

# Identifying Potential Inhalation and Hearing Hazards In Abrasive Blasting Operations

A Supplement to “The Use of Personal Protective Equipment and Regulations & Standards Affecting Safe Abrasive Blasting”

**CLEMCO**®  
INDUSTRIES CORP.

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# **Identifying Potential Inhalation and Hearing Hazards in Abrasive Blasting Operations**

This article supplements the article entitled “The Use of Personal Protective Equipment and Regulations and Standards Affecting Safe Abrasive Blasting,” published by Clemco Industries Corp., appearing on [www.clemcoindustries.com](http://www.clemcoindustries.com). This supplement focuses on protecting workers from exposure to inhalation and noise hazards during surface preparation work in coating operations. For easy reference, a guide to common acronyms and terms appears at the end of this article.

This article discusses:

- **Inhalation Hazards**
  - Inhalation Hazards from the Treated Surface  
Paint, Epoxy, Heavy Metals
  - Inhalation Hazards from Abrasives  
Sand, Coal Slags, Steel Grit
  - Inhalation Hazards from Breathing Air  
Carbon Monoxide, Oil, Odors, Mist, Breathing-air Requirements
  - OSHA Requirements for NIOSH-approved Supplied-air Respirators
- **Hearing Hazards and Protection**
  - Noise Generated by Blasting
  - Understanding Noise Reduction Ratings (NRR)
  - OSHA Guidelines for Calculating Hearing Protection

## **Inhalation Hazards**

### Inhalation Hazards from Treated Surfaces:

Sources of inhalation hazards from surfaces being treated are:

- The base surface—commonly metal, concrete, plastic, composite, or wood
- The protective coatings or surface contaminants present on the surface—rust, primer, etc.

29 CFR 1910, Subpart Z, “Toxic and Hazardous Substances” describes the OSHA standards for protecting workers from inhalation hazards. To fully understand the OSHA regulation, the reader should visit <http://osha.gov>, click on the “Regulation” tab and page down to Section 1910 of the General Industry Standard.

## Base Surface

Contractors using abrasive blasting to prepare surfaces for coatings can expect exposures to many inhalation hazards from the base surface; the hazards are discussed in the following sections of Subpart Z:

Base Surface	Inhalation Hazard	OSHA Subpart Z Citation	PEL	
Concrete	Silica Sand	1910.1000 Table Z-3	10mg/m <sup>3</sup> /%SiO <sub>2</sub> +2	
	Asbestos	1910.1001 & 1926.1101	0.1 f/cm <sup>3</sup>	
	Portland Cement	1910.1000 Table Z-1	5 mg/m <sup>3</sup>	
Marble	Silicates(<1%Silica)	1910.1000 Table Z-3	20 mpp/ft <sup>3</sup>	
	Mica			
	Soapstone			
	Talc			
	Nuisance Dust	1910.1000 Table Z-3	5 gm/m <sup>3</sup>	
	Marble	1910.1000 Table Z-1	5 mg/m <sup>3</sup>	
	Metal	Aluminum	1910.1000 Table Z-1	5 mg/m <sup>3</sup>
		Beryllium	1910.1000 Table Z-2	2 µg/m <sup>3</sup>
		Cadmium	1910.1027	5 µg/m <sup>3</sup>
		Chromium II or III	1910.1000 Table Z-1	0.5 mg/m <sup>3</sup>
Chromium IV		1910.1026	5 µg/m <sup>3</sup>	
Cobalt		1910.1000 Table Z-1	0.1 mg/m <sup>3</sup>	
Copper		1910.1000 Table Z-1	0.1 mg/m <sup>3</sup>	
Lead		1910.1025	50 µg/m <sup>3</sup>	
Magnesium		1910.1000 Table Z-1	15 mg/m <sup>3</sup>	
Nickel		1910.1000 Table Z-1	1 mg/m <sup>3</sup>	
Silver		1910.1000 Table Z-1	0.1 mg/m <sup>3</sup>	
Tin		1910.1000 Table Z-1	5 mg/m <sup>3</sup>	
Titanium		1910.1000 Table Z-1	5 mg/m <sup>3</sup>	
Uranium		1910.1000 Table Z-1	0.25 mg/m <sup>3</sup>	
Vanadium		1910.1000 Table Z-1	0.5mg/m <sup>3</sup>	
Zinc		1910.1000 Table Z-1	5 mg/m <sup>3</sup>	
Zirconium		1910.1000 Table Z-1	5 mg/m <sup>3</sup>	
Stone	See Concrete			
Composites	Must obtain MSDS to determine components of composite			

## Protective Coatings or Surface Contaminants

Coatings and surface contaminants also present inhalation hazards. The best method to determine what these hazards are is to obtain the Material Safety Data Sheet (MSDS) for the coatings to be removed. Frequently, a contractor does not or cannot obtain the MSDS; in such cases, general knowledge or chemical analysis must be used. The most common inhalation hazards associated with coatings and contaminants include:

Surfaces	Inhalation Hazard	OSHA Subpart Z Citation	PEL
Contaminants	Nuisance Dust	1910.1000 Table Z-3	5 mg/m <sup>3</sup>
	Oils, Mist, Minerals	1910.1000 Table Z-1	5 mg/m <sup>3</sup>
	Oxidation (Rust)	Listed at Nuisance Dust	5 mg/m <sup>3</sup>

Coatings	Lead	1910.1025	50 µg/m <sup>3</sup>
	Cadmium	1910.1027	5 µg/m <sup>3</sup>
	Chromium II or III	1910.1000 Table Z-1	0.5 mg/m <sup>3</sup>
	Chromium IV	1910.1026	5 µg/m <sup>3</sup>
	Zinc	1910.1000 Table Z-1	5 mg/m <sup>3</sup>

### Inhalation Hazards from Abrasives:

Surfaces treatment operations commonly employ dozens of types of abrasives, which present specific hazards to the worker; these hazards can be identified by consulting the Material Safety Data Sheet. The majority of construction and outdoor surface preparation operations use but a few different types of abrasives, such as:

Abrasive	Inhalation Hazard	OSHA Subpart Z Citation	PEL
Sand	Free Silica	1910.1000 Table Z-3	10mg/m <sup>3</sup> /%SiO <sub>2</sub> +2
Crush Glass	Nuisance Dust	1910.1000 Table Z-3	5 mg/m <sup>3</sup>
Garnet	Nuisance Dust	1910.1000 Table Z-3	5 mg/m <sup>3</sup>
Coal Slag	Aluminum Oxide	1910.1000 Table Z-1	10 mg/m <sup>3</sup>
	Ferric Oxide	1910.1000 Table Z-1	5 mg/m <sup>3</sup>
	Amorphous Silica	1910.1000 Table Z-3	80mg/m <sup>3</sup> /%SiO <sub>2</sub>
	Calcium Oxide	1910.1000 Table Z-1	5 mg/m <sup>3</sup>
	Magnesium Oxide	1910.1000 Table Z-1	10 mg/m <sup>3</sup>
	Titanium Oxide	1910.1000 Table Z-1	10 mg/m <sup>3</sup>
	Nickel Slag	Silica as SiO <sub>3</sub> <sup>2-</sup>	1910.1000 Table Z-3
Magnesium Oxide		1910.1000 Table Z-1	10 mg/m <sup>3</sup>
Iron Oxide		1910.1000 Table Z-1	10 mg/m <sup>3</sup>
Aluminum Oxide		1910.1000 Table Z-1	10 mg/m <sup>3</sup>
Calcium Oxide		1910.1000 Table Z-1	5 mg/m <sup>3</sup>
Nickel		1910.1000 Table Z-1	1 mg/m <sup>3</sup>
Copper Slag	Chromium Oxide	1910.1000 Table Z-1	10 mg/m <sup>3</sup>
	Iron	1910.1000 Table Z-1	10 mg/m <sup>3</sup>
	Amorphous Silica	1910.1000 Table Z-3	80mg/m <sup>3</sup> /%SiO <sub>2</sub>
	Aluminum Oxide	1910.1000 Table Z-1	10 mg/m <sup>3</sup>
	Calcium Oxide	1910.1000 Table Z-1	5 mg/m <sup>3</sup>

The permissible exposure limit (PEL) for inhalation hazards affecting abrasive blasting operators as a general rule is 5 mg/m<sup>3</sup>—except for the following:

1. Sand as an abrasive, the PEL is reduced to 10mg/m<sup>3</sup>/%SiO<sub>2</sub>+2,
2. Coating containing lead, the PEL is reduced to 50 µg/m<sup>3</sup>,
3. Coating containing cadmium, the PEL is reduced to 5 µg/m<sup>3</sup>,
4. Coating containing chromium II or III, the PEL is reduced to 0.5 mg/m<sup>3</sup>
5. Coating containing chromium IV, the PEL is reduced to 5 µg/m<sup>3</sup>, and
6. Coating containing asbestos, the PEL is reduced to 0.1 f/cm<sup>3</sup>

## Inhalation Hazards from Breathing Air:

29 CFR 1919.134(i) addresses Breathing Air for Supplied-Air Respirators. This section states; "Compressed breathing air shall meet at least the requirements for Grade D breathing air described in ANSI/Compressed Gas Association Commodity Specification for Air, G-7.1-1989 to include:

- Oxygen content of between 19.5% and 23.5%
- Hydrocarbon (Oil Mist) content of less than 5mg/m<sup>3</sup>
- Carbon monoxide (CO) content of less than 10 ppm
- Carbon dioxide (CO<sub>2</sub>) content of less than 1000 ppm
- Lack of noticeable odor
- Compressor is situated so as to:
  - Prevent entry of contaminated air into the air supply system
  - Minimize moisture content so that the dew point at 1 atmosphere pressure is 10 degrees F (5.56 deg.C) below the ambient temperature.

The standard also adds the following requirements when providing breathing air from a compressor:

- Have suitable in-line air-purifying sorbent beds and filters to further ensure breathing air quality. Sorbent beds and filters shall be maintained and replaced or refurbished periodically following the manufacturer's instructions and have a tag containing the most recent change date and the signature of the person authorized by the employer to perform the change.
- For compressors that are not oil-lubricated, the employer shall ensure that carbon monoxide levels in the breathing air do not exceed 10 ppm.
- For oil-lubricated compressors, the employer shall use a high-temperature or carbon monoxide alarm, or both, to monitor carbon monoxide levels. If only high-temperature alarms are used, the air supply shall be monitored at intervals sufficient to prevent carbon monoxide in the breathing air from exceeding 10 ppm.
- Ensure that breathing air couplings are incompatible with outlets for non-respirable worksite air or other gas systems. No asphyxiating substance shall be introduced into breathing-air lines.

OSHA requires users of Supplied-Air Respirators to use an in-line "Sorbent Bed Filter" as shown in Figure 1.



Figure 1

This sorbent bed removes the objectionable oil odors and mists mentioned in the OSHA standard above. It contains a replaceable filter which enables the user to comply with the standard, which requires maintenance of such a filter.

Unless using a compressor which specifically states it is a "Breathing-Air" compressor, the employer must install a carbon monoxide monitor in the air-supplied system. Historically, there were two types of carbon monoxide monitors: a permanently-installed type as shown in Figure 2, and a portable-type, as shown in Figure 3.



Figure 2



Figure 3

In early 2011, OSHA issued a "Letter of Interpretation" stating that the CO monitor shown in Figure 4 may be used as an individual CO monitor, meeting the standard stated in 29 CFR Section 1910.134(i) provided NIOSH would approve its placement inside the respirator. Figure 5 shows the only such approved respirator and its placement.



Figure 4



Figure 5

This new carbon monoxide monitor provides assurance that the operator who uses it is independently alerted when the CO level inside the respirator rises to 10 ppm. This direct alert to the operator wearing the monitor means that the blast operation no longer requires an additional employee to monitor the CO alarm which is customarily placed out-of-sight and beyond the hearing range of the blast operator, who is served by the monitor.



## OSHA Requirements for NIOSH-Approved Supplied-Air Respirators:

The final element needed to assure the operator and other employees exposed to inhalation hazards in excess of the permissible exposure limits is an OSHA-compliant respirator.

29 CFR 1910.94(a)(5)(i) states: Employers must use only respirators approved by the National Institute for Occupational Safety and Health (NIOSH) under 42 CFR part 84 to protect employees from dust produced during abrasive-blasting operations and 1910.94(a)(5)(ii) states: Abrasive-blasting respirators shall be worn by all abrasive-blasting operators.

This standard is repeated in 29CFR 1926.57(f)(f)(i) which states: Employers must use only respirators approved by NIOSH under 42 CFR part 84 for protecting employees from dusts produced during abrasive-blasting operations, and 1926.57(f)(5)(ii) Abrasive-blasting respirators shall be worn by all abrasive-blasting operators.

An abrasive-blasting respirator is shown in Figure 6 below:



Figure 6

The Supplied-Air Respirator shown in Figure 6 includes the hood, lenses, cape, air valve and yellow air hose attached to the “Point of Attachment” located on top of the sorbent bed filter. While the respirator assembly begins at the “Point of Attachment,” this attachment is mandated by 42 CFR Part 84, Subpart J.149 and shown in Figure 7:



Figure 7

42 CFR Part 84, Subpart J.149 sets the requirements for this “Point of Attachment” which are:

- **POA - Point of Attachment:** A pressure gauge, regulator, relief valve, and congruous fitting are necessary to be considered a POA.
  - Regulator allows adjustment of air pressure to manufacturer’s specified pressure range based on range of hose length used (see 84.149 (b)).
  - Pressure gauge allows verification of this pressure setting at the point of attachment (see 84.149 (b)).
  - Pressure relief valve prevents pressure from exceeding 125 psi (see 84.149 (d) (1)).
  - Congruous fitting allows connection of “detachable couplings” as part of NIOSH-approved respirator system (see 84.131 (5)).
  - The maximum length of hose allowed from the “Point of Attachment” to the worker is 300 ft. (91m) for type-C Supplied-Air Respirators. This hose must be provided in multiples of 25 ft. (7.6m). Reference: *42CFR Part 84 Subpart J.149 - Table 8, Air Supply-Line Requirements and Tests*

The Supplied-Air Respirator discussed above must be worn by the person doing the blasting. However, often the employees performing work adjacent to the blasting operation, such as pot tenders, or clean-up workers erroneously believe they are adequately protected and compliant with this the OSHA standard. These employees are at serious risk of exceeding the PELs as well as being in violation of the OSHA standards.

Many employees working around abrasive blasting operations use a standard “dust” mask shown in Figure 8. These respirators most often have an Assigned Protection Factor of five (5), which means the employee may be exposed to the inhalation hazards up to five times the PEL. In the case of inhalation hazards such as free-silica, lead, cadmium, asbestos, and chromium, these dust masks are inadequate protection. The employer, while not required to wear a Supplied-Air Respirator should seriously consider providing them to employees working in the vicinity of blasting operations.



Figure 8

29 CFR 1910.134(d)(3)(i)(A) addresses the “Assign Protection Factor (APF)” of respirators, including the abrasive blasting supplied-air respirator, continuous flow mode. As shown in Table 1 below, the APF for continuous flow supplied-air respirators is either 25 or 1000.

**Assigned Protection Factors (APFs)** Employers must use the assigned protection factors listed in Table 1 to select a respirator that meets or exceeds the required level of employee protection. When using a combination respirator (e.g., airline respirators with an air-purifying filter), employers must ensure that the assigned protection factor is appropriate to the mode of operation in which the respirator is being used.

Table 1. Assigned Protection Factors<sup>5</sup>

Type of respirator <sup>1, 2</sup>	Quarter mask	Half mask	Full facepiece	Helmet/hood	Loose-fitting facepiece
1. Air-Purifying Respirator	5	<sup>3</sup> 10	50	.....	.....
2. Powered Air-Purifying Respirator (PAPR)	.....	50	1,000	<sup>4</sup> 25/1,000	25
3. Supplied-Air Respirator (SAR) or Airline Respirator					
• Demand mode	.....	10	50	.....	.....
• <b>Continuous flow mode</b>	.....	50	1,000	<sup>4</sup> 25/1,000	25
• Pressure-demand or other positive-pressure mode	.....	50	1,000	.....	.....
4. Self-Contained Breathing Apparatus (SCBA)					
• Demand mode	.....	10	50	50	.....
• Pressure-demand or other positive-pressure mode (e.g., open/closed circuit)	.....	.....	10,000	10,000	.....

**Notes:**

<sup>1</sup>Employers may select respirators assigned for use in higher workplace concentrations of a hazardous substance for use at lower concentrations of that substance, or when required respirator use is independent of concentration.

<sup>2</sup>The assigned protection factors in Table 1 are only effective when the employer implements a continuing, effective respirator program as required by this section (29 CFR 1910.134), including training, fit testing, maintenance, and use requirements.

<sup>3</sup>This APF category includes filtering facepieces, and half masks with elastomeric facepieces.

<sup>4</sup>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. This level of performance can best be demonstrated by performing a WPF or SWPF study or equivalent testing. Absent such testing, all other PAPRs and SARs with helmets/hoods are to be treated as loose-fitting facepiece respirators, and receive an APF of 25.

<sup>5</sup>These APFs do not apply to respirators used solely for escape. For escape respirators used in association with specific substances covered by 29 CFR 1910 subpart Z, employers must refer to the appropriate substance-specific standards in that subpart. Escape respirators for other IDLH atmospheres are specified by 29 CFR 1910.134 (d)(2)(ii).

This dual APF rating is confusing until you decipher the footnotes of the table.

Footnote number 4 says that all abrasive blasting supplied-air respirators have an APF of 25. This APF is fine when working with the nuisance dust PEL of 5mg/m<sup>3</sup>. However, when abrasive blasting involves free silica, lead, cadmium, asbestos, chromium or other inhalation hazards, with low PELs, the APF of 25 is inadequate. Footnote number 4 goes on to allow an APF of 1000 if the employer has a copy of an independent third party report indicating the respirator exhibited a protection factor of over 1000. Simply having the statement from the manufacturer is insufficient. The employer must have the independent third party report. Most manufacturers of supplied-air respirators have this report on their websites. An example of one such report may be found at:

[http://www.clemcoindustries.com/safety\\_showitem.php?item\\_id=11121](http://www.clemcoindustries.com/safety_showitem.php?item_id=11121).

To adequately protect abrasive blasting workers, employers should always provide supplied-air respirators that have the official documentation of the APF of 1000.

## Hearing Hazards and Protection

### Noise Generated by Abrasive Blasting:

Another direct hazard to abrasive blasting workers is noise. The blaster is regularly exposed to noise in excess of 120 dBA. OSHA has set the duration of noise exposure in 29 CFR 1910.95(b)(2) shown in Table 2 below:

TABLE 2 - PERMISSIBLE NOISE EXPOSURES <sup>(1)</sup>

Duration Per Day, Hours	Sound Level dBA Slow Response
8	90
6	92
4	95
3	97
2	100
1-1/2	102
1/2	105
¼ or less	115

Footnote(1) When the daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect should be considered, rather than the individual effect of each. If the sum of the following fractions:  $C(1)/T(1) + C(2)/T(2) + C(n)/T(n)$  exceeds unity, then, the mixed exposure should be considered to exceed the limit value.  $C_n$  indicates the total time of exposure at a specified noise level, and  $T_n$  indicates the total time of exposure permitted at that level. Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level.

## Understanding Noise-Reduction Ratings and Calculating Hearing Protection:

An unprotected abrasive blasting operator is limited to less than fifteen (15) minutes per day. In reality, abrasive blasting requires hearing protection at all times.

The standard provides a calculation method for determining how long an operator may blast use hearing protection. 29 CFR 1910.95, Appendix B, provides the employer with a simplified version of calculating the adequacy of hearing protector attenuation. While this writer strongly encourages the reader to review this section of the OSHA standard to fully understand it, a general calculation to use follows:

1. If your dosimeter is measuring on the “A” scale, subtract seven (7) from the stated Noise Reduction Rating (NRR) on the hearing protection, then subtract the result from the measured reading.

- a. IE: If your hearing protection has a 33 NRR and your dosimeter is reading 121 dBA on the “A” scale, the resulting noise exposure calculation will be:

$$121-(33-7) = 95\text{dBA}$$

and by using Table 2 above your worker will be able to blast for 4 hours a day, provided he is exposed to noise under 85dBa for the remainder of the shift.

2. If your dosimeter is measuring on the “C” scale, subtract the stated NRR on the hearing protection from the measured reading.

- a. IE: If your hearing protection has a 33 NRR and your dosimeter is reading 122 dBC on the “C” scale, the resulting noise exposure calculation will be:

$$121-33 = 88\text{dBA}$$

and by using table 2 above your worker will be able to blast for 8 hours a day, provided he is exposed to noise under 85dBa for the remainder of the shift.

NOTE: Most dosimeters read on the A scale and the first calculation is normally used.

NIOSH Publication No. 98-126, titled “*Criteria for a Recommended Standard Occupational Noise Exposure*” states in part; “It is important to note that using such double protection will add only 5 to 10 dB of attenuation [Nixon and Berger 1991]. Using secondary hearing protection such as muffs over earplugs or a supplied-air respirator with an ANSI 3.19 Noise Reduction Rating such as the one shown in Figure 9, can add an additional 5 dBAs of hearing protection.



Figure 9

Using the most common dosimeter “A” scale measurement and calculating the hearing protection attenuation, it is possible to add an additional 4 hours of blasting to the blast operator’s workday, provided the abrasive blasting operator wears a supplied-air respirator with an ANSI 3.19 NRR of above 5 dBA as shown:

1. If your dosimeter is measuring on the “A” scale, subtract seven (7) from the stated Noise Reduction Rating (NRR) of the primary hearing protection then add 5; subtract this result from the measured reading.
  - a. IE: If your hearing protection has a 33 NRR and your dosimeter is reading 121 dBA on the “A” scale the resulting noise exposure calculation will be:

$$121 - [(33 - 7) + 5] = 90\text{dBA} \text{ and by using Table 2 above the worker will be able to blast 8 hours.}$$

EAR, Inc., one of the largest manufacturers of hearing protection, performed and published the Environmental Noise Levels of common activities. As shown in Figure 10, sandblasting is approximately 115dBA. Adding outside construction noise, it is not uncommon for the blasting operation to exceed 120 decibels, and the use of secondary hearing protection is strongly encouraged.

ENVIRONMENTAL NOISE LEVELS	
140 dB	Space rocket at blast-off
130 dB	Jackhammer
120 dB	Ambulance siren Amplified rock band Thunder clap
115 dB	Sandblasting
110 dB	Woodworking shop
100 dB	Pneumatic drill Chainsaw
90 dB	Lawn mower Disco dance music Shop tools Truck traffic Noisy restaurant

80 dB	City traffic Loud music from radio
75 dB	Kitchen appliances
70 dB	Crowded restaurant
65 dB	Conversation speech
60 dB	Sewing machine Typewriter
50 dB	Average home interior
40 dB	Quiet residential community
30 dB	Whisper at five feet
20 dB	Leaves rustling in a breeze
10 dB	Normal breathing
0 dB	Faintest sound heard by a human ear

Figure 10

The information provided in this article covers only the most common inhalation and noise hazards associated with abrasive blasting and offers general recommendations for methods to reduce operator exposures to these hazards through the use of appropriate respiratory and hearing protection. For the most current and complete information and guidelines, consult the OSHA standards.

## **Acronyms & Definitions:**

This listing is a guide to common technical terms related to inhalation hazards associated with abrasive blasting. These terms may be found on the OSHA website (<http://osha.gov>) and on the NIOSH website (<http://www.cdc.gov/NIOSH>):

### **Acronyms:**

ACGIH:	American Conference of Governmental Industrial Hygienists
AIHA:	American Industrial Hygiene Association
ANSI:	American National Standards Institute
APF:	Assigned Protection Factor
APR:	Air-purifying Respirator
Ci:	Concentration measured inside the respirator face piece
Co:	Concentration measured outside the respirator
DOP:	Diocetyl phthalate (see definitions)
DFM:	Dust, fume, and mist filter
EPF:	Effective Protection Factor (see definition)
HEPA:	High efficiency particulate air (filter) (see definition)
IDLH:	Immediately dangerous to life or health (see definition)
LANL:	Los Alamos National Laboratory
LASL:	Los Alamos Scientific Laboratory
LLNL:	Lawrence Livermore National Laboratory
MSHA:	Mine Safety and Health Administration
MUC:	Maximum Use Concentration
NFPA:	National Fire Protection Association
NIOSH:	National Institute for Occupational Safety and Health
NRC:	Nuclear Regulatory Commission
OSHA:	Occupational Safety and Health Administration
OSH Act:	Occupational Safety and Health Act of 1970 (29 U.S.C. 655, 657, 665).
PAPR:	Powered air-purifying Respirator (see definition)
PEL:	Permissible Exposure Limit
PPF:	Program Protection Factor (see definition)
QLFT:	Qualitative fit test (see definition)
QNFT:	Quantitative fit test (see definition)
RDL:	Respirator Decision Logic (see definition)
REL:	Recommended Exposure Limit (see definition)
SAR:	Supplied-air (or airline) Respirator (see definition)
SCBA:	Self-contained Breathing Apparatus (see definition)
WPF:	Workplace Protection Factor (see definition)
TLV:	Threshold Limit Value (see definition)
SWPF:	Simulated Workplace Protection Factor (see definition)

### **Definitions:**

Terms preceded by an asterisk (\*) refer to definitions found in paragraph (b) ("Definitions") of the OSHA Respiratory Protection Standard (29 CFR 1910.134).

**\*Air-purifying respirator:** A respirator with an air-purifying filter, cartridge, or canister that removes specific air contaminants by passing ambient air through the air-purifying element.

**\*Atmosphere-supplying respirator:** A respirator that supplies the respirator user with breathing air from a source independent of the ambient atmosphere, and includes SARs and SCBA units.



**\*Canister or cartridge:** A container with a filter, sorbent, or catalyst, or combination of these items, which removes specific contaminants from the air passed through the container.

**Continuous flow respirator:** An atmosphere-supplying respirator that provides a continuous flow of breathable air to the respirator face-piece.

**\*Demand respirator:** An atmosphere-supplying respirator that admits breathing air to the face-piece only when a negative pressure is created inside the face-piece by inhalation.

**Diocetyl phthalate (DOP):** An aerosolized agent used for quantitative fit testing.

**Elastomeric:** A respirator face-piece made of a natural or synthetic elastic material such as natural rubber, silicone, or EPDM rubber.

**\*Filter or air-purifying element:** A component used in respirators to remove solid or liquid aerosols from the inspired air.

**\*Filtering face-piece (or dust mask):** A negative pressure particulate respirator with a filter as an integral part of the face-piece or with the entire face-piece composed of the filtering medium.

**\*Fit factor:** A quantitative estimate of the fit of a particular respirator to a specific individual and typically estimates the ratio of the concentration of a substance in ambient air to its concentration inside the respirator when worn.

**\*Fit test:** The use of a protocol to qualitatively or quantitatively evaluate the fit of a respirator on an individual.

**\*Helmet:** A rigid respiratory inlet covering that also provides head protection against impact and penetration.

**\*High efficiency particulate air filter (HEPA):** A filter that is at least 99.97% efficient in removing mono-disperse particles of 0.3 micrometers in diameter. The equivalent NIOSH 42 CFR 84 particulate filters are the N100, R100, and P100 filters.

**\*Hood:** A respiratory inlet covering that completely covers the head and neck and may also cover portions of the shoulders and torso.

**\*Immediately dangerous to life or health (IDLH):** An atmosphere that poses an immediate threat to life, would cause irreversible adverse health effects, or would impair an individual's ability to escape from a dangerous atmosphere.

**\*Loose-fitting face-piece:** A respiratory inlet covering that is designed to form a partial seal with the face.

**\*Negative pressure respirator (tight-fitting):** A respirator in which the air pressure inside the face-piece is negative during inhalation with respect to the ambient air pressure outside the respirator.

**Permissible Exposure Limit (PEL):** An occupational exposure limit specified by OSHA.

**\*Positive pressure respirator:** A respirator in which the pressure inside the respiratory inlet covering exceeds the ambient air pressure outside the respirator.

**\*Powered air-purifying respirator (PAPR):** An air-purifying respirator that uses a blower to force the ambient air through air-purifying elements to the inlet covering.

**\*Pressure demand respirator:** A positive pressure atmosphere-supplying respirator that admits breathing air to the face-piece when the positive pressure is reduced inside the face-piece by inhalation.

**Protection factor study:** A study that determines the protection provided by a respirator during use. This determination generally is accomplished by measuring the ratio of the concentration of an airborne contaminant (e.g., hazardous substance) outside the respirator (Co) to the concentration inside the respirator (Ci) (i.e., Co/Ci).

Therefore, as the ratio between Co and Ci increases, the protection factor increases, indicating an increase in the level of protection provided to employees by the respirator.

Four types of protection factor studies include:

**Effective Protection Factor (EPF) study** - a study, conducted in the workplace, that measures the protection provided by a properly selected, fit tested, and functioning respirator when used intermittently for only some fraction of the total workplace exposure time (i.e. sampling is conducted during periods when respirators are worn and not worn). EPFs are not directly comparable to WPF values because the determinations include both the time spent in contaminated atmospheres with and without respiratory protection; therefore, EPFs usually underestimate the protection afforded by a respirator that is used continuously in the workplace.

**Program Protection Factor (PPF) study** - a study that estimates the protection provided by a respirator within a specific respirator program. Like the EPF, it is focused not only on the respirator's performance, but also on the effectiveness of the complete respirator program. PPFs are affected by all factors of the program, including respirator selection and maintenance, user training and motivation, work activities, and program administration.

**Workplace Protection Factor (WPF) study** - a study, conducted under actual conditions of use in the workplace, that measures the protection provided by a properly selected, fit tested, and functioning respirator, when the respirator is worn correctly and used as part of a comprehensive respirator program that is in compliance with the OSHA Respiratory Protection Standard, 29 CFR 1910.134. Measurements of CO and Ci are obtained only while the respirator is being worn during performance of normal work tasks (i.e. samples are not collected when the respirator is not being worn). As the degree of protection afforded by the respirator increases, the WPF increases.

**Simulated Workplace Protection Factor (SWPF) study** - a study, conducted in a controlled laboratory setting and in which CO and Ci sampling is performed while the respirator user performs a series of set exercises. The laboratory setting is used to control many of the variables found in workplace studies, while the exercises simulate the work activities of respirator users. This type of study is designed to determine the optimum performance of respirators by reducing the impact of sources of variability through maintenance of tightly controlled study conditions.

**\*Qualitative fit test (QLFT):** A pass/fail fit test to assess the adequacy of respirator fit that relies on the individual's response to the test agent.

**\*Quantitative fit test (QNFT):** An assessment of the adequacy of respirator fit by numerically measuring the amount of leakage into the respirator.

**Recommended Exposure Limit (REL):** An occupational exposure level recommended by NIOSH.

**Respirator Decision Logic (RDL):** Respirator selection guidance developed by NIOSH that contains a set of respirator protection factors.

**\*Self-contained breathing apparatus (SCBA):** An atmosphere-supplying respirator for which the breathing air source is designed to be carried by the user.

**\*Supplied-air respirator (or airline) respirator (SAR):** An atmosphere-supplying respirator for which the source of breathing air is not designed to be carried by the user.

**Threshold Limit Value (TLV):** An occupational exposure level recommended by ACGIH.

**\*Tight-fitting face-piece:** A respiratory inlet covering that forms a complete seal with the face.

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