# 15 RESPIRATORY PROTECTION

In the course of their work, construction personnel are often exposed to respiratory hazards in the form of dangerous dusts, gases, fumes, mists, and vapours.

In some cases, careful selection of materials and work practices can virtually eliminate respiratory hazards. Where that is not possible, the next best choice is engineering controls such as fume exhaust systems that deal with the hazard at the source.

Respirators are the least preferred method of protection from respiratory hazards because they

- do not deal with the hazard at the source
- can be unreliable if not properly fitted and maintained
- may be uncomfortable to wear.

In spite of these drawbacks, respiratory protective equipment is the only practical control in many construction operations.

## Respiratory Hazards

Respiratory hazards may be present as

- gases
- vapours
- fumes
- mists
- dusts
- bioaerosols (e.g., moulds)

**Gases** consist of individual molecules of substances, and at room temperature and pressure, they are always in the gaseous state. Common toxic gases found in construction are carbon monoxide from engine exhaust and hydrogen sulphide produced by decaying matter found in sewers and other places.

**Vapours** are similar to gases except that they are formed by the evaporation of liquids (e.g., water vapour). Common vapours found in construction are produced by solvents such as xylene, toluene, and mineral spirits used in paints, coatings, and degreasers.

**Fumes** are quite different from gases or vapours, although the terms are often used interchangeably. Technically, fumes consist of small particles formed by the condensation of materials that have been subjected to high temperatures. Welding fume is the most common type of fume in construction. Another example is pitch fume from coal tar used in built-up roofing.

**Mists** are small droplets of liquid suspended in air. The spraying of paint, form oils, and other materials generates mists of varying composition.

**Dusts** are particles that become airborne from tasks such as crushing, grinding, sanding, or cutting and from work such as demolition. Two kinds of hazardous dust common in construction are fibrous dust from insulation materials (such as asbestos, mineral wool, and glass fibre) and non-fibrous silica dust from sandblasting, concrete cutting, or rock drilling.

**Bioaerosols** are airborne particles that contain microbes such as mould, bacteria, viruses, or pollen. If inhaled, they can cause infectious diseases (Legionellosis, Tuberculosis, etc.), respiratory infections, or allergic reactions.

In construction settings, respiratory hazards may be compounded, depending on the number and variety of jobs under way. For example, both mist and vapours may be present from paint spraying or both gases and fumes from welding.

## Health Effects

Inhalation hazards can be divided into the following classes based on the type of effects they cause.

1. **Irritants** are materials that irritate the eyes, nose, throat, or lungs. This group includes fibreglass dust, hydrogen chloride gas, ozone, and many solvent vapours. With some materials (e.g., cadmium fume produced by welding or oxyacetylene cutting of metals coated with cadmium) the irritation leads to a pneumonia-like condition called pulmonary edema. **This effect may not be apparent until several hours after exposure has stopped.**
2. **Asphyxiants** are substances which result in inadequate oxygen in the body. They can be classified as either **simple asphyxiants** or **chemical asphyxiants.**

   **Simple asphyxiants** are other gases or vapours that cause oxygen to be displaced, creating an **oxygen-deficient atmosphere**. For example, nitrogen used to purge tanks can displace oxygen, resulting in unconsciousness and even death for those who enter. Oxygen may also be consumed by chemical or biological activity such as rusting or bacteria digesting sewage.

   **Chemical asphyxiants** interfere with the body's ability to transport or use oxygen. Two examples are carbon monoxide and hydrogen sulphide.
3. **Central nervous system depressants** interfere with nerve function and cause symptoms such as headache, drowsiness, nausea, and fatigue. Most solvents are central nervous system depressants.

4. **Fibrotic materials** cause "fibrosis" or scarring of lung tissue in the air sacs. Common fibrotic materials found in construction include asbestos and silica.
5. **Carcinogens** cause or promote cancer in specific body organs. Silica, asbestos, and hexavalent chromium are examples of carcinogens.
6. **Dusts** do not cause significant effects unless exposure is of high concentration and/or long duration. Excessive exposure to these substances can be adverse in itself or can aggravate existing conditions such as emphysema, asthma, or bronchitis. Examples include plaster dust, cellulose from some insulation, and limestone dust.
7. **Biological hazards** include moulds, bacteria, or viruses. If inhaled, they can cause eye, nose and throat irritation, hypersensitivity pneumonitis, or asthma.
8. **Respiratory sensitizers** are chemicals such as isocyanates in spray foam insulation or certain wood dusts. If inhaled, they can cause asthma.

## Respiratory Protective Equipment

A wide variety of equipment can be used to protect workers from respiratory hazards. Devices range from a simple, inexpensive filtering facepiece respirator to a sophisticated self-contained breathing apparatus. Generally, the equipment can be divided into two distinct classes:

**A. Air-purifying respirators**

**B. Supplied-air respirators.**

### A. Air-purifying Respirators

As the name indicates, these devices purify the air drawn through them. There are two main types of air-purifying respirators:

1) **Non-powered**
Air is drawn through the air-purifying filter, cartridge or cannister by the wearer breathing in and creating a negative pressure in the facepiece. Non-powered respirators depend entirely on the wearer breathing in (inhaling) and breathing out (exhaling) to deliver an adequate supply of purified breathing air.

2) **Powered**
These respirators have a blower carried by the wearer that passes contaminated air through an air-purifying component and supplies the purified air to the wearer.

Air-purifying respirators have limitations and should not be used where

- there is insufficient oxygen (less than 19.5%)
- very high concentrations of contaminant are present.

**Warning:** Air-purifying respirators simply remove certain airborne hazards. They do not increase or replenish the oxygen content of the air and should never be worn in atmospheres containing less than 19.5% oxygen.

Although many different filters have been designed for specific hazards, there are three basic types used with air-purifying respirators:

**1) Particulate filters**
**2) Gas/vapour cartridge filters**
**3) Combination particulate/gas/vapour cartridge filters (Figure 15-1).**

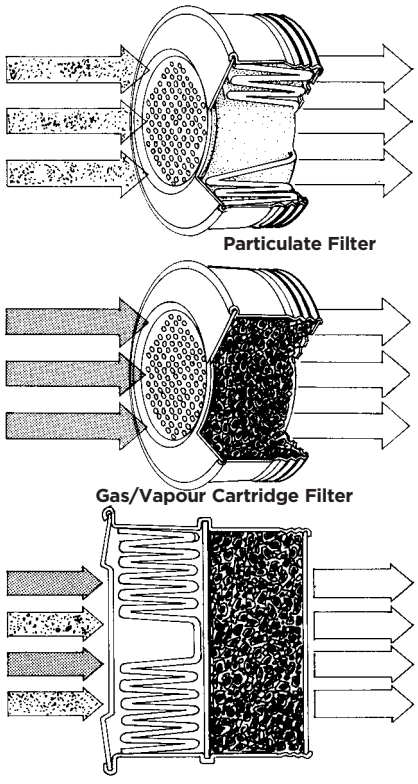



**Figure 15-1: Filter Types**

#### 1) Particulate Filters

This type removes solid particles such as dusts, fumes, or mists and operates like the air filter in a car engine. The devices may be filtering facepiece respirators or respirators with replaceable filters. Different grades of filters are available, depending on the size of particles to be removed.

When particulate filters fill up with dust or fume, they become harder to breathe through but are more efficient, since air is being filtered through the layer of trapped particles as well as the filter itself.

While particulate filters can provide good protection against particles such as dusts, mists, or fumes, they cannot filter out gases or vapours because of the very small size of gas and vapour molecules.

Particulate filters for non-powered air-purifying respirators are divided into three levels of filter efficiency: 95%, 99%, and 99.97%. These numbers refer to the percentage of particles the filter can remove, based on the particle size most difficult to trap. For workers removing asbestos insulation or lead paint, for instance, the 99.97% efficiency cartridge may be appropriate for the circumstances. This is known as the 100 efficiency class, previously identified as the HEPA filter.

Oil has been found to ruin the filtering ability of some filter material. Oil coats the filter fibres, preventing the electrostatic charge on the fibres from attracting and removing particulates. Therefore, to ensure that a suitable filter is being used, particulate filters have an N, R, or P designation:

N – **N**ot resistant to oil
R – **R**esistant to oil
P – oil-**P**roof.

The N series of filters is suitable for airborne particles such as wood dust, when there are no oil-based particles also in the air. For example, an N series filter would be recommended during the removal of old lead paint. However, when spraying form oil or putting down hot asphalt—operations that involve airborne oil particles—the correct filter would have an R or P designation.

The R series—resistant to oil—should only be used for an 8-hour single shift when solvent or oil mist is present in the air. This filter resists oil but may lose its filtering ability when in contact with oil over a long time.

When using P series filters, check the manufacturer's instructions to determine how long the filter can be used when airborne oil particles are present.

**Warning:** N, R, and P series filters by themselves do not provide protection against organic vapours.

### 2) Gas/Vapour Cartridge Filters

This type uses substances which absorb or neutralize gases and vapours. Unlike particulate filters, gas/vapour cartridge filters become less efficient the longer they are used. They act like sponges and, when full, allow gas or vapour to pass through without being absorbed. This is called "breakthrough."

Common gas/vapour cartridge filters include the following:

- "Organic Vapour Cartridges" usually contain activated charcoal to remove vapours such as toluene, xylene, and mineral spirits found in paints, adhesives, and cleaners.
- "Acid Gas Cartridges" contain materials which absorb acids and may be used for protection against limited concentrations of hydrogen chloride, sulphur dioxide, and chlorine.
- "Ammonia Cartridges" contain an absorbent designed specifically to remove only ammonia gases.

**Note:**

Certain cartridges are available with an end-of-service-life indicator. These cartridges have been developed for a few contaminants with poor warning properties. The end-of-service-life indicator changes colour to warn the user to change the cartridge.

Cartridges must not be used for contaminants with poor warning properties unless the respirator manufacturer can offer cartridges with end-of-service-life indicators.

If the respirator is not equipped with an end-of-service-life indicator, a change-out schedule is required. The schedule is used to determine the service life of the cartridge. The respirator manufacturer should be consulted for guidance on the development of this schedule.

### 3) Combination Particulate/Gas/Vapour Cartridge Filters

This type removes particulate matter, vapours, and gases from the air. It is used where more than one type of hazard is present or may develop.

## B. Supplied-Air Respirators

Supplied-air respirators provide clean breathing air from an uncontaminated source, usually a special compressor located in a clean environment, or from cylinders containing compressed breathing air. The quality of the air supplied should meet the requirements of CSA Standard Z180.1, *Compressed Breathing Air and Systems*.

The moisture content of supplied air should be limited to prevent fogging, corrosion, and freezing of regulators and valves and to prolong the service life of filters used to remove other contaminants.

The "pressure dew point" is important in relation to moisture. The term refers to the temperature at which moisture in compressed air, at a given pressure, will condense out as droplets or "dew."

It must be kept at least 5°C below the lowest expected ambient temperature. Water vapour can be removed from compressed air with a drying system or water-absorbing materials.

### Types of Supplied-Air Respirators

The three basic types of supplied-air respirators are:

**1) Air-line unit**

**2) Self-contained breathing apparatus (SCBA)**

**3) Multifunctional unit (combination air-line and SCBA).**

The **air-line unit** consists of compressed breathing air, portable supplied air, or a clean ambient air system. The air is supplied to the user by a hose attached to the wearer's belt. This allows for quick disconnecting in an emergency. The clean air flows from the air supply system through the hose and to the user's respirator facepiece (Figure 15-2).


Type CE abrasive-blast supplied-air respirators are the only respirators suitable for abrasive-blast (sandblasting) operations. As a minimum, NIOSH recommends a type CE, positive pressure, with tight-fitting half-mask facepiece respirator.

**Figure 15-2: Abrasive–Blaster's Supplied-Air Hood**

The **self-contained breathing apparatus** (SCBA) uses a cylinder of air carried by the wearer (Figure 15-3). SCBAs are awkward, heavy, and require frequent cylinder changes.

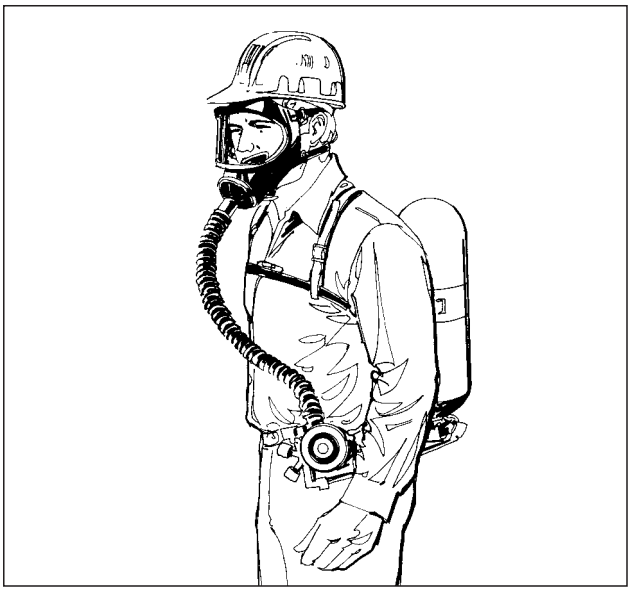


**Figure 15-3: Self-Contained Breathing Apparatus (SCBA)**

The **multifunctional unit** is available for working in confined spaces and other high-risk assignments where reserve protection is required (Figure 15-4).

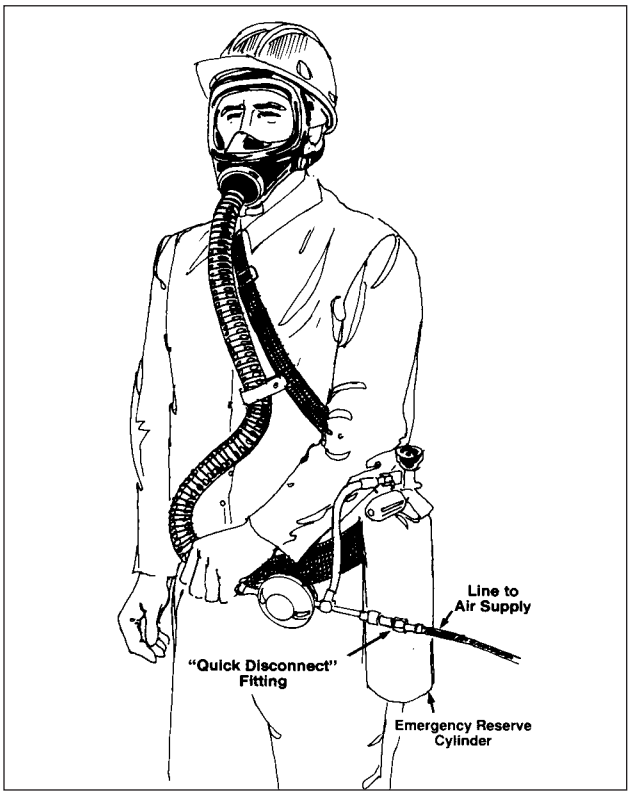



**Figure 15-4: Multifunctional (Combination Air-Line/SCBA)**

With these devices or with simple air-line units, the wearer's mobility is understandably restricted by the trailing hose and the length of line available. In addition, air-lines may get crimped or may snag on equipment.

If an atmosphere is immediately dangerous to life or health, a combination air-line/SCBA unit is required.

Both air-line and SCBA units are more expensive than air-purifying systems, but they provide much greater protection.

## Modes of Operation

Respirators can operate in the following modes:

**1) "Pressure-demand" or "positive pressure"**
**2) "Constant-flow"**
**3) "Negative-pressure" or "demand"**

### 1) Pressure-Demand or Positive Pressure Mode

In "pressure-demand" or "positive pressure" mode, the pressure in the facepiece or hood always remains positive. When there is a slight decrease in positive pressure inside the facepiece, more air is supplied. If leakage occurs, it is directed outside of the facepiece rather than inside.

### 2) Constant-Flow Mode

As the name implies, these devices deliver a constant flow of air to the wearer. Powered air-purifying respirators (PAPRs) use a battery-powered fan to draw air through the filter and then blow it into the facepiece (Figure 15-5). When working conditions are hot and humid, PAPRs provide more comfort than non-powered air-purifying respirators. However, they should never be used in oxygen-deficient conditions. Constant-flow supplied-air respirators such as sandblasters' hoods use a simple valve to control the flow of "clean" air from the compressor.

Minimum flow rates of 170 litres per minute (6 cubic ft/min) for loose-fitting hoods or helmets and 115 litres per minute (4 cubic ft/min) for tight-fitting facepieces must be maintained to minimize inward leakage of contaminated air and still provide adequate breathing air.

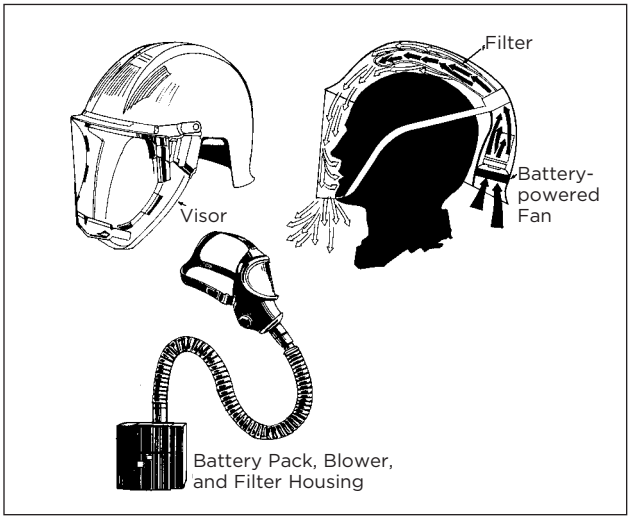



**Figure 15-5: Powered Air-Purifying Respirators (PAPRs)**

### 3) Negative-Pressure or Demand Mode

In "negative-pressure" or "demand" mode, air is delivered only when there is a slight negative pressure created in the facepiece. Contaminated air may leak inward around the facepiece, so these devices have limited use in high-exposure conditions.

## Styles of Facepieces

In addition to the type of respirator and mode of operation, the style of facepiece is used to classify respirators. Different styles are available, as shown in Figure 15-6.

**Filtering Half-Facepieces**—Most of these devices are designed to be worn only once. They fit over the mouth and nose, rest on the chin, and are held in place by two straps. Some of the more sophisticated versions with adjustable straps and exhalation valves can be worn more than once, provided they are not damaged.

**Hoods and Helmets**—These devices do not rely on tight seals to prevent inward leakage of contaminated air. Instead they depend on the continuous flow of large volumes of air. Hoods and helmets can be used with powered air-purifying and supplied-air systems.

**Full-Face Mask**—This style covers the entire face and consists of a moulded rubber or plastic frame and a clear visor. Since it fits against the relatively smooth rim of the face, it provides more protection than other face masks. Full-face masks can be used with air-purifying, powered air-purifying, and supplied-air respirators.

**Half-Face Mask**—This style is widely used as an air-purifying respirator with one or more filters or cartridges attached to the facepiece. The silicone, thermoplastic, or rubber facepiece covers the mouth and nose, cups under the chin, and is usually held in place by two straps. It generally provides better protection than quarter-face masks because the chin cup affords a more secure fit.

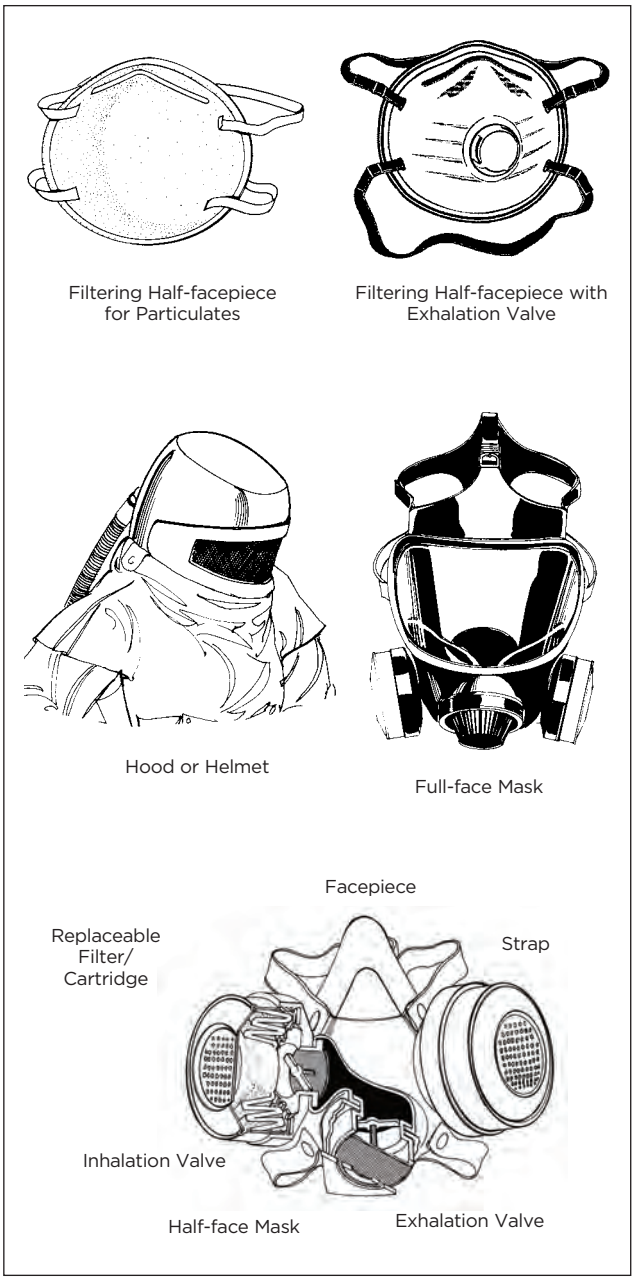



**Figure 15-6: Styles of Facepieces**

## Assigned-Protection Factors

The assigned-protection factor (APF) is a measure of the anticipated level of protection provided by a properly functioning respirator to properly trained users. Most respirators are assigned an APF, which are used in the selection process to determine the maximum use concentration (MUC) for the respirator.

The MUC is the maximum level of an airborne contaminant that an employee is expected to be protected from when wearing a respirator. It is determined by multiplying the APF of the respirator or class of respirators by the occupational exposure limit (OEL) for that contaminant.

For example, the OEL for chrysotile asbestos in Ontario is 0.1 fibre/cm$_3$ of air. If we are using a half-mask respirator with N100 filters (APF=10), the MUC is 1 fibre/cm3 (i.e., 10 (APF) * 0.1 (OEL) = 1 (MUC)). If the concentration of asbestos becomes greater than 1 fibre/cm$_3$ during the course of work, a respirator with a greater APF must be used.

The Canadian Standards Association (CSA), the US National Institute for Occupational Safety and Health (NIOSH), and the American National Standards Institute (ANSI) have each published slightly different APFs. In this manual, OHSA-assigned protection factors are used.

The degree of protection depends on the type of respirator, style of facepiece, and principle of operation. Generally, supplied-air respirators provide better protection than air-purifying respirators; full-face masks provide better protection than half-face masks; and positive-pressure devices provide more protection than negative-pressure types.

Table 15-1 lists APFs for the respirators described so far. The information can be used to select the most appropriate device for any given situation.

These APFs were determined by testing a wide variety of devices worn by a large number of people and represent the average degree of protection achieved. APFs for individual wearers may differ significantly from the values listed.

**Table 15-1: Assigned-Protection Factors (APF)**

| Type of Respirator | Style of Facepiece | Mode | APF |
|---|---|---|---|
| Air-purifying | Filtering facepiece | Negative | 10 |
| | Half-facepiece | Negative | 10 |
| | Full-facepiece | Negative | 50 |
| Powered Air-purifying | Helmet/hood | Continuous | 25/1000* |
| | Loose-fitting facepiece/visor | Continuous | 25 |
| | Half-facepiece | Continuous | 50 |
| | Full-facepiece | Continuous | 1000 |
| Supplied-air or Air-line | Half-facepiece | Continuous | 50 |
| | Full-facepiece | Continuous | 1000 |
| | Helmet/hood | Continuous | 25/1000* |
| | Loose-fitting facepiece | Continuous | 25 |
| | Half-facepiece | Pressure-demand | 50 |
| | Full-facepiece | Pressure-demand | 1000 |
| Self-Contained Breathing Apparatus (SCBA) | Full facepiece or tight-fitting hood | Pressure-demand | 10,000 |

*Source: CSA Z94.4-11*

*The employer must have evidence provided by the respirator manufacturer that testing of these respirators demonstrates performance at a level of protection of 1000 or greater to receive an APF of 1000. Without such information, all other PAPRs and SARs with helmets/hoods are to be treated as loose-fitting facepiece respirators, and receive an APF of 25.

## Respirator Selection

In order to select the proper respirator for a particular job, it is necessary to know and understand

- the characteristics of the contaminant(s)
- the anticipated exposure conditions
- the performance limitations of the equipment
- any legislation that applies.

It is also important to realize that facial hair and deep facial scars can interfere with the seal between respirator and face. Respirators should only be selected by someone who understands all of these factors.

Before using or handling a hazardous product, consult the safety data sheet (SDS) for the type of respiratory protection required. Under the Workplace Hazardous Materials Information System (WHMIS), an SDS must be available for every hazardous product.

The chart at the end of this section is intended as a guide to respirator selection only and may not be applicable to every case. For activities not listed, information regarding type of work, nature of material(s) involved, and working conditions is required and expert advice should be obtained.

If there is any doubt about the correct type of protection for a specific material and operation, consult the manufacturer of the product, a supplier or manufacturer of respirators, or IHSA. When seeking information on the type of respirator for use in specific situations, provide as much of the following information as possible:

a) Name and form of the material (oil or non-oil). If the form is unknown, consider it an oil.
b) Type of work to be done (e.g., painting, welding).
c) Description of worksite conditions (e.g., inside a tank, outdoors).
d) Exposure concentration, if known (e.g., 150 ppm of toluene).
e) Whether the material will be heated, sprayed, etc.
f) Other materials being used in the vicinity. The respiratory protection specialist will evaluate this information and compare it with the following additional data:
   - The occupational exposure limit of the dust, gas, or vapour, often referred to as the TLV® or Threshold Limit Value*. These values are used in conjunction with the assigned-protection factors listed in Table 15-1 to determine the maximum use concentration.
   - The physical properties of the contaminant:
     - Vapour Pressure — The maximum amount of vapour that can be generated under given conditions.
     - Warning Properties (e.g., irritation, odour, taste)–Warning properties of the contaminent shall not be relied on for cartridge/canister change out.

*TLV is a term copyrighted by the American Conference of Governmental Industrial Hygienists.

  - Health Effects — With cancer-causing materials, a higher degree of protection is usually specified.
  - Performance of Filters — With some gases and vapours, the filter can become overloaded in just a few minutes. Therefore, knowledge of the filtering material and its performance against specific gases and vapours is necessary.
- The concentration considered to be Immediately Dangerous to Life or Health (IDLH). IDLH atmospheres pose an immediate threat to life or health or the threat of a serious but delayed effect on health (e.g., radioactive dust exposures). One example of an IDLH situation is the repair of a chlorine leak where a worker could be overcome by the gas very quickly. IDLH atmospheres should only be entered by persons wearing SCBA or SCBA/air-line respirators as shown in Figures 15-3 and 15-4.
- Possibility of skin absorption. With some chemicals the amount of material that can be absorbed through the skin is of equal or greater concern than the amount of gas or vapour that can be inhaled. For these situations, supplied-air protective suits may be necessary.
- Eye irritation — some contaminants will cause eye irritation, making it difficult to see. For these contaminants, a full-face mask must be worn.

As shown by points a) to f), many factors must be considered to ensure that the proper respirator is selected for a specific situation.

## Fit Testing and Seal Checks

Once a respirator has been selected, the next critical step is ensuring that it fits properly. One size does not fit all. No person should be assigned a tight-fitting respirator or wear one unless a fit test has been conducted.

With negative-pressure respirators (e.g., non-powered air-purifying respirators and supplied-air respirators) gaps in the seal will permit contaminated air to enter the breathing zone.

With positive-pressure respirators (e.g., powered air-purifying respirators and pressure-demand supplied-air respirators) a lot of air will be wasted through outward leakage and the degree of protection provided to the wearer could be reduced. Also, "venturi effects" may allow air to escape in one area and draw contaminated air into the facepiece around the escaping air.

A fit test is carried out prior to initial use of a tight-fitting respirator. However, there are other circumstances when a fit test should be done:

- When changes occur to a user's physical condition that could affect the fit (e.g., a significant weight change or changes to facial or dental features)
- When there is a change in the respirator (e.g., new make, model, or size)
- When a respirator user experiences continued significant discomfort during use or difficulty in completing a successful user seal check
- When there is a change in PPE use that could affect the respirator (e.g., user now required to wear safety glasses)
- At least every 2 years, generally.

For these and other reasons, the fit of respirators must be carefully tested. Generally there are two types of fit testing — qualitative and quantitative.

### Qualitative Fit Tests

Before carrying out a qualitative fit test, it should be confirmed that the respirator user can taste or smell the test agent being used.

1) **Irritant Smoke Test** — This test is used to determine the fit of P100 particulate filter respirators. (Note: It is not intended for N- or R-respirators.) A cloud of irritant smoke is created around the wearer. If leakage is detected, the respirator should be adjusted.

   **Caution:** Most of the smoke clouds used in this test are very irritating to the eyes, nose, and throat. Workers are advised to keep their eyes closed during the test and to back out of the smoke as soon as they notice any leakage or irritation.
2) **Iso Amyl Acetate (Banana Oil) Test** — The wearer puts on the respirator with "organic vapour" cartridge filters in place. If the wearer smells the solution, the respirator should be adjusted.
3) **Saccharin Test** — This test is similar to the iso amyl acetate test except that it uses saccharin as the test material and a respirator equipped with a particulate filter. If the sweet taste or smell of saccharin is detected, the fit must be adjusted.
4) **Bitter Solution Aerosol Test** — In this test, the wearer puts on the respirator with any particulate filter. A hood or test enclosure is put over the wearer's head and shoulders. Bitter solution is then sprayed into the hood or enclosure. Bitter solution can easily be detected if it leaks through the face seal. If the wearer cannot taste the bitter solution, then the respirator fits properly.

### Quantitative Fit Tests

In these tests, the wearer puts on a special respirator that has a probe mounted inside the facepiece. The fit of the respirator can be determined by

1) comparing the amount of test aerosol outside the respirator to the amount inside the respirator
2) comparing the amount of ambient aerosol outside of the respirator to the amount inside the respirator
3) measuring the amount of pressure leakage from the respirator.

### User Seal Checks

Every time you put a on a tight-fitting respirator, check the seal using the negative-pressure and positive-pressure method (Figure 15-7).

1) **Negative-Pressure Seal Check** — The wearer puts on the respirator and adjusts it so that it feels relatively comfortable. Then the air inlets are blocked off with the hands or a plastic cover, and the wearer inhales gently and holds for five seconds. If the respirator is properly fitted, it should collapse slightly and not permit any air into the facepiece. If leakage is detected, the mask should be readjusted and the test repeated until the fit is satisfactory.
2) **Positive-Pressure Seal Check** — The wearer puts on the respirator and adjusts it so that it feels relatively comfortable. Then the exhaust port of the respirator is covered and the wearer tries to exhale gently. The facepiece should puff away from the wearer, but no leakage should occur.

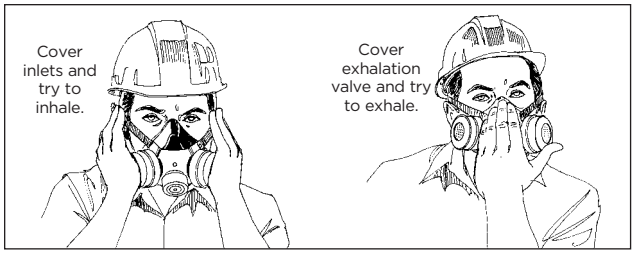



**Figure 15-7: Negative-Pressure and Positive-Pressure Seal Check**

## Respirator Maintenance

Like any equipment, respirators need maintenance. The following instructions cover the major points.

1) Filters should be changed as follows:
   - Dust/mist/fume filters should be changed when there is noticeable resistance to normal breathing.
   - Chemical cartridges should be changed when indicated by the end-of-service-life indicator or according to the change-out schedule.
   - Any filter should be changed at the interval specified by the manufacturer or when damaged in any way.
2) Inhalation and exhalation valves should be checked before the respirator is used.
3) Damaged facepiece, straps, filters, valves, or other parts should be replaced with "original equipment" parts.
4) Facepieces should be washed in accordance with the manufacturer's instructions.
5) Respirators should be assigned to the exclusive use of individual workers.
6) Where a respirator must be assigned to more than one worker, it should be disinfected after each use (check with the manufacturer regarding acceptable sanitizers/disinfectants).
7) Check all supply hoses, valves, and regulators on supplied-air respirators as specified by the manufacturer.
8) SCBA units and high-pressure cylinders of compressed breathing air should be used and maintained in accordance with current CSA Standards Z94.4: *Selection, Care and Use of Respirators* and Z180.1: *Compressed Breathing Air and Systems.*
9) Compressors and filtration systems used with supplied-air respirators must be maintained in accordance with the manufacturers' recommendations.
10) Consult manufacturer for information on respirator cartridge change-out.
11) Store respirators in a location away from dust, ozone, sun, heat, extreme cold, excessive moisture, vermin, damaging chemicals, oils, and grease. Also ensure the rubber facepiece is not deformed.

## Approvals and Standards

The most commonly referenced standards for respiratory protection in North America are the test criteria used by the National Institute for Occupational Safety and Health (NIOSH).

NIOSH is a U.S. government agency which tests and approves respiratory protective equipment as one of its major activities and publishes a list of approved devices annually.

IHSA recommends that only NIOSH-approved equipment be used for protection against respiratory hazards.

The CSA has issued two standards pertaining to respiratory protection, which should be reviewed by the person who is responsible for the respirator program:

- Z94.4 *Selection, Care and Use of Respirators* offers recommendations on these three aspects of the subject.
- Z180.1 *Compressed Breathing Air and Systems* lists the criteria for air purity and delivery systems

These standards are copyrighted by CSA. Copies can be purchased from www.csagroup.org (1-800-463-6727).

# Review

The following section lists common claims about respirators and explains why the statements are true or false. The information provides a convenient review of major points in this chapter.

| | | |
|---|---|---|
| 1) All respirators are the same. | (False) | Most respirators, especially air-purifying types, are limited to certain types of hazards. For instance, filtering facepiece respirators may be suitable for dusts, but do not provide protection against gases and vapours. |
| 2) One size fits all. | (False) | Most manufacturers offer three sizes of facepieces (small, medium, and large) to ensure a proper fit. In some cases, no size from one manufacturer may fit an individual and a different brand may be necessary. |
| 3) Respirators make breathing more difficult. | (True) | With air-purifying respirators, the air is being inhaled through a filter, so some additional effort is required. With most pressure/demand supplied-air respirators, additional effort is required to activate the inhalation and exhalation valves. |
| 4) Air-purifying respirators supply oxygen. | (False) | These devices simply filter out specific gases, vapours, dust, mists, or fumes, but do not increase the oxygen content of the air. |
| 5) Most respirators require maintenance. | (True) | With the exception of disposable and single-use respirators, some maintenance is required. |
| 6) Any source of compressed air will be adequate for supplied-air respirators. | (False) | Compressed breathing air must be "clean" and free from carbon monoxide, oil mist, and other contaminants. |
| 7) Assigned protection factors (APFs) are the same for everyone. | (False) | The APFs listed in Table 15-1 are averages obtained by testing a large number of wearers. Individual protection factors can be considerably different from those listed. |
| 8) Respirators are the best way to control respiratory hazards. | (False) | Good ventilation is the best way of controlling respiratory hazards, though it is not always practical in many construction applications. |
| 9) The moisture content of compressed air is important. | (True) | If the moisture content of the air in a pressurized breathing air system is too high, the regulators can freeze shut and cut off the supply of air. Moisture can also cause deterioration of storage cylinders. |
| 10) Parts can be interchanged from one manufacturer to another. | (False) | Using improperly fitted or matched components voids the NIOSH approval and can cause failure of the respirator, posing serious risk to the wearer. |
| 11) Fitting of respirators is not important | (False) | No matter how effective its protection against specific hazards, the respirator must be properly fitted to prevent inward leakage of contaminated air. The only exceptions are hoods and helmets, and even these depend on fit to a certain degree. |

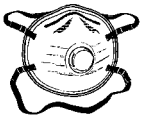
| | | |
|---|---|---|
| 12) Self-Contained Breathing Apparatus (SCBA) and air-line respirators provide the best protection. | (True) | They also have disadvantages, which make their use impractical in some situations. |
| 13) Respirators should be checked each time they are used. | (True) | Damaged straps, missing or ill-fitting valves, and other problems can make the device useless. |
| 14) Only one respiratory hazard is present in a particular job. | (False) | Often there are two or more hazards present. For instance, spray painting produces mists and vapours and welding can produce fumes and gases. |
| 15) Respirators can be fitted with filters suitable for more than one hazard. | (True) | Many manufacturers offer filters that will remove selected dusts, fumes, gases, and vapours all at the same time. |
| 16) Single-use filtering facepiece respirators should not be worn more than once. | (True) | These inexpensive respirators are meant to be put on once only. They may not provide adequate protection once the straps have been stretched. |
| 17) Respirators provide absolute protection. | (False) | Every respirator has limitations that the wearer must understand. Protection is ensured not only by the respirator but also by its proper use. |
| 18) Respirators are simple to select for any job. | (False) | In many cases, even the respiratory protection specialists have problems in selecting the right device. |
| 19) Respirators interfere with eye protection. | (True) | Protective goggles and glasses may not fit properly with many respirators. Full-face masks may be necessary. |
| 20) NIOSH approvals are important. | (True) | NIOSH approvals indicate that the device has passed a set of minimum design and performance standards. Unapproved respirators may provide similar protection, but this can only be evaluated by expert review of the manufacturer's claims. |
| 21) Beards and mustaches do not affect respiratory protection. | (False) | With the exception of hoods and some helmets, beards and mustaches cause a great deal of leakage and reduce the effectiveness of respirators significantly. Respirator wearers should be clean shaven to obtain the best possible protection. |

**Summary**

Respiratory protective equipment can prevent illness, disease, and death from breathing hazards. But the equipment must be properly selected, fitted, worn, and maintained to ensure maximum protection.

IHSA can provide assistance in selecting respiratory protection and training workers in its use, care, and maintenance. For additional information, contact IHSA.

## Table 15-2: Respirator Selection Guide for Common Construction Activities

| | Air-purifying | | | | | | | | Supplied-air | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Half facepiece | | | | Full facepiece | | Powered air-purifying (PAPR) helmet/hood† or full face | | Helmet/hood† NIOSH type CE pressure demand Full facepiece pressure demand | | SCBA or SCBA + air-line, full facepiece and pressure demand | |
| | Filtering facepiece  | Elastomeric facepiece  | | |  | |  | | | | | |
| Filter efficiency and type | 95 | 100 | 95 | 100 | Organic vapour | 95+ organic vapour | 100+ organic vapour | 100 | 100+ organic vapour | 100 | | |
| Assigned-protection factor* CSA Z94.4-11 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 50 | 50 | 1000 | 1000 | 10,000 |
| **Asbestos (see chapter on asbestos)** | | | | | | | | | | | | |
| **Lead** | | | | | | | | | | | | |
| Application of lead-containing coatings with a brush or roller | | | Optional ✓ N, R, or P | | | | | | | | | |
| Spray application of lead-containing coatings | | | | | | | | | | ✓ Hood or helmet | | |
| Removal of lead-containing coatings or materials by scraping or sanding using non-powered hand tools | | | ✓ N, R, or P | | | | | | | | | |
| Removal of lead-containing coatings or materials using non-powered hand tools—other than manual scraping or sanding | | | Optional ✓ N, R, or P | | | | | | | | | |
| Removal of lead-containing coatings with a chemical gel or paste and fibrous laminated cloth wrap | | | Optional ✓ N, R, or P | | | | | | | | | |
| Removal of lead-containing coatings or materials using a power tool ***without*** a dust collection system equipped with a HEPA filter (airborne dust ≥ 0.05 mg/m³) | | | | | | | | | | ✓ Tight-fitting full facepiece | | |

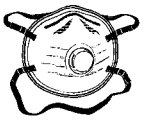
**Continued on next page . . .**

**N = Not resistant to oil R = Oil-resistant P = Oil-proof OV = Organic vapour cartridge**

✓ Indicates suitable protection. If oil mist is present, use R or P filters.

* See page 15-20.

† See page 15-20.

| | Air-purifying | | | | | | | | Supplied-air | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Half facepiece | | | | Full facepiece | | Powered air-purifying (PAPR) helmet/hood† or full face | | Helmet/hood†<br>NIOSH type CE pressure demand<br>Full facepiece pressure demand | | SCBA or SCBA + air-line, full facepiece and pressure demand | |
| | Filtering facepiece | | Elastomeric facepiece | | | | | | | | | |
| |  | |  | |  | |  | | | | | |
| Filter efficiency and type | 95 | 100 | 95 | 100 | Organic vapour | 95+ organic vapour | 100+ organic vapour | 100 | 100+ organic vapour | 100 | | |
| Assigned-protection factor* CSA Z94.4-11 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 50 | 50 | 1000 | 1000 | 10,000 |
| **Lead cont'd** | | | | | | | | | | | | |
| Removal of lead-containing coatings or materials using a power tool ***with*** a dust collection system equipped with a HEPA filter (airborne dust must be controlled to < 0.05 mg/m³) | | | Optional ✓ N, R, or P | | | | | | | | | |
| Abrasive blasting of lead-containing coatings or materials | | | | | | | | | | | ✓ Type CE blasting; positive pressure; tight-fitting half-facepiece | |
| Dry removal of lead-containing mortar using an electric or pneumatic cutting device | | | | | | | | | | ✓ Tight-fitting full facepiece | | |
| Welding or high-temperature cutting of lead-containing coatings or materials indoors or in a confined space | | | | | | | | | | ✓ Tight-fitting full facepiece | | |
| Welding or high-temperature cutting of lead-containing coatings or materials outdoors—long-term operations or if material not pre-stripped | | | | | | | | | | ✓ Tight-fitting full facepiece | | |
| Welding or high-temperature cutting of previously stripped lead-containing coatings or materials outdoors—short term only | | | Optional ✓ N, R, or P | | | | | | | | | |

**Continued on next page . . .**

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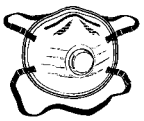
| | Air-purifying | | | | | | | | Supplied-air | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Half facepiece | | | | Full facepiece | | Powered air-purifying (PAPR) helmet/hood† or full face | | Helmet/hood†<br>NIOSH type CE pressure demand<br>Full facepiece pressure demand | | SCBA or SCBA + air-line, full facepiece and pressure demand | |
| | Filtering facepiece  | Elastomeric facepiece  | | |  | |  | | | | | |
| Filter efficiency and type | 95 | 100 | 95 | 100 | Organic vapour | 95+ organic vapour | 100+ organic vapour | 100 | 100+ organic vapour | 100 | | |
| Assigned-protection factor* CSA Z94.4-11 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 50 | 50 | 1000 | 1000 | 10,000 |
| **Lead cont'd** | | | | | | | | | | | | |
| Burning of a surface containing lead | | | | | | | | | | ✓ Tight-fitting full facepiece | | |
| Soldering | | | Optional ✓ N, R, or P | | | | | | | | | |
| Installation or removal of lead-containing sheet metal | | | Optional ✓ N, R, or P | | | | | | | | | |
| Installation or removal of lead-containing packing, babbit, or similar material | | | ✓ N, R, or P | | | | | | | | | |
| Demolition or cleanup of a facility where lead-containing products were manufactured | | | | | | | | | | ✓ Tight-fitting full | | |
| Manual demolition of lead-painted plaster walls or building components using a sledgehammer or similar tool | | ✓ N, R, or P | | | | | | | | | | |
| Removal of lead-containing dust using an air-mist extraction system | | | | | | | | | | | | |

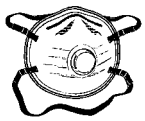
**Continued on next page . . .**

**N = Not resistant to oil R = Oil-resistant P = Oil-proof OV = Organic vapour cartridge**

✓ Indicates suitable protection. If oil mist is present, use R or P filters.

* See page 15-20.

† See page 15-20.

| | Air-purifying | | | | | | | | Supplied-air | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Half facepiece | | | | Full facepiece | | Powered air-purifying (PAPR) helmet/hood† or full face | | Helmet/hood†<br>NIOSH type CE pressure demand<br>Full facepiece pressure demand | | SCBA or SCBA + air-line, full facepiece and pressure demand | |
| | Filtering facepiece  | Elastomeric facepiece  | | |  | |  | | | | | |
| Filter efficiency and type | 95 | 100 | 95 | 100 | Organic vapour | 95+ organic vapour | 100+ organic vapour | 100 | 100+ organic vapour | 100 | | |
| Assigned-protection factor* CSA Z94.4-11 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 50 | 50 | 1000 | 1000 | 10,000 |
| **Lead cont'd** | | | | | | | | | | | | |
| Removal or repair of a ventilation system used for controlling lead exxposure | | | | | | | | | | ✓ Tight-fitting full | | |
| An operation that may expose a worker to lead dust, fume, or mist, that is not a Type 1, Type 2, or Type 3b operation | | | | | | | | | | ✓ Tight-fitting full | | |
| **Painting** | | | | | | | | | | | | |
| Spraying latex paint | ✓ N, R, or P (small-scale) | | ✓ N, R, or P (small-scale) | | | ✓ N, R, or P (large-scale) | | | | | | |
| Alkyds, enamels, and sealers: brush and roller application indoors but well-ventilated | | | | | ✓ R or P | | | | | | | |
| Alkyds and enamels: spray painting in well-ventilated area | | | | | | ✓ R or P | | | | | | |
| Alkyds and enamels: painting in a confined space | | | | | | | | | | | | ✓ |
| Epoxy or polyurethane spray painting | | | | | | | | | | | ✓ | |
| Spraying lead paint | | | | | | | | | ✓ N, R, or P | ✓ | | |
| Spraying stucco | | | | | | ✓ R or P | | | | | | |

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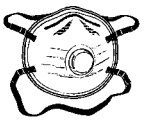
| | Filtering facepiece  | Elastomeric facepiece  | | |  | |  | | | | | |
| Filter efficiency and type | 95 | 100 | 95 | 100 | Organic vapour | 95+ organic vapour | 100+ organic vapour | 100 | 100+ organic vapour | 100 | | |
| Assigned-protection factor* CSA Z94.4-11 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 50 | 50 | 1000 | 1000 | 10,000 |
| **Roofing** | | | | | | | | | | | | |
| Removal of roofing material (built-up roofing, no asbestos) | ✓ R or P | | ✓ R or P | | | | | | | | | |
| Heat welding roofing membrane | ✓ N, R, or P | | ✓ N, R, or P | | | | | | | ✓ Tight-fitting full | | |
| Adhesive welding roofing membrane | | | | | ✓ N, R, or P | | | | | | | |
| Roofing kettle operators (asphalt) | | | | | | | | | ✓ N, R, or P | ✓ +OV | | |
| **Silica** | | | | | | | | | | | | |
| Breaking concrete outdoors | ✓ N, R, or P | | ✓ N, R, or P | | | | | | | | | |
| Crushing rock and gravel | | | ✓ N, R, or P | ✓ N, R, or P | | | | | | | | |
| Blasting rock | | | ✓ N, R, or P | ✓ N, R, or P | | | | | | | | |
| Abrasive blasting—either ≥ 1% silica in the abrasive blasting media or ≥ 1% silica in the target material being blasted | | | | | | | | | | | ✓ | |
| Drywall sanding | | | ✓ N, R, or P | ✓ N, R, or P | | | | | | | | |
| Machine mixing concrete or mortar | | | ✓ N, R, or P | ✓ N, R, or P | | | | | | | | |

**Continued on next page . . .**

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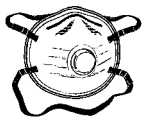
| | Filtering facepiece  | Elastomeric facepiece  | | |  | |  | | | | | |
| Filter efficiency and type | 95 | 100 | 95 | 100 | Organic vapour | 95+ organic vapour | 100+ organic vapour | 100 | 100+ organic vapour | 100 | | |
| Assigned-protection factor* CSA Z94.4-11 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 50 | 50 | 1000 | 1000 | 10,000 |

| **Silica cont'd** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drilling holes in concrete or rock that is not part of a tunnelling operation or road construction | | | ✓ N, R, or P | ✓ N, R, or P | | | | | | | | |
| Milling of asphalt from concrete highway pavement | | | ✓ N, R, or P | ✓ N, R, or P | | | | | | | | |
| Charging mixers and hoppers with silica sand (sand consisting of at least 95% silica) or silica flour (finely ground sand consisting of at least 95% silica) | | | ✓ N, R, or P | ✓ N, R, or P | | | | | | | | |
| Any other operation at a project that requires the handling of silica-containing material in a way that a worker may be exposed to airborne silica | | | ✓ N, R, or P | ✓ N, R, or P | | | | | | | | |
| Entry—for less than 15 minutes— into a dry mortar-removal or abrasive-blasting area for inspection or sampling where airborne dust is visible | | ✓ N, R, or P | ✓ N, R, or P | | | | | | | | | |
| Entry into an area where abrasive blasting is being carried out for more than 15 minutes | For short-term applications or applications involving tools | | | | | ✓ N, R, or P | | | | | | |
| Dry method dust clean-up from abrasive blasting operations | | | | | | ✓ N, R, or P | | ✓ | | | | |

**Continued on next page . . .**

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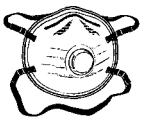
| | Filtering facepiece  | Elastomeric facepiece  | | |  | |  | | | | | |
| Filter efficiency and type | 95 | 100 | 95 | 100 | Organic vapour | 95+ organic vapour | 100+ organic vapour | 100 | 100+ organic vapour | 100 | | |
| Assigned-protection factor* CSA Z94.4-11 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 50 | 50 | 1000 | 1000 | 10,000 |
| **Silica cont'd** | | | | | | | | | | | | |
| Removal of silica-containing refractory materials with a jackhammer | or equipment with adequate controls (local exhaust ventilation or water), a half-facepiece respirator may be appropriate | | | | | | ✓ N, R, or P | | | ✓ | | |
| Drilling holes in concrete or rock as part of a tunnelling operation or road construction | | | | | | | ✓ N, R, or P | | | ✓ | | |
| Using a power tool to cut, grind, or polish concrete, masonry, terrazzo, or refractory materials | | | | | | | ✓ N, R, or P | | | ✓ | | |
| Using a power tool to remove silica-containing materials | | | | | | | ✓ N, R, or P | | | ✓ | | |
| Using a power tool **indoors** to chip or break and remove concrete, masonry, stone, terrazzo, or refractory materials | | | | | | | ✓ N, R, or P | | | ✓ | | |
| Tunnelling (operation of tunnel boring machine, tunnel drilling, tunnel mesh insulation) | | | | | | | ✓ N, R, or P | | | | | |
| Tuckpointing and surface grinding | | | | | | | ✓ N, R, or P | | | | | |
| Dry-mortar removal with an electric or pneumatic cutting device | | | | | | | ✓ N, R, or P | | | | | |
| Using compressed air outdoors to remove silica dust | | | | | | | ✓ N, R, or P | | | | | |

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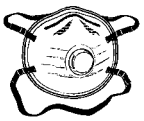
| | Filtering facepiece  | Elastomeric facepiece  | | |  | |  | | | | | |
| Filter efficiency and type | 95 | 100 | 95 | 100 | Organic vapour | 95+ organic vapour | 100+ organic vapour | 100 | 100+ organic vapour | 100 | | |
| Assigned-protection factor* CSA Z94.4-11 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 50 | 50 | 1000 | 1000 | 10,000 |
| **Synthetic Vitreous Fibres (Man-made mineral fibres)** | | | | | | | | | | | | |
| Installation, removal, or blowing cellulose, fiberglass, mineral wool, or calcium silicate | ✓ N, R, or P | ✓ N, R, or P | ✓ N, R, or P | ✓ N, R, or P | | | | | | | | |
| Installation of refractory ceramic fibres (silica may be present) | | | | ✓ N, R, or P | | | | | | | | |
| Removal of refractory ceramic fibres (silica may be present) | | | | | | | | ✓ N, R, or P | | ✓ | | |
| **Other dust and fibre exposure** | | | | | | | | | | | | |
| Removal of roofing material (built-up roofing, no asbestos) | ✓ R or P | | ✓ R or P | | | | | | | | | |
| Dry method dust clean-up from abrasive blasting operations | For short-term applications or applications involving tools or equipment with adequate controls (local exhaust ventilation or water) a half-facepiece respirator may be appropriate. | | | | | | | ✓ N, R, or P | | ✓ | | |
| Wood dust, including pressure-treated wood dust | ✓ N, R, or P | | ✓ N, R, or P | | | | | | | | | |
| Vinyl or laminate floor sanding | ✓ N, R, or P | | ✓ N, R, or P | | | | | | | | | |
| **Miscellaneous** | | | | | | | | | | | | |
| Epoxy adhesive (large-scale use) | | | | | | | | | | | ✓ | |
| Solvents, adhesives, and epoxy (small scale) | | | | | ✓ R or P | | | | | | | |
| Caulking compounds, solvent-based, large-scale use | | | | | ✓ R or P | | | | | | | |
| Form oil spraying | | | | | ✓ R or P | | | | | | | |
| Paving | | | | | | ✓ R or P | | | | | | |

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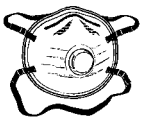
| Air-purifying | | | | | | | | | Supplied-air | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Half facepiece | | | | Full facepiece | | Powered air-purifying (PAPR) helmet/hood† or full face | | Helmet/hood†<br>NIOSH type CE pressure demand<br>Full facepiece pressure demand | | SCBA or SCBA + air-line, full facepiece and pressure demand | |
| Filtering facepiece | | Elastomeric facepiece | | | | | | | | | |
|  | |  | |  | |  | | | | | |
| Filter efficiency and type | 95 | 100 | 95 | 100 | Organic vapour | 95+ organic vapour | 100+ organic vapour | 100 | 100+ organic vapour | 100 | | |
| Assigned-protection factor* CSA Z94.4-11 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 50 | 50 | 1000 | 1000 | 10,000 |
| **Welding and flame-cutting** | | | | | | | | | | | | |
| Any welding in confined spaces when the atmosphere is not monitored | | | | | | | | | | | | ✓ |
| Aluminum** | ✓ N, R, or P | | ✓ N, R, or P | | | | | | | | | |
| Mild steel | ✓ N, R, or P | | ✓ N, R, or P | | | | | | | | | |
| Stainless steel | ✓ N, R, or P | | ✓ N, R, or P | | | | | | | | | |
| Galvanized or plated metals | ✓ N, R, or P | | ✓ N, R, or P | | | | | | | | | |
| Lead-painted steel: flame cutting or welding, short-term, not repeated, material stripped before work | | | ✓ N, R, or P | ✓ N, R, or P | | | | | | | | |
| Welding or high-temperature cutting of lead-containing coatings or materials indoors or in a confined space | | | | | | | | ✓ N, R, or P | | ✓ | ✓ | |

**N = Not resistant to oil R = Oil-resistant P = Oil-proof OV = Organic vapour cartridge**

✓ Indicates suitable protection. If oil mist is present, use R or P filters.

* Assigned protection factor means the anticipated level of respiratory protection that would be provided by a properly functioning respirator or class of respirators worn by users who are properly fitted and trained. Higher numbers mean greater protection. You may use a respirator with a greater protection factor than the one recommended for your task but never use a respirator with a smaller protection factor.

† The employer must have evidence provided by the respirator manufacturer that testing of these respirators demonstrates performance at a level of protection of 1000 or greater to receive an APF of 1000. Without such information, all other PAPRs and SARs with helmets/hoods are to be treated as loose-fitting facepiece respirators, and receive an APF of 25.

** Protection from ozone may be required in some circumstances. Contact the respirator manufacturer.

**NOTE:** These recommendations will provide adequate protection in most circumstances. Factors such as ventilation, duration of exposure, and user characteristics can affect how well a respirator protects you. If unsure about the respirator required for a task, contact the manufacturer or IHSA at 1-800-263-5024 or www.ihsa.ca