Retail Trade	25	96%	$1,647	($678)	$1,559
	50		$1,611	($715)	$1,522
	1,000		$1,785	($506)	$1,698
	10,000		$8,935	$6,675	$8,849
Services	25	95%	$1,661	($703)	$1,538
	50		$1,624	($740)	$1,501
	1,000		$1,799	($529)	$1,678
	10,000		$8,949	$6,651	$8,829

Table C-25: Alternative Incremental PPE Costs (includes cost savings where more protective PPE has lower costs), Supplied Air Only, Recurring Costs

Sector	APF	Baseline Percentage of No Use	Baseline No Use Cost	Baseline Use Cost	Average Incremental APF Cost
Manufacturing	25	72%	$1,138	($1,528)	$384
	50		$1,278	($1,389)	$524
	1,000		$1,328	($1,291)	$587
	10,000		$2,483	$76	$1,803
Construction	25	78%	$1,301	($1,475)	$695
	50		$1,462	($1,315)	$856
	1,000		$1,514	($1,211)	$919
	10,000		$2,706	$178	$2,154
Mining	25	66%	$1,280	($1,537)	$319
	50		$1,441	($1,376)	$480
	1,000		$1,492	($1,307)	$536
	10,000		$2,685	$50	$1,786
Transportation and Public Utilities	25	88%	$1,389	($1,519)	$1,045
	50		$1,559	($1,349)	$1,216
	1,000		$1,612	($1,225)	$1,277
	10,000		$2,823	$278	$2,523
Wholesale Trade	25	85%	$1,070	($1,536)	$684
	50		$1,202	($1,404)	$816
	1,000		$1,252	($1,321)	$871
	10,000		$2,356	($63)	$1,998
Retail Trade	25	96%	$928	($1,468)	$837
	50		$1,042	($1,354)	$951
	1,000		$1,095	($1,235)	$1,006
	10,000		$2,131	($125)	$2,045
Services	25	95%	$1,320	($1,544)	$1,170
	50		$1,479	($1,385)	$1,329
	1,000		$1,532	($1,264)	$1,386
	10,000		$2,725	$1	$2,582

12. Appendix C References

3M. (2015). "Service Life Calculation Software." Retrieved June 22, 2015, from http://extra8.3m.com/SLSWeb/submitChemicalInfoSLife.html.

3M. (2019). "OSHA Respirator Medical Evaluation Questionnaire." Retrieved March 22, 2019, from https://www.3m.com/3M/en_US/safety-centers-of-expertise-us/respiratory-protection/respirator-medical-evaluations/.

29 CFR 1910.134 (d)(3)(i)(B) Respiratory Protection Standard. Occupational Safety and Health Administration (OSHA).

Eastern Research Group (ERG) (2003). Support for an Economic Analysis of a Proposed OSHA Standard for Assigned Protection Factors for Respirators: Final Report; as prepared for OSHA, OSHA, Office of Regulatory Analysis, U.S. Department of Labor. 2015**:** TASK Order NO. 51, Option-Year Fourt Contract NO. J-59-F-59-0010.

Koo, W. L. (2015). Determining the Economic Value of Preventative Maintenance. Jones Lang LaSalle. T. V. Hoy.

MST Inc. (2001). "Instruction Manual Fresh-Air Pump Model 8050501."

National Institute for Occupational Safety and Health (NIOSH). (2012, August 22, 2012). "Certified Equipment List. Definitions of Terms." Retrieved April 2, 2019, from https://www2a.cdc.gov/drds/cel/def.htm.

Northern Safety & Industrial. (2016). "Allegro(R) 1-Worker 1/4 HP Ambient Air Pumpt." Supplied Air Airline Respirators & Ambient Air Pumps Retrieved January 8th, 2016, 2016, from https://www.northernsafety.com/Product/3589/Allegro-1-Worker-1-4-HP-Ambient-Air-Pump.

Occupational Safety and Health Administration (OSHA) (1996). "Final Economic and Regulatory Flexibility Analaysis for OSHA's Standard for Occupational Exposure to Methylene Chloride." 135-137.

Occupational Safety and Health Administration (OSHA) (2010). III. Costs of Compliance. Docket H054A Ex. 50-2-3**:** 25-29.

Occupational Safety and Health Administration (OSHA). (2015). "Respirator Fit Testing." from https://www.osha.gov/video/respiratory_protection/fittesting_transcript.html.

Occupational Safety and Health Administration (OSHA) (2016). Beryllium Final Economic Analysis (FEA) and Final Regulatory Flexibility Analysis. OSHA-H005C-2006-0870-2042.

U.S. Bureau of Labor Statistics (BLS) (2003). Respirator Usage in Private Sector Firms, 2001. National Institute for Occupational Safety and Health (NIOSH).

U.S. Bureau of Labor Statistics (BLS) (2023a). BLS Occupational Employment Statistics (Occupational Employment and Wages), For May 2022.

U.S. Bureau of Labor Statistics (BLS) (2023b). Consumer Price Index - All Urban Consumers (Current Series). CUUR0000SAM2,CUUS0000SAM2. Medical care services in U.s. city average, all urban consumers.

U.S. Bureau of Labor Statistics (BLS) (2023c). Employer Costs for Employee Compensation (ECEC) Supplementary Tables, for June 2022.

U.S. Bureau of Labor Statistics (BLS) (2023d). Employer Costs for Employee Compensation. Table 4. Private industry workers by occupational and industry group. December 2022.

U.S. Bureau of Labor Statistics (BLS) (2023e). May 2022 Occupational Employment and Wage Statistics (OEWS).

U.S. Census Bureau. (2001). "2001 County Business Patterns (NAICS)." Retrieved April 9, 2019.

U.S. Department of Energy (DOE) (1999). DOE-HDBK-1122-99: Site Academic Training Study Guide Phase I; Module 2.07 - Respiratory Protection.

U.S. Environmental Protection Agency (EPA) (2020a). EPA Valuing Time Handbook - 2020.

U.S. Environmental Protection Agency (EPA) (2020b). Handbook on Valuing Changes in Time Use Induced by Regulatory Requirements and Other EPA Actions. EPA-236-B-15-001. National Center for Environmental Economics.