Chapter 11
Respiratory Protection

Much of the information in this chapter is derived from the following documents:

- EPA: *Health and Safety Guidelines for EPA Asbestos Inspectors* - March 1991. Although much of the information in this document is out of date, a number of procedural issues are still pertinent and are referenced in this chapter.


The following components of OSHA’s *Respiratory Protection Standard* (29 CFR Part 1910.134) apply to individuals subject to OSHA’s *Asbestos Standard for the Construction Industry* (*Construction Standard*).

**Definitions - §1910.134 (b)**

**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; includes supplied-air respirators (SARs) and self-contained breathing apparatus (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.

**Demand respirator** – an atmosphere-supplying respirator that admits breathing air to the facepiece only when a negative pressure is created inside the facepiece by inhalation.

**Filter or air purifying element** – A component used in respirators to remove solid or liquid aerosols from the inspired air.
Filtering facepiece (dust mask) – A negative pressure particulate respirator with a filter as an integral part of the facepiece or with the entire facepiece composed of the filtering medium.

Fit factor – A quantitative estimate of the fit of a particular respirator to a specific individual; 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 (HEPA) filter – A filter that is at least 99.97% efficient in removing monodispersed particles of 0.3 micrometers in diameter. The equivalent NIOSH 42 CFR Part 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 facepiece – 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 facepiece is negative during inhalation with respect to the ambient air pressure outside the respirator.

Oxygen deficient atmosphere – An atmosphere with oxygen content below 19.5% by volume.

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 facepiece when the positive pressure is reduced inside the facepiece by inhalation.

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.

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

Tight-fitting facepiece – A respiratory inlet covering that forms a complete seal with the face.

User seal check – An action conducted by the respirator user to determine if the respirator is properly seated to the face.

**Respiratory Protection Program - §1910.134 (c)**

Employers are required to develop and implement a written respiratory protection program with worksite requirements for respirator use. The following OSHA web site contains more information and assistance: [http://www.osha.gov/SLTC/respiratoryprotection/index.html](http://www.osha.gov/SLTC/respiratoryprotection/index.html).

The respiratory protection program must be administered by a suitably trained program administrator and must contain the following provisions, as applicable:

- Procedures for selecting respirators;
- Medical evaluations of employees required to use respirators;
- Fit testing procedures for tight-fitting respirators;
- Procedures for proper use of respirators (routine and emergency situations);
- Maintenance and care of respirators;
- Procedures to ensure adequate air quality, quantity, and flow of breathing air for atmosphere-supplying respirators;
- Training of employees in the respiratory hazards;
- Training of employees in the proper use of respirators; and
- Procedures for regularly evaluating the effectiveness of the program.
Specific Respiratory Program Requirements

Selection of respirators – §1910.134 (d)

The employer must evaluate respiratory hazard(s) in the work place, identify relevant workplace and user factors, and base respirator selection on these factors.

Fit testing – §1910.134 (f)

Before an employee is required to use any respirator with a negative or positive pressure tight-fitting facepiece, the employee must be fit tested with the same make, model, style, and size of respirator that will be used.

Use of respirators – §1910.134 (g)

Employers must establish and implement procedures for the proper use of respirators. These requirements include prohibiting conditions that may result in facepiece seal leakage, preventing employees from removing respirators in hazardous environments, and taking actions to ensure continued effective respirator operation throughout the work shift.

Maintenance and care of respirators – §1910.134 (h)

The employer must provide for the cleaning and disinfecting, storage, inspection, and repair of respirators used by employees.

Breathing air quality and use – §1910.134 (i)

The employer must provide high purity breathing gases for atmosphere-supplying respirators (supplied-air and SCBA) used by employees.

Identification of filters, cartridges, and canisters – §1910.134 (j)

The employer must ensure that all filters, cartridges and canisters used in the workplace are labeled and color-coded with the NIOSH approval label and that the label is not removed and remains legible.

Training and information – §1910.134 (k)

The employer must provide effective training to employees who are required to use respirators. The training must be comprehensive, must be understandable, and must occur annually and more often if necessary.
Program evaluation – §1910.134 (l)

The employer must conduct evaluations of the workplace as necessary to ensure that the provisions of the current written program are being effectively implemented and that it continues to be effective.

Recordkeeping – §1910.134 (m)

The employer must establish and retain written information regarding medical evaluations, fit testing, and the respirator program.

Respiratory Protection

Employers must select and provide an appropriate respirator based on the respiratory hazard to which the worker is exposed, and workplace and worker factors that affect respirator performance and reliability. The employer must select a NIOSH-certified respirator and it must be used in compliance with the conditions of its certification.

The employer must identify and evaluate the respiratory hazards in the workplace; this evaluation should include a reasonable estimate of employee exposures and an identification of the contaminant’s chemical state (acid, base, corrosive, organic solvent?) and physical form (solid, liquid, gas?). Where exposures cannot be identified or reasonably estimated the atmosphere shall be considered Immediately Dangerous to Life and Health (IDLH).

Employers must determine the workers’ exposures to a concentration of an airborne contaminant that would occur if the employee were NOT using respiratory protection. For asbestos, this is measured with personal air monitoring, a process in which a worker wears a sampling pump which draws air in the worker’s breathing zone through a filter, typically over an eight-hour work day. Materials collected on the filter are then analyzed, usually by phase contract microscopy (PCM), and results are reported in fibers per cubic centimeter of air (f/cc).

When selecting respirators for use, the employer must have available a sufficient number of models and sizes so that the respirator is acceptable to and correctly fits the user. The practices of properly fitting respirators will be discussed in detail later in this chapter.

Respirator Styles

This chapter briefly describes the types of respiratory protection required where asbestos exposure may occur. All varieties of filtering facepiece respirators, commonly referred to as dust masks, are specifically prohibited by OSHA for use in asbestos-contaminated environments. Approved facepiece styles include tight-fitting and loose-fitting varieties.
Tight-fitting respirators

Tight-fitting styles, which include half-mask and full-face respirators, conform to the face of the user and are held in place by a suspension system.

Half-mask respirator

A half-mask respirator fits over the bridge of the nose, along the cheeks, and under the chin. Two headbands form a four-point suspension to hold the mask in place and maintain the facepiece seal. Although half-mask respirators are lightweight, comfortable, and non-restrictive to vision, they are not very protective. EPA does not allow its asbestos inspectors to wear half-masks at asbestos sites. OSHA allows the use of a half-face respirator when asbestos fiber concentration is known to be no greater than 1 f/cc.

Full-face respirator

A full-face respirator fits across the forehead, along the temples and cheeks, and under the chin. A head harness with a 5-or 6-point suspension holds the mask in place and maintains the facepiece seal. A full-face respirator provides better protection against contaminants and facial injury, but may restrict one’s vision. A full-face respirator is the minimum respiratory protection EPA permits its inspectors to wear at an asbestos sites.

Loose-fitting respirators

Loose-fitting (hood or helmet) respirators do not seal to the face, but may be worn by individuals with beards or moustaches or other conditions (e.g., facial scarring, poor dentition, etc.) that preclude use of tight-fitting styles. These respirators are rarely used in the asbestos control industry. Certain models that have proven high protection factors, however, may be worn in the lowest risk situations and are presumed to have the same protection factor as a half mask respirator.

Classes of Respirators

The two major types of respiratory protection equipment are air-purifying respirators (APRs) and atmosphere-supplying respirators.

Air-Purifying Respirators (APRs)

APRs remove specific air contaminants by passing ambient air through an air-purifying element. APRs may be classified as positive- or negative-pressure respirators depending on whether the user creates the suction to draw air into the mask (negative-pressure) or a fan propels filtered air to the facepiece (positive-pressure).
Negative-Pressure Air-Purifying Respirators

When an individual wearing a negative-pressure respirator (NPR) inhales, the slight vacuum created causes ambient air to be drawn through the filter and into the facepiece. Exhaled air leaves through a valve located at the bottom of the facepiece.

NPRs are available in both half-mask and full-face styles and are popular because they minimally impede work activities. They are also easy to clean and store and are more moderately priced than other types of respirators. Various filters are available which can protect against single or multiple contaminants and some manufacturers make NPRs that can be converted into positive pressure respirators.

NPRs have several disadvantages. NPRs, in general, provide less protection than other types of respirators and cannot be used in oxygen-deficient atmospheres. Filter selections are limited and filters must be changed if they become wet or as needed due to ambient dust loading. Also, full-face NPRs may fog in cool environments, and nose cups (which help reduce fogging) may be an additional expense. Many of the most current models of full-face respirators are made with nose cups to alleviate this problem.

Positive-Pressure Air-Purifying Respirators

Positive-pressure air-purifying respirators are referred to as powered air-purifying respirators (PAPRs). PAPRs have battery-powered motors which blow purified air to the facepiece. Since the airflow creates a slight positive pressure in the mask, any breach in the facepiece seal should permit only the outward flow of air from the mask, thereby preventing inhalation of contaminated air.

PAPRs may have tight-fitting facepieces or loose-fitting hoods or helmets. PAPRs with tight-fitting masks must supply at least 4 cubic feet of air per minute (CFM), and the hood or helmet type must provide 6 CFM. PAPR motor units are worn on the waist or may be a component of the mask itself.

PAPRs, because they do not create breathing resistance, may be less stressful to use than negative-pressure respirators. Their design minimizes potential leakage of contaminants into the facepiece and they are also more comfortable to use in hot environments since they enhance evaporation of perspiration.

In the absence of a negative exposure assessment (NEA) or air monitoring data which might allow lesser respiratory protection, OSHA requires PAPRs to be used as minimum respiratory protection in Class I (disturbance/removal of surfacing material and TSI) work areas.

Use of a PAPR, however, does have disadvantages. PAPRs are much more expensive than negative-pressure respirators. They limit ones ability to look into tight spaces and cannot be used in oxygen-deficient atmospheres. PAPR cartridges are available only for a limited number of contaminants and combination cartridges (needed when more than one airborne contaminants...
contaminant is present) may not exist. In addition, the use of the PAPR in positive pressure mode is predicated on the battery. If the battery fails, the respirator reverts to negative pressure mode so the protection factor is reduced. Properly conditioned, most current PAPR batteries can operate for 8 hours.

**Atmosphere-Supplying Respirators**

Atmosphere-supplying respirators provide the user with breathing air from a source independent of the ambient atmosphere and include supplied-air respirators (SARs) and self-contained breathing apparatus (SCBA) units.

**Supplied-Air Respirators (SARs)**

Supplied-air respirators are also known as "airline respirators". Type C supplied-air respirators may be used at asbestos worksites. These respirators, which require a source of respirable air, consist of a hose; a control valve, orifice, demand or pressure-demand valve, and a facepiece, hood, or helmet.

SARs with tight-fitting masks must supply a minimum of 4 CFM, and the hood or helmet type must supply 6 CFM. Some SARs may have additional "escape" components such as a self-contained auxiliary air supply or HEPA filter.

- **Airline Respirator with Self-Contained Auxiliary Air Supply** - This respirator combines an airline respirator with an auxiliary air supply (SCBA) to provide the user with a limited amount of respirable air (5-15 minutes) if the main air supply fails.

- **Airline Respirator with HEPA Filter** - This respirator combines an airline respirator with a backup HEPA filter. In an emergency, the user can disconnect the air supply system and leave the worksite while breathing through the HEPA cartridges.

SARs may operate in continuous-flow or pressure-demand mode:

- **Continuous-Flow Mode** - A continuous-flow SAR maintains a constant airflow and therefore, in most cases, a positive pressure within the facepiece at all times. Instead of a regulator it uses a control valve or orifice to adjust airflow.

- **Pressure-Demand Mode** - A pressure-demand SAR has a regulator and valve design that maintains a positive pressure in the facepiece at all times. Should a reduction of pressure within the mask be sensed, airflow is increased to preserve a positive pressure.

SARs were widely used in the abatement industry in the 1980s. Today, however, they are used primarily where required by regulation or contract, or where IDLH conditions exist. Only a full facepiece, pressure demand SAR with auxiliary self-contained air supply may be used in an IDLH atmosphere.
SARs are lightweight, do not rely on batteries or filters, and provide a high level of protection against many contaminants. However:

- SAR systems are very expensive and difficult to maintain;
- the hose or airline restricts movement and may become damaged;
- SARs offer no protection if the air supply fails (unless equipped with auxiliary devices);
- the compressor location must be free of asbestos and other contaminants (CO, exhaust fumes, etc.); and
- SARs systems are not easily erected or transported.

**Self-Contained Breathing Apparatus (SCBA)**

Self-contained breathing apparatus components include a facepiece, respirable compressed air supply, valves, gauges, timer, and low air warning device. The SCBA eliminates the need for a stationary air supply, provides the highest respiratory protection, and may be used in IDLH conditions. SCBAs are commonly used on sites where multiple chemical contaminations may exist and by first responders.

SCBAs, however:

- are extremely expensive and require regular maintenance;
- have air tanks can be used only for 30-60 minutes and then require refilling;
- are bulky, heavy, and difficult to decontaminate; and
- require more user training than required for other respiratory devices.

**Filters, Canisters and Cartridges**

Negative pressure respirators and PAPRs rely upon a filter to remove solid or liquid contaminants from inspired air. The filter medium (element, sorbent, catalyst or combination thereof) is typically housed in a metal canister or plastic cartridge and removes specific contaminants as air passes through the container.

All filters, canisters and cartridges used in the workplace must be color coded and have a NIOSH approval label. The label may be glued onto or imprinted into the device or may consist of raised lettering. The label must contain the word “NIOSH”, the manufacturer’s name and part number and an abbreviation to indicate the cartridge or filter type (e.g., P-100 etc.).

For non-powered air-purifying respirators, NIOSH (under 42 CFR Part 84) now certifies three classes of filters – N-, R-, and P-series, with three levels of filter efficiency – 95%, 99% and
99.97% in each class. The letters “N”, “R” and “P” represent increasing resistance to oil aerosol degradation and establish filter parameters to follow:

- If no oil particles are present in the work environment, a filter of any series (i.e., N-, R-, or P-series) may be used.

- If oil particles (e.g., lubricants, cutting fluids, glycerin, etc.) are present, an R- or P-series filter may be used.

- If oil particles are present and the filter is to be used for more than one work shift, only a P-series filter may be used and change it per manufacturer’s recommendation.

To help remember the filter series, the following guide can be used:

- “N” denotes not resistant to oil;
- “R” denotes resistant to oil; and
- “P” denotes oil-proof.

Filter efficiency selection (e.g., 95%, 99%, or 99.97%) is based on the level of filter leakage that is acceptable. Higher filter efficiency means lower filter leakage. The NIOSH web site provides additional information on selecting appropriate filters at URLs such as www.cdc.gov/niosh/docs/96-101/ which was valid at the time of this manual update.

P-100 filters are most commonly used in the asbestos control industry for full and half-face negative pressure respirators.

**High Efficiency Filters**

High efficiency filters, commonly referred to as HEPA filters are at least 99.97% efficient in removing particles of 0.3 micrometers in diameter. For PAPRs, high efficiency filters are rated Type-H or HEPA. Type H and P-100 are functionally the same.

NIOSH requires all respirators it certifies to be color coded. Type H and P-100 filters must be magenta, sometimes called fuchsia and a purple-like color halfway between blue and red on the color wheel. Manufacturers’ colors may vary between shades of red and shades of purple.

**Additional Information**

All respirator cartridges must be kept dry. If they get wet, they must be properly disposed of and replaced. If P-100 and Type-H cartridges become difficult to breathe through, they must be replaced. Asbestos NESHAP inspectors must dispose of used cartridges after each inspection, even if only light dust exposures have been encountered, so that contaminants are not transferred to other sites.
Canisters and cartridges that are used for protection from gasses and vapors, must be kept properly sealed so that filter medium is not expended prematurely. The employer must establish an appropriate change schedule based on the concentration of the contaminant.

Many respirator manufacturers provide on-line guidance via their web pages or downloadable programs. OSHA also provides useful guidance on this topic at its web site: www.osha.gov/SLTC/etools/respiratory/index.html.

**Protection Factors**

The overall protection afforded by a given respirator may be stated in terms of its assigned protection factor, or a user-specific fit factor. Table 11-1 below contains the Department of Labor (OSHA) assigned protection factors that are relevant to 29 CFR 1910, 1915, and 1926 as printed in the *Federal Register*, August 24, 2007; Page 50188. Each factor depicts the ratio of the concentration of a contaminant in the ambient atmosphere to that inside the respirator facepiece under use conditions.

**Assigned Protection Factors (APFs)**

APFs are values assigned to an entire class of respirators (e.g., half-face, full-face, etc.) and may be based solely on laboratory fit testing or workplace performance testing. APFs provide an average value that takes into account the variety of makes and models and the different facial structures of the user population.

The higher the protection factor, the more protective the device. Half-face, negative-pressure air-purifying respirators have the lowest APF of all classes of nondisposable respirators, whereas SCBA systems have the highest.

APFs may be used to select appropriate respiratory protection when the ambient concentration of a contaminant and its permissible exposure limit (PEL) are known. By dividing the PEL into the ambient concentration of the contaminant, one can determine which type of respirator will suffice.

**Fit Factors**

Fit factors are values derived from testing an individual wearing a specific respirator. A fit factor, therefore, could be less or greater than the APF for a particular class of respirators. If an individual's fit factor is greater than the APF for that class of respirator, the respirator may not be used in correspondingly more contaminated conditions. If an individual's fit factor is less than the APF for that class of respirator, the individual must consider the fit factor to determine the maximum contamination in which the respirator may be worn. Fit factors are determined during quantitative fit testing, a procedure addressed later in this chapter.
Table 11-1 – OSHA Assigned Protection Factors

<table>
<thead>
<tr>
<th>Type of Respirator</th>
<th>Quarter Mask</th>
<th>Half Mask</th>
<th>Full Facepiece</th>
<th>Helmet/Hood</th>
<th>Loose-fitting Facepiece</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Air-Purifying Respirator</td>
<td>5</td>
<td>10&lt;sup&gt;4&lt;/sup&gt;</td>
<td>50</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>2. Powered Air-Purifying Respirator (PAPR)</td>
<td>--</td>
<td>50</td>
<td>1,000</td>
<td>25/1,000&lt;sup&gt;5&lt;/sup&gt;</td>
<td>25</td>
</tr>
</tbody>
</table>
| 3. Supplied-Air Respirator (SAR) or Airline Respirator  
• Demand mode | -- | 10 | 50 | -- | -- |
| • Continuous flow mode | -- | 50 | 1,000 | 25/1,000<sup>5</sup> | 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 | -- |

<sup>1</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).

<sup>2</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>3</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>4</sup>This APF category includes filtering facepieces, and half masks with elastomeric facepieces.

<sup>5</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.

**Fit Testing**

Before an employee is required to use any respirator with a negative- or positive-pressure tight-fitting facepiece, the employee must be fit tested with the same make, model, style, and size of respirator that will be used. Employees must pass an appropriate, OSHA-approved qualitative fit test or quantitative fit test before initial use of the respirator, whenever a different respirator facepiece (size, style, model or make) is used, and at least annually thereafter.

A qualitative fit test (QLFT) is a pass/fail test used to assess the adequacy of respirator fit that relies on an individual's response to a test agent. A quantitative fit test (QNFT) is an assessment of...
the adequacy of respirator fit made by numerically measuring the amount of leakage into the respirator. Simply put, fit testing is a way for the employer to ascertain whether the respirator issued to an employee will provide adequate protection when used with the correct filter; canister or cartridge. Procedures for the conduction of each of these types of fit tests are detailed in OSHA’s Respiratory Protection Standard found in 29 CFR 1910.134, Appendix A.

An additional fit test is required whenever changes in an individual's physical condition occur which could affect respirator fit. Such conditions include, but are not limited to facial scarring, dental changes, cosmetic surgery, or obvious change in body weight.

**Preliminary Procedures**

Prior to having a qualitative or quantitative fit test performed, the test subject selects the most appropriate respirator from a group of various models and sizes, attaches the appropriate filters (if needed) for the test to be performed, and after a variety of procedures to assess proper sizing and respirator seating wears the respirator for at least 5 minutes to assess comfort.

After this five-minute period, the subject "seats" the mask by moving the head slowly from side to side and up and down while taking in a few deep breaths, and then performs either negative and positive pressure checks ("user seal check" commonly referred to as “fit check”) detailed in OSHA's Respiratory Protection Standard at 29 CFR 1910.134, Appendix B, or equivalent manufacturer-recommended tests.

A negative pressure check involves blocking the respirator inlets, inhaling gently to slightly collapse the facepiece, and holding one's breath for 10 seconds. If no air leaks into the facepiece during this time span, the mask is considered satisfactory.

A positive pressure check involves blocking the exhalation valve and exhaling gently into the facepiece. The face fit is considered satisfactory if a slight positive pressure can be built up inside the facepiece with no outward leakage of air at the seal.

If the test subject fails either the fit checks or the manufacturer's test, another facepiece must be selected and preliminary procedures redone.

Fit checks must be performed every time the respirator is donned for actual use.

**Qualitative Fit Test (QLFT)**

In qualitative fit testing, a subject's sensitivity to a certain smell, taste or irritation from a "challenge" atmosphere helps determine the respirator fit. There are four OSHA test protocols: (1) isoamyl acetate vapor (banana oil/IAA); (2) saccharin solution aerosol; (3) Bitrex™ (denatonium benzoate); and (4) irritant smoke (or stannic chloride). (See Table 11-2 below.)

A QLFT may be performed on negative-pressure air-purifying respirators that must achieve a fit factor of 100 or less (i.e., half-mask or full-face respirators). If a full facepiece air-purifying respirator passes a QLFT, it may be worn only at levels at which half-facepiece air purifying
respirators are permitted. This (maximum asbestos concentration = 1 f/cc; see OSHA’s *Construction Standard* [CFR 1926.1101(h)(4)(ii)]).

A QLFT also may be used to test the fit of tight-fitting PAPRs and atmosphere-supplying respirators (supplied-air respirators and SCBAs). Such respirators must be tested in the negative-pressure mode. To accomplish this, a user's actual facepiece may be temporarily converted into a negative-pressure respirator with appropriate filters, or an identical negative-pressure air-purifying respirator facepiece with the same sealing surfaces may be used as a surrogate. Tight-fitting PAPRs, SARs and SCBAs which pass a qualitative fit test may be worn only when the maximum asbestos concentration does not exceed 1.0 f/cc.

| **Table 11-2 - Qualitative Fit Test Protocol Summary** |
|----------------------------------|-----------|----------|-----------|
| **Sense tested** | ISOAMYL ACETATE | SACCHARIN | BITREX | IRRITANT SMOKE |
| **Fit test enclosure** | Smell | Taste | Taste | Respiratory tract irritation |
| **Respirator cartridge** | Yes | Yes | Yes | No |
| **Respirator cartridge** | Organic vapor | Particulate | Particulate | HEPA or P100 |

**Qualitative Fit Test Procedures**

Before proceeding with the fit test, odor threshold screening is conducted to determine the test subject's sensitivity to the challenge agent. If the subject cannot sense the challenge agent, qualitative fit testing cannot be performed.

Following successful odor threshold screening, the subject dons the selected respirator and performs each of the following test exercises for one minute in the "challenge" atmosphere.

1. Normal breathing.
2. Deep breathing.
3. Turning head side to side.
4. Moving head up and down.
5. Talking.
6. Bending over (jogging may be substituted if necessary).
7. Normal breathing.

If the subject detects the challenge agent at any time, the test is failed. The subject may readjust the respirator, or select a different size or model, and must be completely retested.
NIOSH Concerns

Although NIOSH endorses all provisions of OSHA’s 29 CFR Part 1910.134, as published on January 8, 1998, NIOSH does not recommend the use of irritant smoke for qualitative respirator fit testing because of the health risk associated with exposure to the irritant smoke. This recommendation was based primarily on studies conducted as part of a NIOSH Health Hazard Evaluation (HHE).

In this study NIOSH discovered that individuals being fit-tested with irritant smoke may be subjected to levels of hydrogen chloride gas that exceed 5 parts per million (ppm), the ceiling limit for both the NIOSH recommended exposure limit and OSHA’s PEL. A ceiling limit is an air concentration that should not be exceeded during any part of a workday.

NIOSH reviewed the revised protocol for the irritant smoke test in OSHA’s final respiratory protection standard and concluded that a risk still exists for overexposure to HCl during a facepiece fit test. To check their sensitivity, test subjects are required to breathe irritant smoke both before and after a successful fit test. Generated concentrations to which test subjects are subjected are not measured in the test protocol. A concentration of 5 ppm is the accepted threshold level at which a response is observed from most persons. A fit test is a failure when a test subject experiences an involuntary cough or irritation. Retesting requires repeating the sensitivity check. In each case, the responses of coughing and irritation are the adverse health effects against which HCl’s exposure limits are intended to protect. Consequently, NIOSH maintains its recommendation against the use of irritant smoke as a fit testing agent.

Quantitative Fit Test (QNFT)

To quantitatively fit test a tight-fitting respirator, a permanent sampling probe can be installed on a surrogate facepiece, or a temporary sampling adapter may be used on an individual's actual facepiece. During the test, instrumentation is used to numerically record the amount of leakage into the facepiece.

Acceptable quantitative fit testing procedures include those using:

- a non-hazardous aerosol (such as corn oil or other materials) generated in a test chamber and employing instrumentation to quantify the fit of the respirator;
- ambient aerosol as the test agent and appropriate instrumentation to quantify the respirator fit; and
- controlled negative pressure and instrumentation to measure the volumetric leak rate of a facepiece to quantify the respirator fit.
Procedures for the conduction of quantitative fit tests can be found in OSHA’s *Respiratory Protection Standard* (29 CFR Part 1910.134, Appendix A).

If the fit factor determined using an OSHA protocol is equal to or greater than 100 for a tight-fitting half-mask respirator, or equal to or greater than 500 for a tight-fitting full facepiece respirator, the QNFT has been passed with that respirator.

**Respirator Selection**

Following is an excerpt from 29 CFR 1926.1101 relative to respirator selection:

*Respirator selection. 1926.1101(h)(3)*

(i) Employers must:

(A) Select, and provide to employees, the appropriate respirators specified in paragraph (d)(3)(i)(A) of 29 CFR 1910.134; however, employers must not select or use filtering facepiece respirators for use against asbestos fibers.

(B) Provide HEPA filters for powered and non-powered air-purifying respirators.

(ii) Employers must provide an employee with tight-fitting, powered air-purifying respirator (PAPR) instead of a negative pressure respirator selected according to paragraph (h)(3)(i)(A) of this standard when the employee chooses to use a PAPR and it provides adequate protection to the employee.

(iii) Employers must provide employees with an air-purifying half mask respirator, other than a filtering facepiece respirator, whenever the employees perform:

(A) Class II or Class III asbestos work for which no negative exposure assessment is available.

(B) Class III asbestos work involving disturbance of TSI or surfacing ACM or PACM.

(iv) Employers must provide employees with:

(A) A tight-fitting powered air-purifying respirator or a full facepiece, supplied-air respirator operated in the pressure-demand mode and equipped with either HEPA egress cartridges or an auxiliary positive-pressure, self-contained breathing apparatus (SCBA) whenever the employees are in a regulated area performing Class I asbestos work for which a negative exposure assessment is not available and the exposure assessment indicates that the exposure level will be at or below 1 f/cc as an 8-hour time-weighted average (TWA).

(B) A full facepiece supplied-air respirator operated in the pressure-demand mode and equipped with an auxiliary positive-pressure SCBA whenever the employees...
are in a regulated area performing Class I asbestos work for which a negative exposure assessment is not available and the exposure assessment indicates that the exposure level will be above 1 f/cc as an 8-hour TWA.

Highlights from the 29 CFR 1926.1101 excerpt above include:

- Filtering face pieces (dust masks) are not allowed.
- A PAPR must be provided to a worker upon request, if it provides proper protection.
- For OSHA Class III work involving surfacing material and TSI; at least a half mask respirator must be provided.
- For OSHA Class I work where an NEA is not available and asbestos fiber concentrations are ≤ 1.0 f/cc as an 8-hour, time weighted average; workers must start work with at least a tight-fitting PAPR. (In geographical areas where asbestos worksites have little regulatory oversight, contractors may be ignoring this provision.

To determine whether a selected (and properly fit-tested) respirator is appropriate for a particular asbestos-contaminated environment, a Maximum Use Concentration (MUC) calculation should be performed. In this formula, \( C_I \) is the desired concentration inside the respirator facepiece, and PF is the OSHA-published protection factor for a specific respirator type:

\[
MUC = \left( C_I \right) (PF)
\]

**Question:** What is the maximum airborne asbestos fiber concentration in which it would be appropriate to wear a full-face negative pressure respirator with HEPA filters?

**Solution:** EPA recommends that inspectors limit their asbestos exposure to <0.01 f/cc as an 8-hour time-weighted average (TWA), so \( C_I = 0.01 \) f/cc.

A full-face, negative-pressure respirator with HEPA filters has an assigned PF of 50.

Therefore:

\[
(0.01 \text{ f/cc})(50)=0.5 \text{ f/cc}
\]

This calculation shows that a full-face negative pressure respirator may be used in work areas where the asbestos fiber concentration does not exceed 0.5 f/cc.

Based on the above assumptions (0.01 f/cc maximum inside the respirator facepiece, properly fitted respirator and published OSHA PFs), Table 11-3 lists the MUC for each type of commonly used respirator.
### Table 11-3 Maximum Use Concentrations with HEPA (P-100 or Type H)

<table>
<thead>
<tr>
<th>Respirator type</th>
<th>MUC</th>
<th>OSHA MUC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Half face APR</td>
<td>0.1 f/cc</td>
<td>1.0 f/cc</td>
</tr>
<tr>
<td>Full face APR</td>
<td>0.5 f/cc</td>
<td>5.0 f/cc</td>
</tr>
<tr>
<td>PAPR</td>
<td>10.0 f/cc</td>
<td>100 f/cc</td>
</tr>
<tr>
<td>Type C pressure demand</td>
<td>10.0 f/cc</td>
<td>100 f/cc</td>
</tr>
<tr>
<td>SCBA</td>
<td>100 f/cc</td>
<td>1000 f/cc</td>
</tr>
</tbody>
</table>

The “OSHA MUC” information is derived by using the PEL for asbestos (0.1 f/cc) as the desired concentration inside the facepiece. Most employers and standard EPA training materials used in industry recommend a maximum concentration of 0.01 f/cc inside the facepiece, but they may select respiratory protection based on the OSHA MUC.

### Health and Safety Guidelines for EPA Asbestos Inspectors (March 1991)

Although both the OSHA Construction Standard and Respiratory Protection Standard have been revised since 1991, the Health and Safety Guidelines document has not and therefore contains some information contrary to current OSHA requirements. As a result, only those components of the Guidelines document that continue to be pertinent today are discussed below.

#### General Requirements

All EPA employees required to wear respirators must receive 6 hours of respiratory protection training, be fit-tested at least semi-annually, and receive approved refresher training annually. (OSHA requires annual fit testing.)

Inspectors should not wear respirators unless they have been deemed medically fit to do so by a physician relying on a medical and work history questionnaire, a physical examination including a chest x-ray, pulmonary function tests, and other tests or information deemed necessary.

Inspectors should use only agency-owned respiratory protection equipment that they have been specifically trained and fit-tested to use. Inspectors should never use equipment offered by the abatement contractor. Inspectors probably will not wear supplied-air respirators other than SCBAs since it is doubtful that their agencies will provide the equipment necessary for this type of system.

#### Respirator Selection Criteria

EPA bases its respirator selection criteria on its recommendation that inspectors' asbestos exposures be limited to <0.01 f/cc as an 8-hour time-weighted average (TWA).

EPA believes that, under most circumstances, asbestos inspectors can limit their exposure to 0.01 f/cc or less by using a NIOSH-approved, full-facepiece respirator with HEPA filtration, or
any approved tight-fitting (i.e. having a tight face-to-facepiece seal) powered air-purifying respirator (PAPR) with HEPA filtration.

**OSHA Asbestos Standard Compliance**

An abatement project's compliance with the OSHA asbestos standards can be gauged by findings that:

- records indicate that all employees have been trained as required. Individuals (workers, contractors/supervisors) who perform the following activities with respect to friable ACBM in a school or public and commercial building must be accredited: (1) a response action other than a small-scale, short-duration (SSSD) activity, (2) a maintenance activity that disturbs friable ACBM other than an SSSD activity, or (3) a response action for a major fiber release episode. Such individuals must have their initial and current accreditation certificates at the location where they are conducting work per 40 CFR Part 763, Subpart E, Appendix C - Asbestos Model Accreditation Plan (MAP);

- individuals performing abatement work in facilities other than schools, public, or commercial buildings need not be accredited under the MAP; they may, however, be subject to state and/or local training requirements;

- records, either on-or off-site, show that project employees have been given medical exams, including a determination that they are fit to wear respirators;

- amended water is being used to wet the ACM. (Check to see that amended water is on-site outside the envelope);

- no power tools are being used to remove ACM;

- the envelope is secure and no dust or debris appears to be coming from the removal area;

- warning signs are posted and adequately labeled containers are being used;

- employees are carefully removing ACM and are not dropping materials on the floor;

- decontamination accommodations, including shower facilities, are in place;

- existing monitoring data indicate that asbestos fibers in the work area do not exceed 2.0 f/cc as an 8-hour TWA. This reflects EPA’s original recommendation of no more than 0.01 f/cc inside the facepiece which can be achieved by wearing a PAPR or full-face APR in the area for no more than 2 hours.

- there is a written respiratory protection program and respirators are being used; and

- a removal plan has been, or can be, made available for review.
The asbestos NESHAP inspector must exercise proper judgment in determining whether air-purifying respirators will provide adequate protection. The capability to make such determinations must be obtained through both classroom and on-the-job training.

**Conducting Removal, Demolition or Renovation Inspections**

EPA inspectors entering a removal area should select the appropriate respiratory protection according to the following locations and conditions.

**No Respiratory Protection Required**

No respiratory protection is required outside of the asbestos area enclosing envelope when:

- inspecting office areas and other locations outside the barrier. All barrier seals must be intact, and all envelope entrances must have at least a double barrier. No visible airborne dust or debris that is potentially asbestos-contaminated should be present on any surface in the area;

- secondary containment is in place during glove-bagging operations. The secondary containment enclosure must be complete, and, for all but small-scale, short-duration operations, must also be under negative pressure;

- materials removed from the envelope have been cleaned and the pathway for removal of bags and equipment is clear and clean;

- all ventilation systems in the envelope are off and sealed (excluding negative-pressure systems designed for the removal project); and

- wet methods are being used.

No respiratory protection is required inside the envelope (regulated area) when:

- inspecting any restricted area that has already passed an appropriate clearance test (minimum of aggressive sampling demonstrating a concentration below 0.01f/cc by PCM); or

- no removal work has begun and all ACM is intact, not disturbed, not damaged, and no debris is present.

Inspectors should always carry a tight-fitting PAPR or full-face APR when visiting such areas. They may encounter unexpected work project conditions that require the use of a respirator and should always be prepared by having available appropriate safety equipment including respiratory protection.
Respiratory Protection Required

Respiratory protection will be required in many situations encountered by inspection personnel, both inside and outside the active removal area. For example, respiratory protection and personal protective equipment are required for inspections conducted outside the work area if the conditions listed in "No Respiratory Protection Required" have not been met. In addition, respirators and personal protective equipment are required whenever an inspector enters a work area that has not been cleared for re-occupancy. To determine the type of respiratory protection required, an inspector must rely on available information and observations of the conditions at the work site. As a minimum, an inspector must use either a full-face, air-purifying, negative-pressure respirator with HEPA filters or a tight-fitting, powered air-purifying respirator (PAPR) with HEPA filters. An inspector can upgrade respirator selections at any time.

To determine the type of respirator to use, a number of conditions must be met. These conditions can be identified through a records review, pre-entry observations and interviewing site personnel. If adequate information is not available to document all of these conditions, an inspector must use his/her judgment to determine the level of respiratory protection to wear. If upon entering the work area enclosure the inspector determines that the conditions have not been met, he/she should immediately leave the work area and upgrade the level of respiratory protection.

Air-purifying Respirators

Full facepiece air-purifying respirators or tight-fitting PAPRs shall be worn by inspectors when:

- inspecting outside the barrier, and workers outside the barrier are wearing air-purifying respirators;

- inspecting outside the barrier where the barrier is not complete and/or asbestos-containing debris is present;

- inspecting inside the envelope when an inspection of the operation shows it to be in compliance with the OSHA asbestos standard. If, upon entering the envelope, visible emissions are seen or other evidence suggesting non-compliance is apparent, the inspector will immediately leave the area. Prior to returning to the removal area to document the violations, the inspector shall don SCBA gear;

- inspecting inside the barrier and no active removal or disturbances have occurred in past 24 hours and the inspection will not disturb any ACM.
**Atmosphere-supplying Respirators**

Atmosphere-supplying respirators are required when:

- performance of the asbestos abatement project is not in accordance with OSHA standards;
- materials are being removed which are not being properly wetted, or removal causes the generation of significant levels of dust;
- monitoring data at the site show levels in excess of 2.0 f/cc, or the EPA inspection may last for more than 2 hours;
- others at the site are wearing atmosphere-supplying respirators.

Since an inspector cannot bring an airline respirator system to a worksite and is not allowed to use contractor equipment, he or she may need to use an SCBA when the above conditions exist. If the inspector knows the work area asbestos fiber concentrations however, he or she may use the MUC chart to select an appropriate respirator.

**Collecting Bulk Samples**

Inspectors collecting bulk samples should wear full-face, air-purifying respirators with HEPA filter cartridges (This includes NIOSH-approved, tight-fitting PAPRs equipped with HEPA filters.).

Asbestos inspectors in industry commonly use half-mask APRs when collecting samples in areas relatively free of asbestos contamination.

**Inspecting Asbestos Waste Disposal and Storage Sites**

Inspectors should select respiratory protection according to the following criteria:

**No Respiratory Protection Required**

- all disposal trenches have been covered for a minimum of 24 hours; and
- no ACM is visible at the disposal site.

**Respiratory Protection Required**

Full-face APRs or tight-fitting PAPRs should be worn when:

- no airborne dust is visible, but trenches are being dug at the disposal site; or
• asbestos materials are on the ground or floor of the site, or damaged bags or drums are present; or

• a storage site is being inspected.

Atmosphere-supplying respirators (SCBAs or SARs) should be worn when:

• others at the site are wearing atmosphere-supplying respirators; or

• airborne dust is visible.

As mentioned previously a PAPR may be the highest level of protection available unless the inspector brings an SCBA to the site.

Inspecting an Abandoned Building

Inspectors should select respiratory protection according to the following conditions:

No Respiratory Protection

• no suspect materials are present; or

• intact suspect materials are present and no debris from those materials is observed.

Due to the likely presence of respiratory hazards such as molds and animal and bird feces at such site one should ALWAYS wear, at a minimum, a full-face-NPR or tight-fitting PAPR with P-100 filters.

Respiratory Protection Required

Full-face APRs or tight-fitting PAPRs should be worn when:

• suspect materials are visible on the floor or surfaces; and

• collecting bulk samples.

EPA's Health and Safety Guidelines for EPA Asbestos Inspectors also provides guidance concerning respirator selection for inspections conducted at asbestos manufacturing and fabricating plants and emergency removal operations at Superfund sites. Inspectors should review the document’s recommendations prior to conducting such inspections.
Respirator Maintenance and Care

In order to ensure that all respirators are maintained at their original level of effectiveness, any organization subject to OSHA's Respiratory Protection Standard (29 CFR Part 1910.134) must have written procedures and schedules for cleaning, disinfecting, storing, inspecting, repairing, discarding, and otherwise maintaining respirators.

Respirator maintenance and care procedures summarized below can be found in the OSHA standard.

Cleaning and Disinfecting Respirators

Employers must provide each respirator user with a respirator that is clean, sanitary, and in good working order. An employer may choose to use the following cleaning procedures detailed in Appendix B-2 of the OSHA standard or follow equally effective recommendations provided by the manufacturer:

- Remove filters, cartridges, or canisters. Disassemble facepieces. Discard or repair any defective parts.

- Wash components in warm water with a maximum temperature of 43° C (110° F) using a mild detergent or recommended cleaner.

- Rinse components thoroughly in clean, warm, preferably running water. Drain. If the cleaner does not contain a disinfecting agent, immerse respirator components for two minutes in:
  - a 50 ppm solution of hypochlorite;
  - a 50 ppm solution of iodine; or
  - other commercially available cleanser of equivalent disinfectant quality recommended or approved by the respirator manufacturer.

- Rinse components thoroughly in clean, warm, preferably running water. Drain.

- Allow components to air-dry or dry them with a clean, lint-free cloth.

- Reassemble facepiece, replacing components as needed.

- Test the respirator to ensure that all components work properly.
Respirator Storage

Store all respirators in a manner that protects them from damage, contamination, dust, sunlight, extreme temperatures, excessive moisture, and damaging chemicals. Pack or store respirators in a manner that prevents deformation of the facepiece and exhalation valve.

Respirators are often stored in gallon-sized zip bags or resealable plastic containers. Plastic containers are preferable since the respirator does not deform during storage. Make sure that the all parts, including elastic straps, are thoroughly dry before placing the respirator into the storage container; failure to do so may result in fungal growth.

Respirator Inspection

All respirators should be inspected before each use and during cleaning. When inspecting respirators, the following should be checked:

- Respirator function;
- Tightness of connections;
- The condition of the various parts including facepieces, head straps, valves, connecting tubes, filtration mechanisms; and
- Elastomeric parts – for pliability and signs of deterioration.

Respirator Repair

If a respirator fails an inspection or is defective, it should be removed from service and discarded unless an appropriately trained individual is available to repair or adjust it. Only the respirator manufacturer’s NIOSH-approved parts should be used for repairs and repairs should be made according to the manufacturer’s recommendations and specifications.

Miscellaneous Considerations

Proper fit of respirators is essential and may be ensured by:

- being clean-shaven in the facial areas to which sealing surfaces must adhere;
- using eyewear (spectacle) kits when use of glasses is a necessity;
- getting an additional fit test when bodily changes occur that would affect respirator fit such as weight loss, facial scarring, tooth loss, etc.; and
- conducting negative and positive pressure seal checks before each respirator use.
Additional considerations include:

- conducting a trial run using personal protective clothing and a respirator to determine whether claustrophobia or any other physical condition would impair the ability of the inspector to conduct an actual inspection while in full gear; and

- avoiding purchase of respirators that are difficult to decontaminate such as those with Velcro® closures and mesh head harnesses.