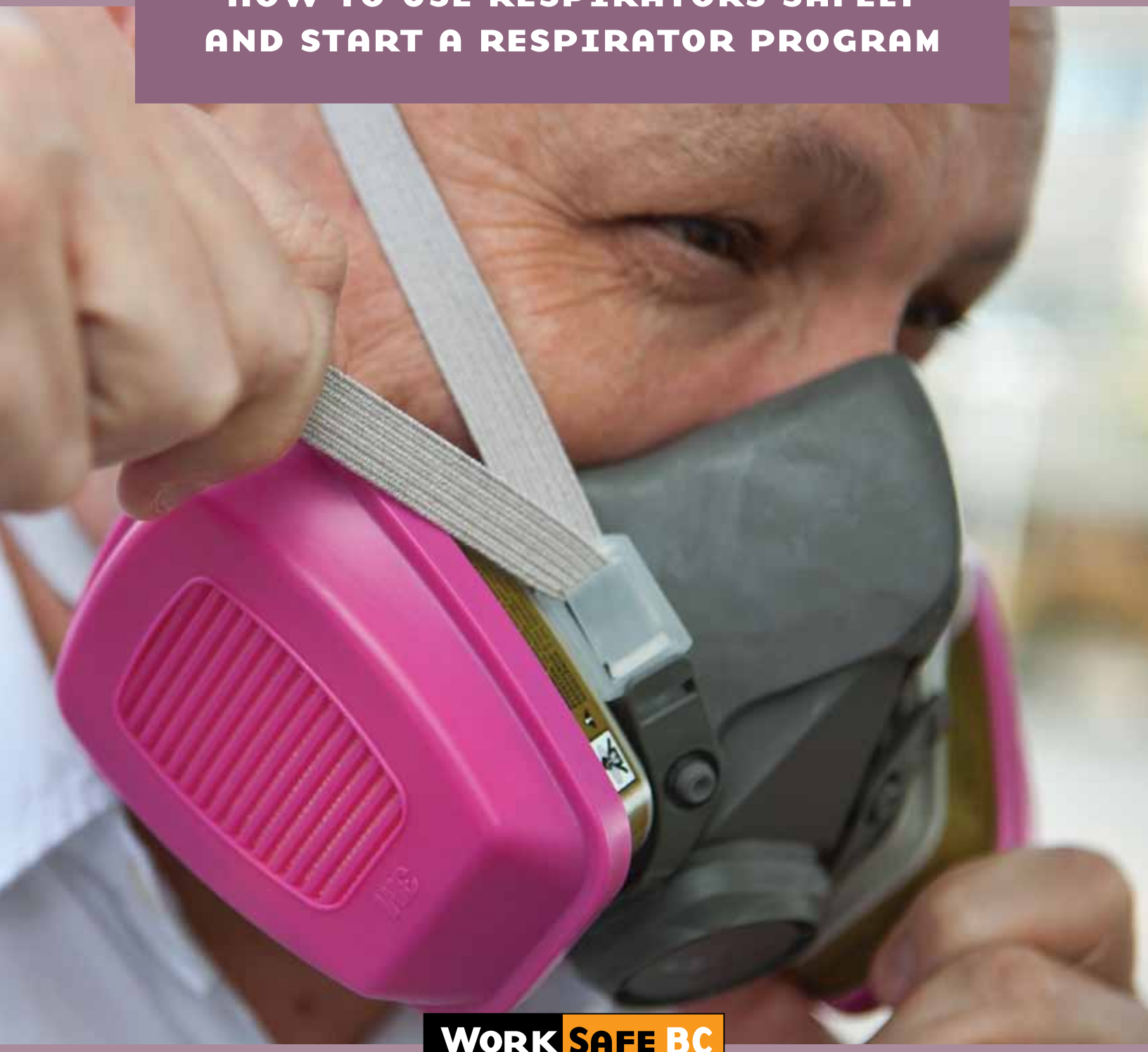
Breathe Safer

How to use respirators safely and start a respirator program



WorkSafeBC

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About WorkSafeBC

WorkSafeBC (the Workers' Compensation Board) is an independent provincial statutory agency governed by a Board of Directors. It is funded by insurance premiums paid by registered employers and by investment returns. In administering the *Workers Compensation Act*, WorkSafeBC remains separate and distinct from government; however, it is accountable to the public through government in its role of protecting and maintaining the overall well-being of the workers' compensation system.

WorkSafeBC was born out of a compromise between B.C.'s workers and employers in 1917 where workers gave up the right to sue their employers or fellow workers for injuries on the job in return for a no-fault insurance program fully paid for by employers. WorkSafeBC is committed to a safe and healthy workplace, and to providing return-to-work rehabilitation and legislated compensation benefits to workers injured as a result of their employment.

WorkSafeBC Prevention Information Line

The WorkSafeBC Prevention Information Line can answer your questions about workplace health and safety, worker and employer responsibilities, and reporting a workplace accident or incident. The Prevention Information Line accepts anonymous calls.

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WorkSafeBC publications

Many publications are available on the WorkSafeBC web site. The Occupational Health and Safety Regulation and associated policies and guidelines, as well as excerpts and summaries of the *Workers Compensation Act*, are also available on the web site: WorkSafeBC.com

Some publications are also available for purchase in print:
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How to use this manual

For many workers, respirators provide protection from breathing hazards when no other means are effective. This manual is for employers, supervisors, and workers who need information on respirators and breathing hazards. You may want to read the whole manual, or you may prefer to select information according to your needs. It is divided into four parts to make it easier for you to find the information you need. The glossary on pages 118–121 explains terms used in this manual.

If you use a respirator or are involved in the use of respirators in any way	See **Part 1** for information about: • When a respirator is needed • Types of breathing hazards
If you are responsible for selecting the appropriate respirator or the cartridge or filter for any given breathing hazard	See **Part 2** for information about: • Types of respirators • How to choose the appropriate respirator for a particular hazard
If you use a respirator, or supervise workers who use respirators, or are responsible for ensuring that respirators are used and maintained correctly	See **Part 3** for information about: • Your medical fitness to use a respirator • Fitting your respirator • Caring for your respirator • Replacing the filter or cartridge
If you are responsible for implementing a respirator program	See **Part 4** for information about: • Respirator program responsibilities • The essential elements of a respirator program See page 99 for a sample respirator program

This manual does not replace the Occupational Health and Safety Regulation. It helps explain the requirements of the Regulation and is a tool to help you work safely in workplaces where there are breathing hazards. In this manual, the word *must* means that a particular safety step is required by the Regulation. The word *should* indicates that a particular action, although not specified in the Regulation, will improve safety in the workplace.

You may have questions about some of the requirements of the Regulation or about situations specific to your worksite. A WorkSafeBC officer can help you. Call your local WorkSafeBC office, or call 604 276-3100 in the Lower Mainland or toll-free in B.C. at 1 888 621-7233 (621-SAFE).

WorkSafeBC exposure limits are available in OHS Guideline 5.48-1, Table of Exposure Limits. At the WorkSafeBC web site (WorkSafeBC.com), look for the Quick Links box, and click the OHS Regulation link. The Regulation page has links to Part 5 of the Regulation and its Guidelines, as well as to the Table of Exposure Limits.

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Contents

1 Introduction

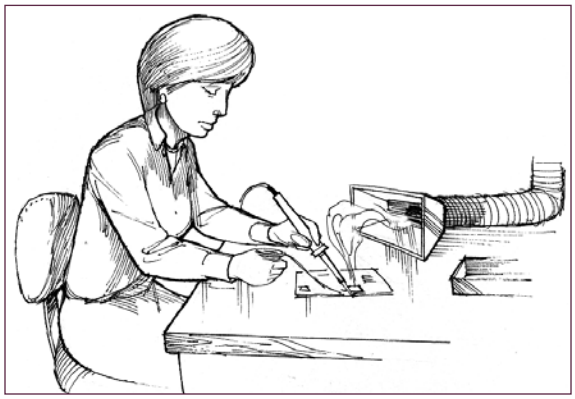
What is a respirator?

A respirator is a protective device that covers the worker's nose and mouth or the entire face and head to keep airborne contaminants out of the worker's respiratory system and provide a safe air supply.

There are many different kinds of respirators.

When is a respirator needed?

In some workplaces, there is a risk to workers from breathing in airborne contaminants or air that is low in oxygen (called "breathing hazards" in this manual). The employer must find ways to **eliminate** the hazard or **control** it below harmful levels.



Engineering controls such as local exhaust ventilation can be used to control contaminant levels. In this picture, the soldering fumes do not go past the worker's face.

There are four basic methods of controlling breathing hazards. The list below contains some examples of different controls:

- **Substitution** involves replacing the hazardous substance or process with a non-hazardous or less hazardous one.
- **Engineering controls** include enclosing the process so that contaminants do not get into the workspace, improving the ventilation, and changing the equipment or processes.
- **Administrative controls** include restricting access to contaminated areas, limiting the total time workers are exposed, and establishing housekeeping procedures to control exposure.
- **Personal protective equipment** includes the use of respirators.

The employer has substituted a non-toxic glue for one with toxic ingredients to eliminate the hazard. The new glue takes longer to dry, so changes to work schedules were also needed.

Most breathing hazards in the workplace can be reduced or eliminated by the first three controls. Wherever practicable (i.e., reasonably capable of being done), substitution, engineering controls, or administrative controls must be used before relying on respirators as the main way to control exposure. Properly used, respirators can protect the worker from the hazard. However, they don't reduce or eliminate the hazard. If the respirator fails, is not used properly, or is not suitable for the task, the worker will be at risk of exposure.

In some cases, however, respirators are the only means to protect workers. Respirators are permitted as the primary means of control only in the following situations:

- Substitution, engineering controls, or administrative controls are not practicable.
- Additional protection is needed because engineering or administrative controls cannot reduce the exposure level enough.
- The exposure results from temporary conditions (non-routine work).
- The exposure results from emergency conditions.

Workplace monitoring and exposure control plans

If respirators are used as a control measure, employers must assess airborne contaminants at the worksite and select respirators that are appropriate to the hazard. A respirator program is also required (see pages 89–96).

Section 5.53 of the Occupational Health and Safety Regulation describes how employers are required to assess and monitor the level of air contaminants present in the workplace. Section 5.54 describes exposure control plans and when one is required.

Types of breathing hazards

This manual deals with the following breathing hazards:

- Particulate contaminants (dusts, fibres, mists, fumes, and biological contaminants)
- Gas and vapour contaminants
- Oxygen deficiency (air that is low in oxygen)
- A combination of the above hazards

Different hazards require different kinds of respirators, so it is important to understand basic information about breathing hazards.

Particulate contaminants

The air we breathe may contain very small particles of solids and liquids. These particles, small enough to be suspended in air, are called *particulates.* You will also see the term *aerosol* used to describe tiny particles of liquid or solid matter suspended in air.

Particulates come in different sizes and are formed in different ways. Particulate contaminants may be found in the workplace, where they can harm workers.

Dusts and fibres (small solid particles)

Dusts and fibres are formed when solid materials are broken down.

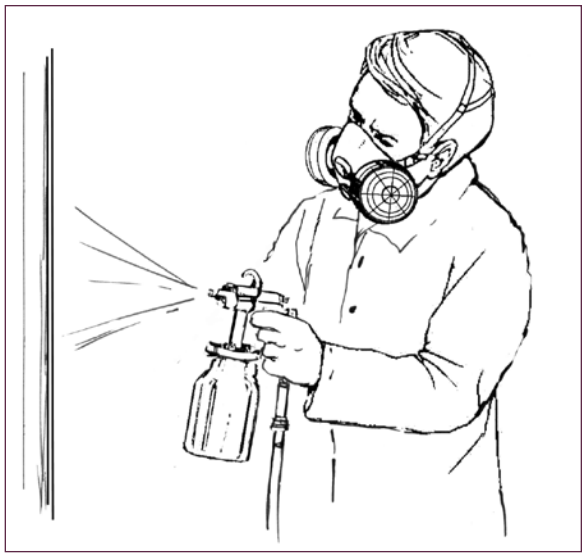
Dusts and fibres are formed when solid materials are broken down by processes such as sanding, milling, cutting, crushing, grinding, or drilling. Powders and granules are used in some industrial processes, and dusts from these can contaminate the air.

Dusts and fibres can irritate the nose, throat, and airways. Very small dust particles and longer fibres can lodge deep in the lungs and cause serious lung disease, depending on the type of dust or fibre inhaled. For example, silica dust can cause a type of lung scarring called *silicosis*. Asbestos fibres can cause a type of lung scarring called *asbestosis*. Both of these contaminants can also cause lung cancer.

Mists (small liquid drops)

Mists are airborne drops of liquid. They form when liquid is sprayed, shaken, mixed, or stirred. Some examples are oil mist produced from the lubricants produced during metal cutting and paint spray mist produced during painting operations. The acid mist produced during electroplating results from air being forced into the liquid to form bubbles.

Mists can irritate the surface tissues they touch, such as the skin, eyes, airways, and lungs. For example, a strong irritant mist such as chromic acid can erode the tissue inside the nose. Mists of some substances can also enter the bloodstream through the lungs and cause damage to internal organs. For example, organophosphate insecticides (OPs) can enter the bloodstream and affect the nervous system.



Paint spraying produces mist—tiny drops of liquid suspended in the air.

Fumes (tiny solid particles)

Fumes form when solid material such as metal or plastic is heated, causing some of the material to "boil off." The boiled-off material cools in the air and condenses into fumes—tiny solid particles. Fumes are produced by processes such as welding, smelting, soldering, and brazing.

Inhaling some types of fumes can cause health problems. For example, exposure to cadmium fumes can cause symptoms such as breathing irritation, coughing, and shortness of breath, and can result in lung disease and even death. Long-term (chronic) exposure to cadmium fumes can result in lung and kidney damage.

Fumes form when boiled-off material cools and condenses into tiny solid particles.

Biological contaminants

Airborne biological hazards can include bacteria (such as *Mycobacteria tuberculosis*), viruses (such as hantavirus), fungi (such as mould and *Histoplasma*), and plant and animal materials (such as grain dust, spores, and dander). If inhaled, these contaminants can cause health problems. Workers in many jobs may have some exposure to biological hazards such as moulds and pathogens found in bird and rodent droppings.

Organic (biological) airborne particles share the same physical characteristics in the air or on surfaces as inorganic particles from hazardous dusts. Choosing the correct respirator fitted with the correct particulate filter is essential to ensuring adequate protection (see pages 21–23). In addition, other personal protective equipment may be required to protect the worker from other routes of exposure—for example, gloves may be needed if the skin is a route of exposure. For more information on hantavirus, see the WorkSafeBC publication *A Hantavirus Exposure Control Program for Employers and Workers.*

Hantaviruses are found in some rodents, especially deer mice. Workers can become infected by inhaling the viruses from the droppings or urine of infected rodents.

Gas and vapour contaminants

Gases, such as carbon monoxide and chlorine, are materials that exist as individual molecules in the air at normal room temperature and air pressure. Gases are often used at the workplace in industrial processes, or are produced as by-products of these processes. Gases readily spread throughout an enclosure or work area.

Vapours are the gaseous form of substances that are normally liquid or solid at room temperature. Substances in vapour form are in the air and can be inhaled. Examples of liquids that can easily evaporate to form vapours at room temperature are solvents such as paint thinners, acetone, and turpentine. Examples of solids that can produce vapours are naphthalene and paradichlorobenzene (both used in mothballs). Whenever liquids are present, you can expect vapours to form.

Depending on the contaminant, gases and vapours can irritate your eyes, nose, throat, lungs, and skin, and can be easily absorbed through your lungs into your bloodstream. Once in your bloodstream, some of these chemicals can go on to damage your nervous system and other internal organs. Some gases and vapours cause health effects right away, and some result in health problems only after a long period of exposure.

The health effects may also depend on the concentration of the contaminant in the air. A low level of hydrogen sulfide gas, for example, may cause only a sore throat and runny nose, while a higher level can cause breathing failure and death within minutes. The vapours produced by solvents can cause headache, dizziness, confusion, loss of consciousness, and death. The vapours produced when mothballs evaporate can damage your liver and kidneys.

In an oxygen-deficient atmosphere, a worker must use a respirator that supplies clean air.

The oxygen level in confined spaces must be tested before workers enter them. Workers must be trained and must follow written confined space entry procedures.

Oxygen deficiency

The air we breathe contains a number of different gases. Almost 21% of normal air is oxygen. Where there is less than 19.5% oxygen by volume, the atmosphere is considered oxygen-deficient. Lack of oxygen can damage your brain and cause your heart to stop after a few minutes. In slightly reduced levels of oxygen, you will feel dizzy and your heart will speed up.

Oxygen deficiency can develop in confined or enclosed spaces such as silos, tanks, ship holds, sewers, and large pipelines. Treat all confined spaces as immediately dangerous to life or health (IDLH) until proven otherwise by testing with gas-monitoring equipment.

Oxygen deficiency can occur in two ways:

- Oxygen can be consumed when it reacts with other material. For example, rusting iron, burning materials, or rotting organic material such as leaves, wood, or sewage all use up oxygen.
- Normal air can be displaced by other gases. For example, welders use argon gas as a shielding gas to displace normal air around the weld during some welding processes. Shielding gas used in a confined or enclosed workspace can build up and displace the air the worker needs for breathing. Leaking gas lines can also discharge gas into areas where it is not normally present.

HAZARD ALERT

Low levels of oxygen can kill

A worker suffocated while preparing to clean a beverage storage tank (a confined space). He crawled through a small opening to position a spray ball used to spray the inside walls of the tank with detergent. The tank had been previously cleaned and purged with nitrogen gas and was low in oxygen. The level of oxygen in the tank was not tested before the worker entered it. After about five minutes in the tank, the worker was found unconscious by a fellow worker, and could not be revived.

The only way to know how much oxygen is present in a confined space is for a trained person to test the atmosphere with an oxygen monitor. Before anyone enters a confined space, test the air and provide ventilation.

Combination of hazards

Look carefully around your work area to identify all types of breathing hazards that may put workers at risk. Take special note of confined or enclosed spaces. Remember that more than one type of breathing hazard can be present at a time. For example, paint spraying may produce mists *and* vapours. Welding may produce gases *and* fumes. Oxygen deficiency can occur along with air contaminants (particulates, gases, and vapours). Workers need protection from each type of breathing hazard present in the workplace.

Immediately dangerous to life or health (IDLH)

Some situations are considered immediately dangerous to life or health (IDLH). IDLH atmospheres contain hazardous substances at a concentration that places the worker in immediate danger because they either:

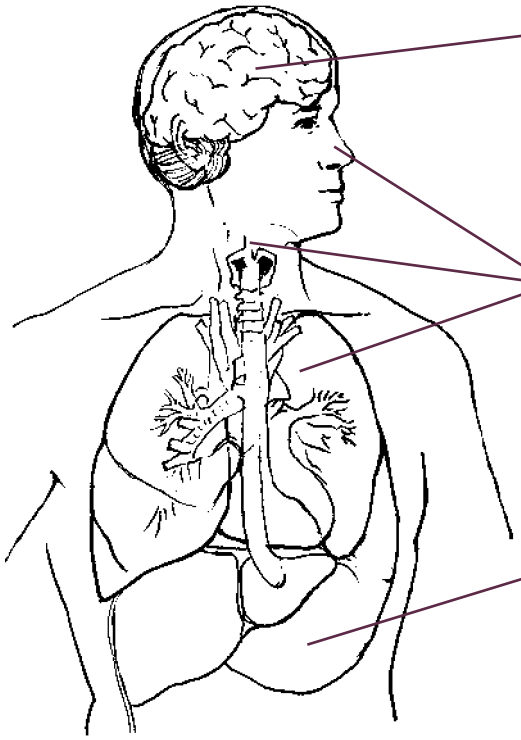
- Impair the ability of the worker to leave the work area ("self-rescue") or
- Lead to irreversible health effects, including serious injury or death, in a matter of minutes

Conditions considered IDLH include:

- A known contaminant at a concentration known to be IDLH
- A known contaminant at an unknown concentration with the potential to be IDLH
- An unknown contaminant at an unknown concentration
- An untested confined space
- An oxygen-deficient atmosphere
- Firefighting
- Contaminants at or above 20% of their lower explosive limit (LEL — the concentration at which the gas or vapour could ignite)

How breathing hazards can affect you

Air contaminants and oxygen deficiency can affect your health in many ways. Some breathing hazards are life-threatening. Other hazards cause minor health problems. A hazard may have health effects after a short period of exposure or a long period, or both. Workers may not be aware of any health effects while they are exposed to certain contaminants, but the contaminants can still have serious long-term effects.



Brain: Lack of oxygen can damage your brain and cause your heart to stop after a few minutes. In slightly reduced levels of oxygen, you will feel dizzy and your heart will speed up. Some gases and vapours can damage your brain.

Airways: Particulates, gases, and vapours can irritate your nose, throat, and upper airways. Gases and vapours can get deep into your lungs, where they can damage your lung tissue and cause serious health problems. If particulates are the right size and shape, they can also enter the lungs.

Bloodstream and internal organs: Some particulates, gases, and vapours can pass directly from your lungs into your bloodstream. Once in your blood, they can damage your internal organs.

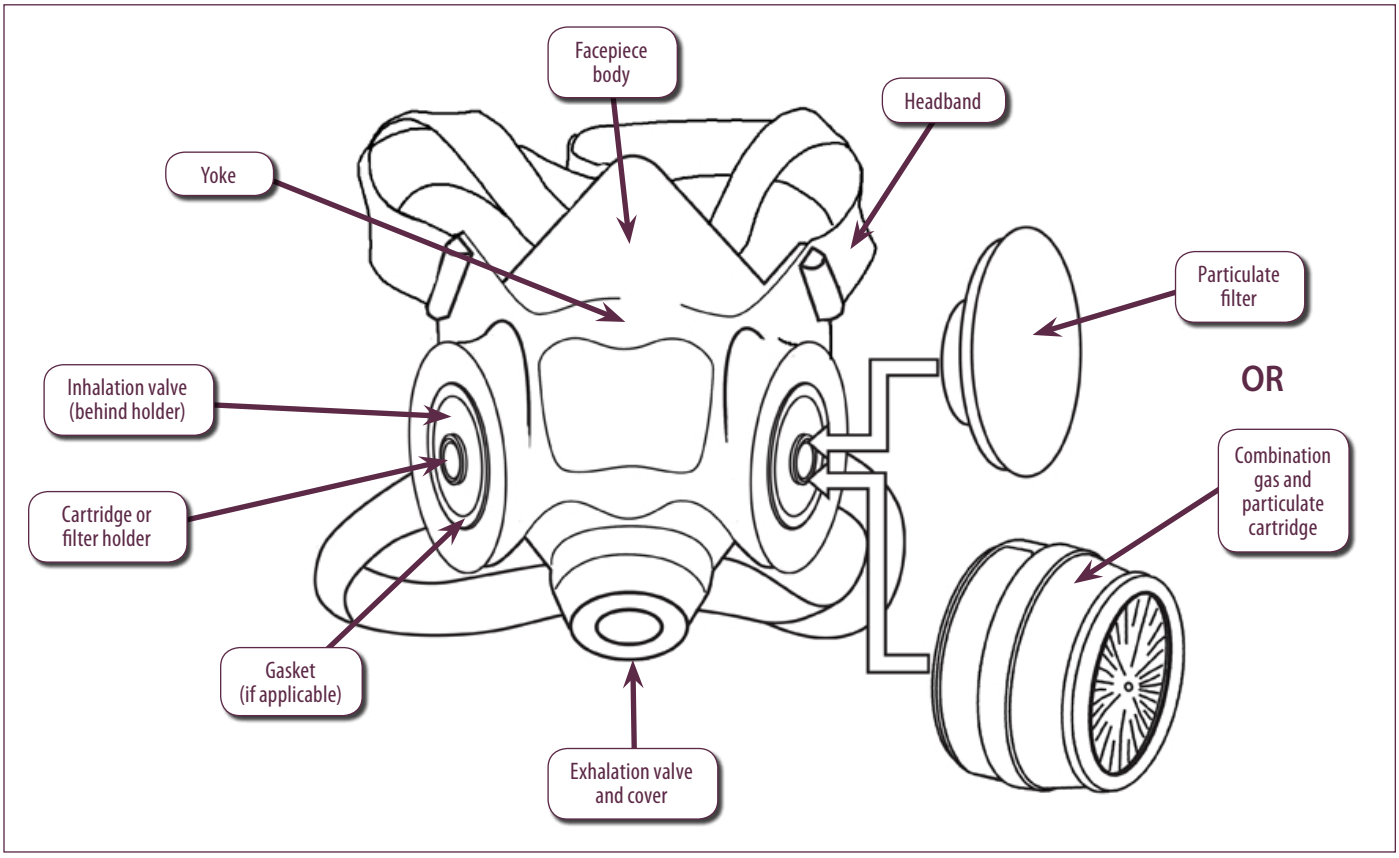
2 Selecting the right respirator

Types of respirators

There are many types of respirators available on the market. It is important to choose the right type of respirator for the breathing hazards in your workplace. In addition, some respirators must also be fitted with the correct filter or cartridge. This section provides information on the most common types of respirators.

If you are responsible for selecting respirators, or if you must select the cartridge or filter to wear in your respirator, you should read this section. If you use a respirator and want to know more about the type of respirator you use, you will find useful information in this section.

The table on pages 14–15 gives an overview of the respirators discussed in this manual for quick reference. (Note that it does not include mine rescue respirators.)



The basic parts of a typical half-facepiece respirator are shown. Two common options are illustrated on the right. Both sides of the respirator would take the same type of filter or cartridge.

Overview of respirator types

Type of respirator	Subtype	How does it work?	How is it used?	Used in oxygen deficiency?	Used in IDLH?	Advantages	Disadvantages	Protection factor
Air-purifying respirator (APR)	Non-powered (half-facepiece; full facepiece) (see pages 18-19)	Cleans the air before the worker breathes it in. Air passes through a filter or cartridge.	Protection against lower levels of contaminants. Filters and cartridges selected for specific contaminants.	No	No	• Small and compact. • Lightweight. • Low initial costs.	• Cannot be used for gases and vapours with poor warning properties unless end-of-service-life indicator available. • Negative pressure inside facepiece may result in leakage with improper fit. • Selection of proper type is critical. • Fit testing required. • Generally high replacement and maintenance costs.	10 – 50 (depends on type of facepiece)
	Powered (half-facepiece; full facepiece; loose-fitting facepiece; hood; helmet) (see page 20)	Cleans the air before the worker breathes it in. Battery-powered blower draws air through filter or cartridge.	Protection against higher levels of contaminants than non-powered respirators. Filters and cartridges selected for specific contaminants.	No	No	• No mobility restrictions. • Minimal breathing resistance and discomfort.	• Cannot be used for gases and vapours with poor warning properties unless end-of-service-life indicator available. • Selection of proper type is critical. • Fit testing required for tight-fitting facepieces. • High replacement and maintenance costs.	25 – 1,000 (depends on type of facepiece)
Air-supplying respirator	Supplied-air (airline) (see pages 28-29)	Supplies clean air to worker through an airline from air tank or air compressor (compressed or non-compressed source)	Protection against higher levels of contaminants and highly toxic contaminants.	No	No	• Can be used for long periods. • Minimal breathing resistance and discomfort. • Low weight and bulk. • High level of protection with some devices. • Moderate maintenance costs.	• Trailing air-supply hose restricts mobility and can be damaged. • Loss of protection with air supply failure. • Air quality must meet specific standards. • Fit testing required with tight-fitting facepieces. • High initial costs for complete system.	10 – 1,000 (depends on negative or positive pressure and type of facepiece)

Type of respirator	Subtype	How does it work?	How is it used?	Used in oxygen deficiency?	Used in IDLH?	Advantages	Disadvantages	Protection factor
Air-supplying respirator	Combination supplied-air (airline) with auxiliary supply bottle (positive pressure only) (see page 29)	Supplies clean air to worker through an airline from air tank or air compressor (compressed or non-compressed source). In addition, worker wears escape bottle of air connected to airline.	Protection against higher levels of contaminants and highly toxic contaminants.	Yes	Yes	• Can be used for long periods. • Preferred over SCBA in confined spaces. • Minimal breathing resistance with some types. • Simple construction, low bulk. • Escape bottle protects if air supply fails. • Moderate maintenance costs.	• Trailing air-supply hose restricts mobility and can be damaged. • Air quality must meet specific standards. • Fit testing required with tight-fitting facepieces. • High initial costs for complete system.	10,000
	Self-contained breathing apparatus (SCBA), pressure-demand (postive pressure only). *Demand (negative pressure) no longer manufactured.* (see pages 29-30)	Supplies air from a cylinder carried by the worker.	Protection against higher levels of contaminants and highly toxic contaminants.	Yes	Yes	• Maximum mobility with minimum restriction. • Maximum level of protection.	• Complex. • Heavy and bulky. • Not suitable for long periods. • Generally not suitable for confined spaces. • *Fit testing required.* • *Extensive training required.* • *Air quality must meet specific standards.* • High initial and maintenance costs.	10,000
Escape	Air-purifying (see pages 31-32)	Various types, but all must be carried by the worker or kept within arm's reach.	Allows the worker to quickly leave an area that has become contaminated.	No	For escape only	• No fit test required for bite block (mouthpiece) type.	• Not for rescue or to enter contaminated area. • Requires appropriate filter and/or cartridge.	Not assigned
	Air-supplying (see page 32)	Small SCBA with enough air for 5-10 minutes.	Allows the worker to quickly leave an area that has become contaminated.	For escape only	For escape only	• Easy to use. • No fit test required.	• Not for rescue or to enter contaminated area.	Not assigned

Use only approved respirators

The National Institute for Occupational Safety and Health (NIOSH) is a U.S. agency that approves respirators. Workers must be supplied with NIOSH-approved respirators at the workplace, or with respirators that have been accepted for use by WorkSafeBC. However, single-strap dust masks and surgical masks are not NIOSH-approved and do not meet WorkSafeBC requirements for respiratory protection.

Included with the respirator or on the filter, cartridge, or package is information that states:

- Type of substance(s) the filter or cartridge protects against
- Limitations of the respirator and of cartridges or filters
- Proper cleaning and maintenance procedures
- Parts (filters, cartridges, airlines, and so on) that make up the complete NIOSH-approved assembly
- The label “NIOSH” on the parts
- Approval number (always starting with the letters TC)

Make sure your respirator has all its proper parts. Since each manufacturer uses a different design, parts are not interchangeable between brands. Make sure you use the correct snap-on or screw-in filter or cartridge for your brand of respirator. Never use cartridges interchangeably. They will not fit correctly and will allow contaminants to leak into the facepiece.

Making alterations and modifications, interchanging parts, or using parts not approved by NIOSH for a specific respirator voids the NIOSH approval.

Air-purifying respirators (APRs)

An air-purifying respirator (APR) uses an air-purifying filter or cartridge to clean the air before you breathe it in. As air is pulled through the filter or cartridge, the contaminant is removed. Air must go through the filter or cartridge to be cleaned.

If you choose an air-purifying respirator, you need to know the concentration of the contaminant in your workplace (see Step 2, page 35).

Never use air-purifying respirators in an oxygen-deficient atmosphere. Air-purifying respirators do not supply air. These respirators only clean the air that is present around you. Cleaning the air does not add the oxygen you need in an oxygen-deficient atmosphere. Cartridges and filters are not effective with certain contaminants (for example, nitrogen dioxide, nitric oxide, and nitrous oxide). In those cases, air-supplying respirators must be used (see pages 27–30).

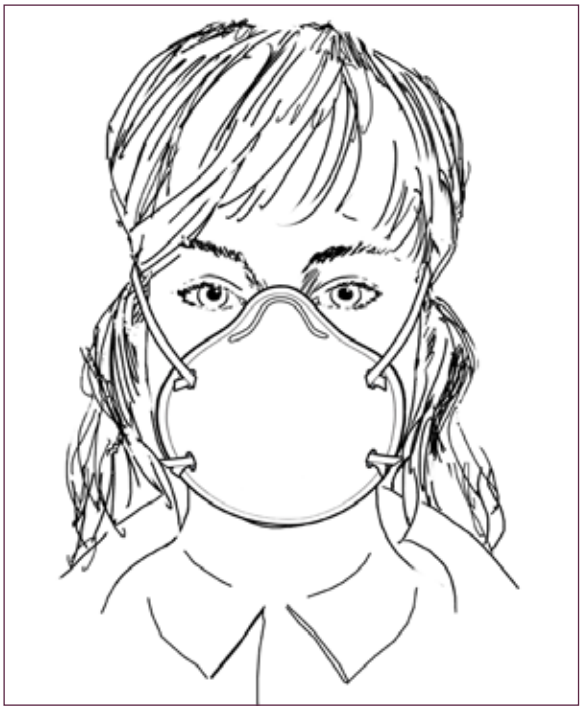
Air-purifying respirators come in two basic types: non-powered and powered. Note that **escape respirators** are discussed separately on pages 31–32.

Filters and cartridges

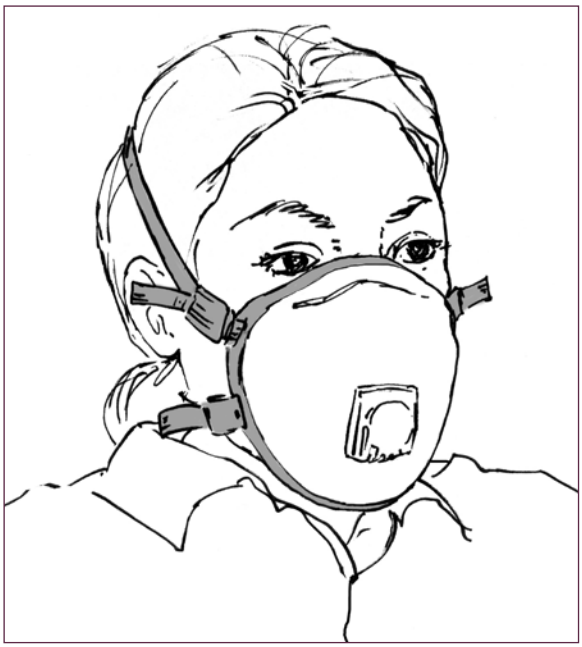
Filters are made of fibrous material that traps particles as you breathe in. Respirators that use filters provide protection against particulate contaminants.

Cartridges provide protection against some gases and vapours. Some cartridges contain a sorbent material such as activated charcoal that removes contaminants from inhaled air. Other cartridges contain a substance that causes a chemical reaction with the contaminant, changing it into a harmless gas.

Some chemical cartridge respirators can also be fitted with filters to provide protection against particulates as well as gases and vapours. Combination gas/vapour and particulate cartridges are also available (see pages 26–27).



Filtering facepiece respirators must be held in place by two elastic head straps.



This filtering facepiece respirator has a one-way exhalation valve and an elastomeric edge to give a good seal with the face

Non-powered air-purifying respirators

Non-powered air-purifying respirators come in two main types:

- Half-facepiece respirators (in filtering facepiece or elastomeric styles)
- Full-facepiece respirators

Half-facepiece respirators

A half-facepiece respirator covers only your nose, mouth, and chin. Half-facepieces (sometimes referred to as half masks) are a very popular, versatile type of respirator and are available in many different models and sizes.

Half-facepiece respirators in the filtering facepiece style are respirators where the entire facepiece acts as a filter medium. Some models have an elastomeric (rubber-like) seal along the edge where it meets the face.

Filtering facepiece respirators have no replacement parts, and the whole respirator is disposed of at the end of its service life. They must have two straps: one above the ears and over the crown of the head, and the other below the ears and around the neck. Single-strap "dust masks" are not accepted by WorkSafeBC for use as respirators. They do not provide an effective seal on the face, and the filter medium may not provide adequate protection against the contaminant.

Half-facepiece respirators in the elastomeric style have a silicone, thermoplastic, or rubber facepiece that is held against the face by two head straps. One or more filters or cartridges attach onto the facepiece.

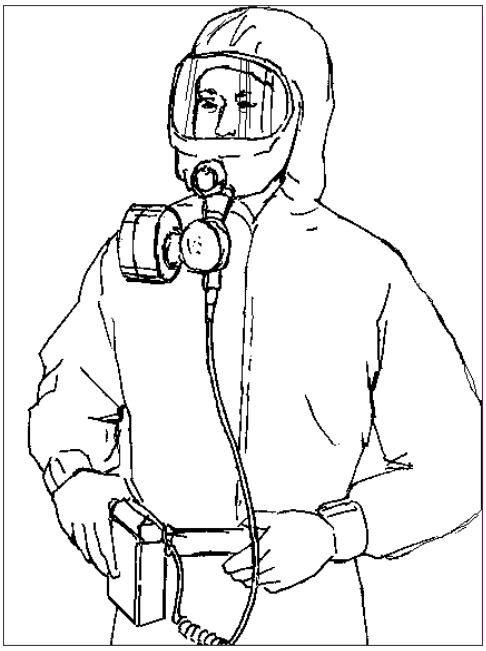
When you inhale, a one-way inhalation valve opens and allows air to be drawn through the filter or cartridge, where contaminants are removed. When you exhale, a one-way exhalation valve opens, letting the air out. After you exhale, this valve closes to stop contaminated air from entering the respirator when you take your next breath.

An elastomeric half-facepiece respirator fits over the nose and under the chin. Cartridges or filters are attached.

Full-facepiece respirator

A full-facepiece respirator is similar to a half-facepiece but covers the entire face from the hairline to below the chin. These respirators have a silicone, thermoplastic, or rubber facepiece that is held against the face by two or more head straps. One or more filters or cartridges attach onto the facepiece. A clear lens is built into the facepiece. These respirators are often used when contaminants irritate the eyes or when a greater level of protection from contaminants is required.

A full-facepiece respirator covers the entire face.



PAPRs use a battery-powered blower to draw air through the filter. This worker is also wearing protective clothing.

Powered air-purifying respirators (PAPRs)

A powered air-purifying respirator (PAPR) uses a battery-powered blower to continuously draw air through the filter or cartridge and deliver it to the facepiece. It is easier to breathe with a PAPR. Other advantages of PAPRs are that they are more protective and more comfortable than non-powered air-purifying respirators.

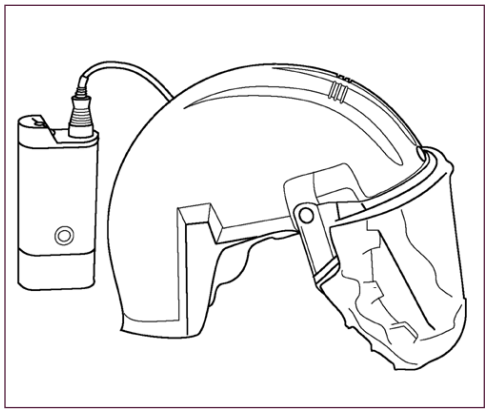
PAPRs are air-purifying; they do not supply clean air. **PAPRs should never be used in oxygen-deficient situations.**

There are various styles of PAPRs:

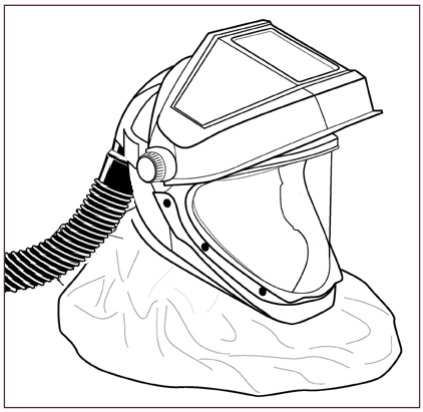
- Half-facepiece respirators (in elastomeric styles)
- Full-facepiece respirators
- Loose-fitting facepiece
- Hood
- Helmet (includes hardhat protection)

Half-facepiece and full-facepiece respirators form a tight seal with the face. The others are loose-fitting and can be worn with some facial hair and glasses. The amount of protection varies depending on the facepiece.

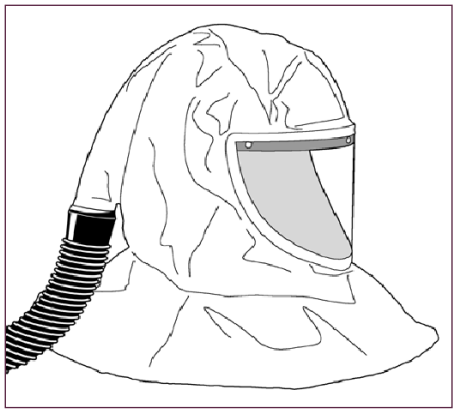
The style chosen depends on the workplace application. For example, helmet styles are popular for welding. Refer to the manufacturer's instructions and the NIOSH approval for acceptable uses of PAPRs.



The motor blower and filter are built into the headgear of this loose-fitting facepiece visor. In other models, they are mounted on a belt.



This welding helmet provides head protection. Helmets also come in other styles for rugged activities such as grinding and chipping.



If the contaminant is a skin irritant, a hood can protect the skin, face, and eyes.

Air-purifying filters and cartridges

The filters and cartridges you use in your respirator are designed to remove specific contaminants from the air. Choose the correct type of filter and cartridge for the contaminants present at your worksite. If the correct type isn't chosen, the contaminant won't be removed, and the worker will inhale it.

Air-purifying filters and cartridges are effective only up to a certain concentration of the contaminant. For more information about when these filters and cartridges can safely be used and what other factors limit use, see the step-by-step selection guide on pages 33–46.

Particulate filters

As a respirator filter traps particles, it becomes clogged, making it harder for air to pass through. This may increase the chance that contaminated air will enter the respirator around the seal.

For **powered** air-purifying respirators, the only approved particulate filter available is the high-efficiency particulate air (HEPA) filter. This type is known as the NIOSH 100 series filters (HEPA filters), or "100" (HEPA) filters.

There are nine classes of particulate filters with NIOSH approval for **non-powered** respirators. These classes apply to particulate material such as dusts, mists, fumes, and airborne biological contaminants. The nine classes of filters are based on three levels of oil resistance and three levels of filter efficiency.

Oil degrades and reduces the filtering efficiency of the filter material. NIOSH certifies the following three classes of filter according to the oil content of the atmospheric particles that the filters are designed to trap:

- N series (**N**ot resistant to oil) may be used in any atmosphere where there is no oil particulate.
- R series (**R**esistant to oil) may be used in any atmosphere where there is no oil particulate, or up to one shift where there is oil particulate present. "One shift" means eight hours of continuous or intermittent use.
- P series (Oil-**P**roof) may be used in any atmosphere, including those with oil particulates, for more than one shift. If the filter is used in atmospheres with oil particulates, contact the manufacturer to find out the service life of the filter.

Each of the N, R, and P series of respirators is further classified according to three levels of filter efficiency. The filters are rated as 95%, 99%, or 99.97% efficient at removing particles 0.3 micrometres in diameter. For example, a filter marked N95 is **not** resistant to oil and is at least 95% efficient at removing particles 0.3 micrometres in diameter. The 99.97% efficient filters (N, R, and P) are NIOSH 100 series filters (HEPA filters).

Particulate filters

Class	Filter type		
	95% efficiency	99% efficiency	99.97% efficiency
N	N95*	N99	N100
R	R95	R99	R100
P	P95	P99	P100*

* most common filters

Although these nine classes of filters have been approved by NIOSH, they may not all be available from manufacturers. Many manufacturers have chosen not to make the 99% efficient filters or the R series. The most common filters available are N95 and P100.

The table on page 23 shows **all** the types of filters that are approved for use with **non-powered** air-purifying respirators according to the type of contaminant. For example, if the air contaminant is a solid particulate, with no oil particulates in the air, then any of the N, R, or P series can be used. The most economical choice would likely be the N series, but the R and P series also provide adequate protection. If the air contains any oil particulate, such as a lubricant, then your choice is restricted to the R and P series of filters.

Depending on the contaminant, you then need to select the appropriate efficiency. For most contaminants the minimum protection needed is N95, but for asbestos, lead, hantavirus, or cadmium, for example, you need a "100" (HEPA) filter. Some viruses, such as hantavirus, are very small particles and require a "100" (HEPA) filter. Other biological contaminants, such as the tuberculosis bacterium, are larger particles, and the minimum protection needed is N95.

You can get help with selecting the right kind of filter by contacting the respirator manufacturer or distributor or a WorkSafeBC occupational hygiene officer.

For information about filter replacement schedules, see page 79. Keep in mind that you must use the same manufacturer for both the filter and the respirator to ensure that the parts are compatible and fit correctly.

The following table is based on the NIOSH description of particulate filter classes for non-powered air-purifying respirators. Remember that powered air-purifying respirators require "100" (HEPA) filters.

Approved particulate filters for non-powered air-purifying respirators

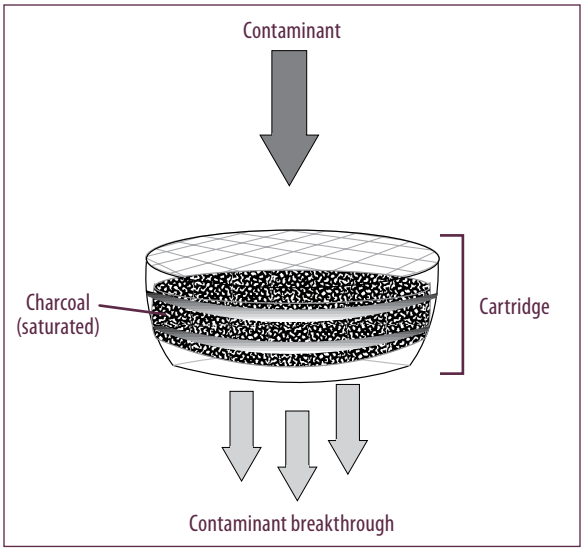
Type of Contaminant	N Class (Not resistant to oil*)	R Class (Resistant to oil*)	P Class (Oil-Proof*)
Solid and water-based particulates, but *not* oil-based	N95, N99, N100	R95, R99, R100	P95, P99, P100
Any particulates (oil or non-oil)		R95, R99, R100 (use for up to one shift in the presence of oil particulates)	P95, P99, P100 (use for more than one shift in the presence of oil particulates)
Non-oil particulates for which a "100" (HEPA) filter is required (e.g., asbestos, lead, hantavirus, cadmium)	N100	R100	P100
Any particulates (oil and/or non-oil) for which a "100" (HEPA) filter is required (e.g., asbestos, lead, hantavirus, cadmium)		R100 (use for up to one shift in the presence of oil particulates)	P100 (use for more than one shift in the presence of oil particulates)

* Oil is defined as a high boiling point liquid hydrocarbon that will accumulate on a respirator's particulate filter with minimal evaporation. Some examples are lubricants, cutting fluids, and glycerine.

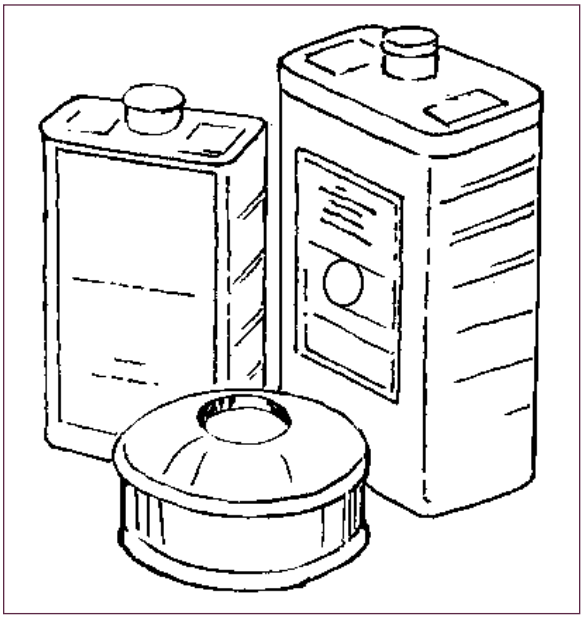
Gas and vapour cartridges

Cartridges are used to remove gases and vapours from the air you breathe. The cartridges contain activated charcoal or other chemical compounds that trap or react with specific contaminants and remove them from the air. These cartridges are also called gas and vapour cartridges, or chemical cartridges.

Cartridges act like sponges, but, like sponges, they have a limited capacity. When a cartridge is saturated, it will stop working, and the gases and vapours will leak through. This is called *breakthrough*. For information about cartridge replacement schedules, see pages 79–80.



When a cartridge is saturated, the contaminant will leak through.



Treat canisters like larger versions of regular cartridges. Date them when they are first opened.

You must use the same manufacturer for both the cartridge and the respirator to ensure that the parts are compatible and fit correctly. Some cartridges screw into the facepiece; others snap on. Cartridges are not interchangeable among brands and models of respirators.

Air-purifying canisters are like cartridges but are much larger and last longer. They attach to the facepiece of a respirator (at the chin) or are worn on the chest or back.

Warning properties

For respirators fitted with gas and vapour cartridges to be used safely, the contaminant must have warning properties that will let you know if the cartridge is no longer working. You must be able to sense the contaminant (by smell, taste, or breathing irritation) when it starts to penetrate the cartridge. Otherwise, you will not know when you are breathing it. An exception is that cartridges can be used for escape even if the warning properties are poor (see pages 31–32). Different contaminants have different warning properties. Some gases and vapours have poor warning properties.

Odour can sometimes be used as a warning property. Be aware that different contaminants have different odour thresholds. Odour threshold is defined as the lowest concentration of a contaminant in the air that can be detected by the human sense of smell.

If you are relying on odour as a warning property, **the odour threshold of a contaminant must be below its exposure limit.** The exposure limit is the maximum concentration of a contaminant that workers are allowed to be exposed to without respirators. When comparing odour threshold to the exposure limit, always use the 8-hour time-weighted average (TWA) limit, where there is one, even if the substance has a short-term exposure limit or a ceiling limit listed as well. If a substance has only a ceiling limit, then use the ceiling limit. WorkSafeBC exposure limits are available on the web site (see page iii).

Odour thresholds are often given as a range because people differ in their ability to detect odour. It is important to look at the upper end of the range in order to protect all workers. The table below gives the odour thresholds and 8-hour TWA limits for four different contaminants.

As you can see from the table, both styrene and acetic acid are smelled well before the concentration gets close to the 8-hour TWA limit. Workers would smell the contaminant when it starts to break through the chemical cartridge. With chloroform, however, by the time the concentration is high enough for the worker to smell, the contaminant level is above the 8-hour TWA limit and the worker has been overexposed. With methanol, some workers in certain environments will smell methanol before the 8-hour TWA limit is reached. For most workers, the concentration will exceed the 8-hour TWA limit before they can smell methanol. Workers cannot use air-purifying respirators to protect themselves against chloroform and methanol.

Odour threshold and exposure limits for four contaminants

Contaminant	**Odour threshold** (ppm*)	**8-hour TWA limit** (ppm*)	**Warning property** (odour)
Styrene	0.017–1.9	50	Good
Acetic acid	0.037–0.15	10	Good
Chloroform	133–276	2	Poor
Methanol (methyl alcohol)	4.2–5,960	200	Poor

* ppm = parts per million

Source for odour thresholds: *Odor Thresholds for Chemicals with Established Occupational Health Standards* (Akron, Ohio: American Industrial Hygiene Association, 1989).

Diisocyanates are another common example. You cannot use an organic vapour cartridge for spraying paints or coatings that contain diisocyanates. Diisocyanates such as MDI and TDI have very poor warning qualities. A worker using an air-purifying respirator would not smell these diisocyanates until they have been exposed to hazardous levels.

For more information about exposure limits and odour thresholds, contact the WorkSafeBC Prevention Information Line or a local WorkSafeBC occupational hygiene officer.

Special cartridges with an **end-of-service-life indicator** (for example, a mercury vapour cartridge) have been designed for a few contaminants that have poor warning properties. An end-of-service-life indicator is a device that changes colour to indicate when the cartridge is used up and needs to be replaced.

Cartridges should not be used for contaminants with poor warning properties *unless* the respirator manufacturer has an end-of-service-life indicator cartridge available (or for escape use). If no end-of-service-life indicator cartridge is available, use an air-supplying respirator (see pages 27–30) instead of an air-purifying respirator.

HAZARD ALERT

Worker overcome by solvent with poor warning properties

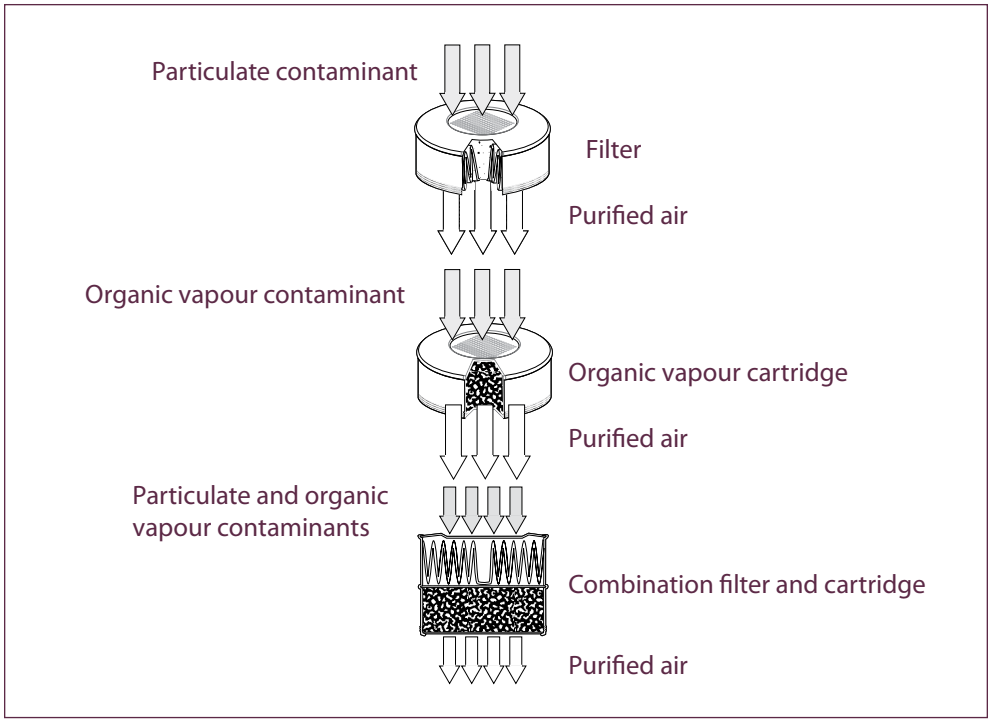
A new worker was told to clean out the sludge from an open tank used to degrease parts. He had to climb into the tank, bend down below the rim, and shovel out sludge that was still soaked with the solvent trichloroethylene.

The worker wore a half-facepiece respirator fitted with organic vapour cartridges. He was overcome by the vapour and collapsed. He was rescued, was hospitalized briefly, and recovered.

An air-purifying respirator is not adequate protection against trichloroethylene because this solvent has poor warning properties. A worker using organic vapour cartridges with this solvent would not know when the vapour was breaking through the cartridges. In this case, the worker should have been fitted with and trained to use a supplied-air respirator and trained in proper work procedures.

Combination cartridges and filters

You can buy gas and vapour cartridges in various combinations. For example, cartridges are available that protect workers against more than one type of vapour or gas. Some cartridges contain a filter medium to provide protection against particulates as well as certain vapours or gases.



Combination cartridges and filters protect against more than one type of contaminant.

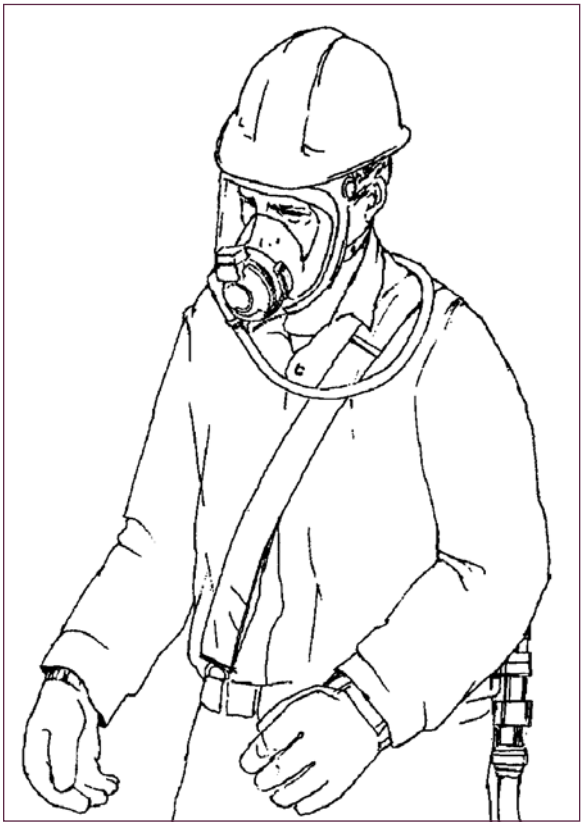
Air-supplying respirators

Air-supplying respirators supply clean air. They do not filter or clean the air. They are also called atmosphere-supplying respirators. There are four types:

- Supplied-air (airline) respirators
- Combination supplied-air (airline) respirator with auxiliary self-contained air supply
- Self-contained breathing apparatus (SCBA)
- Escape only (escape respirators are discussed on pages 31–32)

Air-supplying respirators are generally used to protect workers from high levels of contaminants or against highly toxic air contaminants. This type is also used if the contaminant has poor warning qualities. In addition, air-supplying respirators must be used if a cartridge or filter cannot effectively remove the contaminant—for example, nitrogen dioxide, nitric oxide, or nitrous oxide.

Certain types of air-supplying respirators are used to protect workers from IDLH situations—very hazardous situations where exposure may impair the worker's ability to leave the work area, or "self-rescue." Such situations may lead to irreversible health effects, serious injury, or death in a matter of minutes. For example, an oxygen-deficient atmosphere is classified as IDLH.



Supplied-air respirators provide clean air through an airline.

Air-supplying respirators are complicated systems. **Workers need to be well trained to use them safely.** This section gives only basic information on these systems. It is not a substitute for proper training on this equipment. For information on maintaining the quality of compressed air, see pages 55–56.

Air-supplying respirators come with half-facepiece, full-facepiece, loose-fitting facepiece, hood, and helmet styles (see pages 19–20).

Supplied-air (airline) respirators

Supplied-air respirators supply the user with clean air through a hose called an airline. The airline is attached to a source of clean, respirable air. The air can be provided by either a high-pressure system (compressor or compressed air cylinder) or by a low-pressure system with a pump to supply ambient air. Only NIOSH-approved airlines can be used—you cannot improvise your own airlines. There are three types of supplied-air respirators:

- Pressure-demand (or positive pressure)
- Continuous-flow
- Demand (or negative pressure)

Pressure-demand (or positive pressure)

The pressure-demand type normally maintains a positive pressure in the facepiece by using regulators and exhalation valves. Air flows into the facepiece when leakage or inhalation reduces the pressure inside the facepiece. The positive pressure and the supply of clean air flowing into the facepiece reduce the chance of contaminated air leaking in. This type is commonly used where the air supply is from a limited source, such as a compressed air tank with a 30-minute supply of air.

Continuous-flow

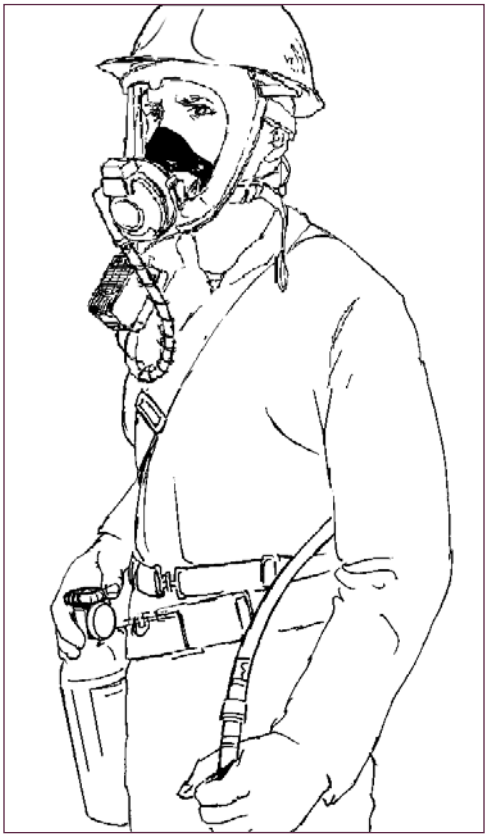
A constant supply of air is delivered to the facepiece, hood, helmet, or suit, which are all under positive pressure. This type of respirator is commonly used for painting, welding, and sandblasting. This type is most suitable where the air supply is essentially unlimited, such as a compressor or a low-pressure pump supplying ambient air.

Demand (or negative pressure)

This is the least commonly used type. Air is supplied to the facepiece only when the user inhales, so the facepiece can be under negative pressure. This makes it easier for contaminated air to leak inside the facepiece, reducing the amount of protection provided by the respirator. This type of system is unlikely to be used in the workplace since these respirators are no longer being manufactured and parts are not available.

Combination supplied-air (airline) respirators with auxiliary self-contained air supply

These devices combine the capabilities of a supplied-air (airline) respirator and a self-contained breathing apparatus (SCBA). They are available only in positive-pressure types. A small auxiliary air cylinder is usually worn attached to a belt. This is called an escape bottle or an egress bottle. The escape bottle is plumbed into the worker's airline system and is used if the supplied air fails or if the worker must disconnect the airline temporarily for any other reason. The bottle contains a limited supply of clean air, enough to last about 5–20 minutes to enable the worker to escape from the hazardous area. These combination supplied-air systems are the only class of supplied-air (airline) respirators permitted for use in IDLH conditions.

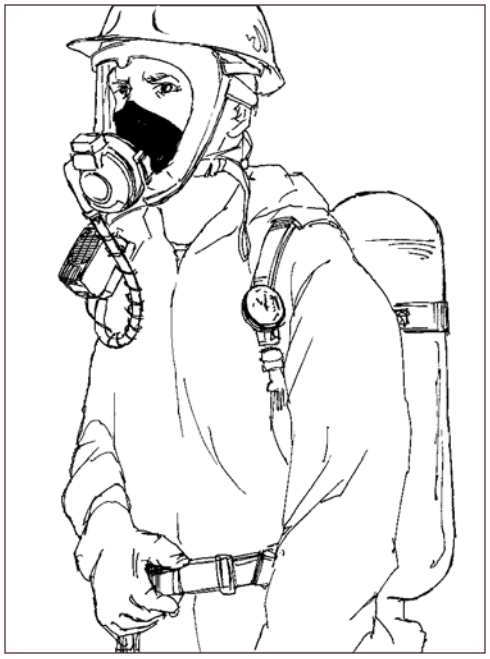


Combination supplied-air (airline) respirators are equipped with an auxiliary air cylinder.

Self-contained breathing apparatus (SCBA)

A self-contained breathing apparatus (SCBA) is also permitted in IDLH conditions. It provides air from a cylinder containing compressed air carried by the wearer. The exhaled air is then released to the surrounding air.

The drawbacks of SCBAs include the limited air supply and the extra bulk and weight that the user has to carry. Because of these limitations, the combination supplied air system described on



SCBAs provide air from a cylinder that is carried by the wearer.

page 29 is preferred over an SCBA in confined spaces. As with supplied-air (airline) systems, the compressor used to fill the air tanks and the quality of compressed air must be carefully maintained.

Pressure-demand (or positive pressure)

This type normally maintains a positive pressure in the facepiece by using regulators and exhalation valves. Air flows into the facepiece when leakage or inhalation reduces the pressure inside the facepiece. This is the most commonly used type of SCBA and is the only type of open-circuit SCBA being manufactured. It can be used in IDLH conditions. (Consult the manufacturer's instructions for specific applications.)

Demand (or negative pressure)

The demand valve permits clean air to flow into the facepiece only when the user inhales. Exhaled air passes through one or more valves in the facepiece to the outside atmosphere and is not recirculated. Because the facepiece is not under positive pressure, contaminants can enter the facepiece. **This type of SCBA is not acceptable for use in IDLH conditions, including firefighting.** Demand-type SCBAs are not widely used and are no longer manufactured.

Rebreathers

A rebreather is a type of SCBA normally used only in underground mines for rescue applications. Some or all of the exhaled air is cleaned and then inhaled again ("rebreathed"). Because the exhaled air is recirculated, oxygen is conserved and the SCBA can be used for a longer time.

Disadvantages of these systems include the increased complexity of the equipment, high maintenance, and cost. Because of their limited use, this manual does not discuss rebreathers further.

Escape respirators

Escape respirators are used only for emergency escape from contaminated areas (for example, where there is a gas leak or toxic spill). Never use an escape respirator to enter a contaminated area, to attempt a rescue, or to do work. Escape respirators must be carried on the worker or be within arm's reach whenever the worker is in a potentially hazardous area. If an area has become contaminated, escape respirators enable the worker to leave quickly and without assistance.

This manual does not cover all types of escape respirators for specialized activities such as mining.

Escape respirators are available as air-purifying or air-supplying types. For both types, potential eye irritation should be considered in choosing the type of facepiece.

Air-purifying escape respirators

Do not use air-purifying escape respirators in areas that are or could be oxygen-deficient. For gases and vapours with poor warning qualities, air-purifying respirators can be used for escape only, not for routine or emergency use.

Air-purifying respirators for escape use include the following types:

- Mouthpiece (bite block)
- Dual cartridge
- Gas mask (canister)
- Auxiliary air-purifying respirator in combination with supplied-air (airline)

Bite blocks are often used by workers in pulp mills and chemical manufacturing plants.

The mouthpiece respirator is also called a *bite block*. Workers in pulp mills and in chemical manufacturing plants often carry these for emergency use in the event of a harmful gas leak. This compact respirator is held in the teeth and the lips seal around it. A nose clamp prevents the worker from breathing contaminated air through the nose. When the worker inhales through the mouth, the respirator purifies the air. Bite blocks have the advantage that they can be carried around the neck and put on very quickly in an emergency.

Air-purifying dual cartridge respirators may be used for escape. It is important to determine in advance that the sorbent and/or filter will remove the airborne contaminants for the duration of the exposure.

"Gas mask" is a term for a canister respirator. A gas mask used for routine work can also be used as an escape respirator. It consists of a full-facepiece and a canister with the appropriate sorbent for the contaminant. The canister can be mounted on the chin, front, or back. The maximum use concentration should not be exceeded. (For more information on maximum use concentration, see page 42.)

A combination supplied-air (airline) with an auxiliary air-purifying respirator can be used where the air-purifying element is sufficient for escape purposes. This type of escape respirator is mainly used in high-hazard asbestos abatement. It is less bulky than an auxiliary SCBA for carrying in case the airline fails.

An SCBA-type escape respirator must be used if there is a risk of oxygen deficiency.

All single-use escape respirators must be discarded after use. Some escape respirators have replaceable cartridges. Record the date the escape respirator or cartridge was put into service.

Air-supplying escape respirators

An SCBA must be used in areas that are or could be oxygen-deficient. The escape SCBA uses a small cylinder of compressed air with a full-facepiece or a hood that fits over the entire head. The air cylinder will be rated for a supply of air for units of time usually ranging from 3 to 15 minutes—enough time for the worker to exit the hazardous area.

A combination supplied-air (airline) respirator with auxiliary self-contained air supply can be used for escape (see page 29). The auxiliary bottle provides an air supply if the airline fails so that the worker can escape a hazardous atmosphere.

A step-by-step approach to choosing the right respirator

Choosing the correct type of respirator is a key employer responsibility. If the wrong type of respirator is chosen, workers will not be protected from hazards and could develop serious short-term or long-term health problems, which may even lead to death.

If you are not responsible for selecting the type of respirator suitable for your workplace, it is not essential that you read this section. You may wish to proceed to Part 3: Using your respirator safely.

When selecting respirators, the employer must consult with the workers who will be using respirators and with the joint health and safety committee or worker representative. Respirators should be selected in accordance with *CSA Standard CAN/CSA-Z94.4-02, Selection, Use, and Care of Respirators,* or another standard acceptable to WorkSafeBC.

To choose the correct respirator for the job, employers, supervisors, or others responsible for respirator selection can follow the step-by-step approach in this section. Use the selection flow chart in the appendix on pages 116–117 as you work through each step. Each step of the flow chart is also shown with the text on the following pages. The flow chart sets out the options for each yes or no answer. You may wish to complete an information form (see sample on page 47) with the information you gather at each step.

You can also get help in selecting a respirator by contacting a WorkSafeBC occupational hygiene officer, manufacturers and distributors of respirators, or occupational health and safety consultants.

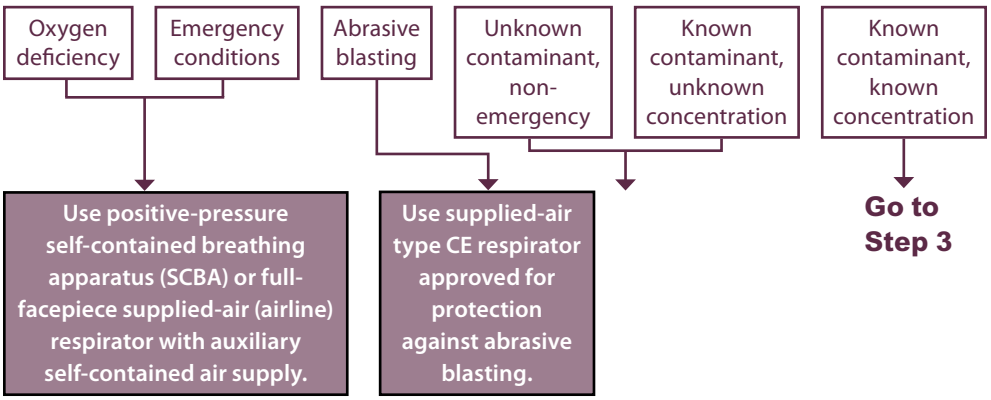
This step-by-step process is intended for emergency and regular-use respirators. For information about selecting a respirator for escape use only, see pages 31–32. If you use an air-purifying respirator for escape only, you must determine that the sorbent or particulate filter will safely remove the airborne contaminants for the duration of the exposure. If there is any doubt, use an SCBA escape respirator.

A word of caution: Some of the steps require an understanding of difficult concepts and depend on accurate calculations. If you find yourself in difficulty working through any of the steps, you should get help with the selection process. A WorkSafeBC occupational hygiene officer or the manufacturer or distributor of respirators will be able to help you.

CSA Standards

For the selection of respirators, the Occupational Health and Safety Regulation references the 1993 *CSA Standard CAN/CSA-Z94.4-93, Selection, Use, and Care of Respirators.* More recent standards can be used as long as the respirator meets the minimum requirements of the 1993 standard.

Step 1: Identify the breathing hazard



a. Is there an oxygen deficiency?

Air-purifying respirators must not be used when the atmosphere is oxygen-deficient. If these respirators are to be used to protect against a contaminant, the oxygen level must be **at least** 19.5%. Any oxygen reading of less than 20.9% should be investigated as it may indicate the presence of other undetected but harmful gases or problems with the monitor. (For more information on oxygen deficiency, see pages 8–9.)

Where the oxygen level is below 19.5% and the condition cannot be corrected, an air-supplying respirator—either a self-contained breathing apparatus (SCBA) or a supplied-air respirator with an escape bottle—must be used.

b. Is there an emergency?

An emergency is an urgent situation in which a worker must enter an atmosphere that is oxygen-deficient, or contains toxic contaminants at an unknown concentration, or contains unknown contaminants. The worker may need to rescue someone or perform an urgent task for safety reasons. An example of an emergency situation would be a chemical gas release or a spill where people need to be rescued or equipment turned off. There would be no time to do air sampling.

In situations such as an emergency or a short-term lack of access to experts who can identify the contaminants, an air-supplying respirator—either an SCBA or a supplied-air respirator with an escape bottle—must be used.

c. Are there hazardous air contaminants?

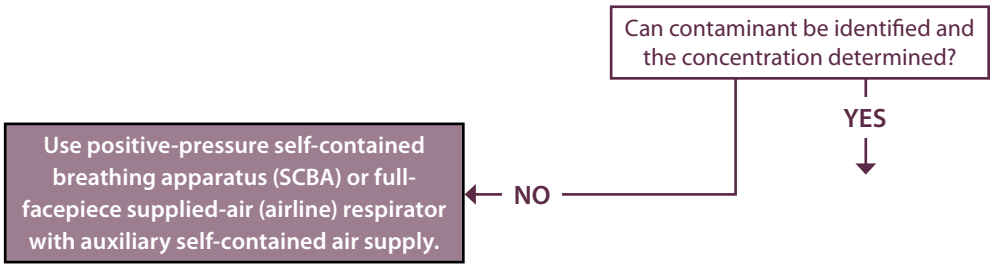
The breathing hazard could be an air contaminant—one or more gases, vapours, or particulates (such as dusts, mists, and fumes). If you do not know the contaminant and it is not an emergency, identify the contaminant or contaminants and proceed to Step 2. You may already know what the contaminant is:

- Known contaminant, unknown concentration—proceed to Step 2
- Known contaminant, known concentration—proceed to Step 3

In all the remaining steps, each identified air contaminant must be considered. Different contaminants will have different respirator requirements, and the respirator selected must be capable of protecting workers against all air contaminants. For example, a supplied-air type CE respirator, or equivalent, should be used for abrasive blasting.

If there are no hazardous levels of air contaminants, no emergency, and no oxygen deficiency, a respirator is not required.

Step 2: Check the concentration of each air contaminant



Find the concentration range of each type of air contaminant identified in the workplace, either by measurement or from historical records.

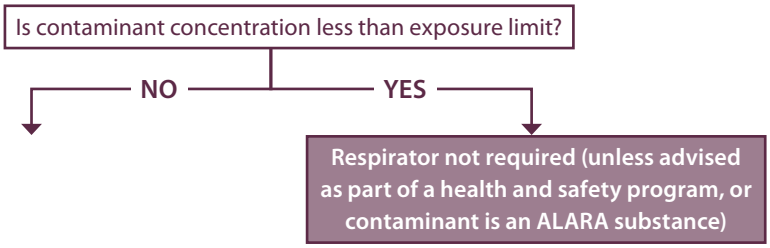
Measurement can be achieved through a monitor worn by the worker (the most accurate method). Concentration can also be estimated by monitoring fixed locations or by sampling for short periods under a range of conditions to account for day-to-day and worker-to-worker variability. Estimating the concentration should be performed under the worst-case conditions to ensure that workers receive adequate protection from breathing hazards. If your workplace has no occupational hygiene specialist on staff, you can hire an occupational hygienist as a consultant to do air sampling and help you determine the type of respirator required.

The person performing the measurements needs to be knowledgeable about the testing process, and should always err on the side of over- rather than under-protection.

Historical measurements may be available from other similar workplaces, from trade organizations, or from the manufacturers of the products or materials used in your workplace. Care must be taken when using historical measurements to ensure that the conditions under which the historical measurements were made (for example, the processes, types of materials, control methods, work practices, and environmental conditions) are similar to those in your own workplace.

If you do not know the contaminant concentration, you must use a positive-pressure SCBA or full-facepiece supplied-air respirator with auxiliary self-contained air supply. If you know the contaminant concentration, proceed to Step 3.

Step 3: Compare the concentration of each contaminant with WorkSafeBC exposure limits



WorkSafeBC sets limits on the level of airborne contaminants to which workers can be exposed in the workplace. The 8-hour TWA limit is the level of an airborne contaminant that must not be exceeded unless the worker is using the appropriate respirator. WorkSafeBC exposure limits for hundreds of workplace chemicals are available on the web site (see page iii).

If there are no exposure limits for the contaminant, use professional judgment. If no information on the contaminant is available, use pressure-demand SCBA or pressure-demand supplied-air respirators with an auxiliary self-contained air supply.

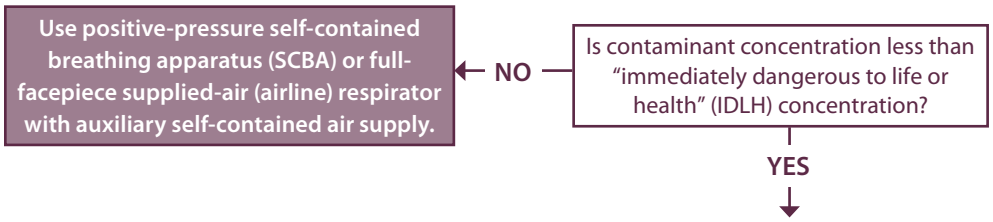
Compare the concentration of each air contaminant found in the workplace with the exposure limits. Employers must take action when workers may be exposed to more than 50% of the 8-hour TWA limit. At this level, the employer must implement an exposure control plan, which must include regular review. If the concentration of any contaminant exceeds its 8-hour TWA limit, proceed to Step 4.

It is not possible to take into account all the factors that can influence how exposure to a substance may affect an individual worker. For all designated substances (including carcinogens, sensitizers, and reproductive toxins, as defined under section 5.57), the guiding principle is eliminating exposure or reducing it so that workers' exposure is **a**s **l**ow **a**s **r**easonably **a**chievable (ALARA) below the 8-hour TWA limit.

Additive effects

When there is exposure to a mixture of two or more substances that exhibit similar toxicological effects, you must consider the additive effects. See section 5.51 of the Occupational Health and Safety Regulation for more information.

Step 4: Check the IDLH concentration



One of the most critical factors in selecting a respirator is whether or not the contaminant is IDLH. If the contaminant is a known contaminant at a concentration known to be IDLH, you must use a positive-pressure SCBA or a full-facepiece supplied-air respirator with auxiliary self-contained air supply. (See page 9 for more information on IDLH atmospheres.)

If the contaminant concentration is less than IDLH concentration, you can consider other types of respirators in the succeeding steps.

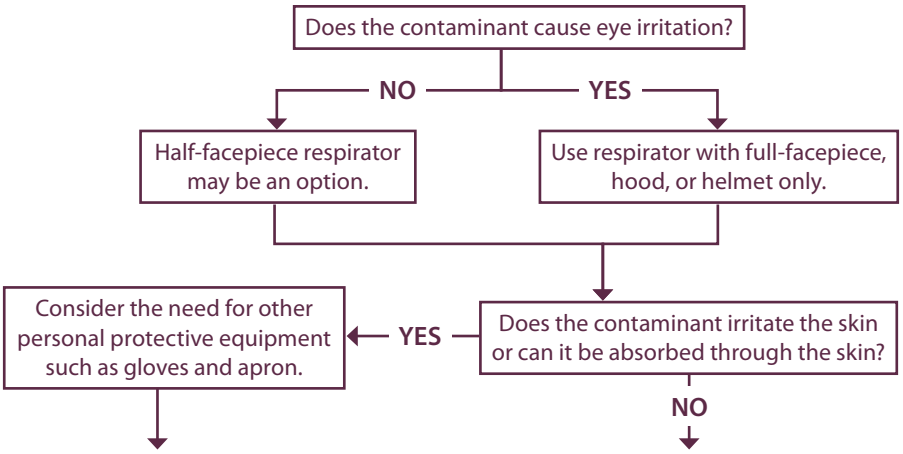
The IDLH concentration is very low for some contaminants. For example, lacquer thinners contain the contaminants toluene and xylene, which have IDLH concentrations of 500 ppm (toluene) and 900 ppm (xylene). Some other low IDLH concentrations are 5 ppm for chlorine dioxide, 10 ppm for chlorine, and 300 ppm for ammonia.

IDLH levels

You can contact the WorkSafeBC Prevention Information Line or an occupational hygiene officer to find out the IDLH level of contaminants.

You can also find this information in the *NIOSH Pocket Guide to Chemical Hazards*, which can be viewed online at www.cdc.gov/niosh/npg/npg.html.

Step 5: Check the properties of each contaminant to select possible respirator types



Check the material safety data sheets (MSDSs) for information about contaminants from products used in the workplace. MSDSs are produced by the product manufacturer or supplier. They provide information about hazardous ingredients and protective measures to take when using the product. Under the Workplace Hazardous Materials Information System (WHMIS), employers are required to have up-to-date MSDSs for all controlled products used in the workplace.

Check the MSDS for:

- Whether the contaminant is an inhalation hazard
- Whether it is an eye irritant
- Whether it can irritate the skin or can be absorbed through the skin
- Warning properties and odour threshold of the contaminant
- Thermal decomposition products, if appropriate
- Suggested respirator(s)

If the MSDS does not supply enough information, check the *NIOSH Pocket Guide to Chemical Hazards* (see box on page 37).

Once you know the concentration and properties of the contaminant in your workplace, you can begin considering which respirator type is the most appropriate for your workplace.

If the contaminant is not irritating to the eyes, a half-facepiece respirator may be an option. If the contaminant is irritating to the eyes, the respirator must provide protection to the eyes (full-facepiece, hood, or helmet).

The MSDS and manufacturer's information will indicate whether other personal protective equipment, such as gloves or body suit, may also be required—for example, if the contaminant is easily absorbed through the skin.

Step 6: Check the assigned protection factor of respirators

Each type of respirator is assigned a number called a protection factor. The assigned protection factor is used to help select the type of respirator that will protect workers from the level of contaminant that exists in the workplace. Check the assigned protection factor for each type of respirator you are considering.

The table on page 40 shows the assigned protection factors. A respirator with a higher number gives more protection than a respirator with a lower number. For example, the assigned protection factor is 10 for half-facepiece respirators (elastomeric) and 50 for full-facepiece respirators. Since full-facepiece respirators have a higher protection factor, they can be used to protect against a higher concentration of the contaminant. The greater the assigned protection factor, the higher the concentration of contaminant where the respirator can be used. You will see how this is calculated on a case-by-case basis in Step 7.

The protection factors listed on page 40 are taken from the Occupational Health and Safety Regulation, Part 8, Table 8-1.

Assigned respirator protection factors

Respirator type	Protection factor
Air-purifying respirators	
Non-powered air-purifying	
Half-facepiece	10
Full-facepiece	50
Powered air-purifying	
Loose-fitting facepiece PAPR	25
Full-facepiece PAPR equipped with "100" (HEPA) filters for exposure to asbestos	100
Full-facepiece PAPR or helmet/hood PAPR for exposure to contaminants other than asbestos	1,000
Hood/helmet	
Hood/helmet PAPR	25
Hood/helmet PAPR (manufacturer has tested the respirator and demonstrated a protection factor of at least 1,000)	1,000
Air-supplying respirators	
Airline – demand (negative pressure)	
Half-facepiece	10
Full-facepiece	50
Airline – continuous flow	
Loose-fitting facepiece	25
Half-facepiece	50
Full-facepiece	1,000
Helmet/hood	1,000
Airline – pressure-demand (positive pressure)	
Half-facepiece	50
Full-facepiece	1,000
Full-facepiece, with egress (escape) bottle	10,000
Self-contained breathing apparatus (SCBA)	
Demand (negative pressure)	50
Pressure-demand (positive pressure)	10,000
Note: Protection factors do not apply to escape respirators.	

Step 7: Calculate the hazard ratio for each air contaminant and compare it with the assigned protection factor

Determine the hazard ratio (minimum protection factor) required (divide the contaminant concentration by the 8-hour TWA limit). Select respirators with a higher assigned protection factor than the hazard ratio.

Calculate the hazard ratio (also called the minimum protection factor) by dividing the airborne concentration of a contaminant by its 8-hour TWA limit. (In Step 2, you checked the contaminant concentration. WorkSafeBC exposure limits are available on the web site—see page iii.) In one workplace, for example, measurements have shown an airborne concentration of 750 ppm of acetone. The 8-hour TWA limit for acetone is 250 ppm. The hazard ratio for acetone is therefore 750 ÷ 250 = 3.

The hazard ratio should then be compared with the assigned protection factor of the respirators being considered. Select respirators with an assigned protection factor greater than the value of the hazard ratio. For example, you might select a non-powered air-purifying half-facepiece (elastomeric) style, which has a protection factor of 10. Fit the respirator with the appropriate cartridge for acetone vapour.

When a worker is exposed to a combination of gases/vapours and dusts, select possible respirators based on the contaminant with the greater hazard ratio. For example, suppose that workers, in addition to being exposed to acetone, are exposed to fibreglass with an airborne concentration of 15 fibres per cubic centimetre (f/cc). The 8-hour TWA limit for synthetic vitreous fibres (continuous filament glass fibres) is 1 f/cc. The hazard ratio for fibreglass is therefore 15 ÷ 1 = 15. The hazard ratio for acetone is 3. Therefore, fibreglass has the higher hazard ratio. An appropriate respirator with an assigned protection factor greater than 15 is required. In this example, a full-facepiece respirator would be suitable. Make sure this respirator is fitted with the appropriate combination gas/vapour and particulate cartridge for acetone and fibreglass.

Some of the possible respirators on your list from Step 7 may be eliminated when you proceed through the remaining steps.

Step 8: Calculate the maximum use concentration (MUC) and compare it with the contaminant concentration

Calculate the maximum use concentration (MUC) for the contaminant by multiplying the 8-hour TWA limit by the assigned protection factor. The workplace contaminant concentration must not be greater than the MUC.

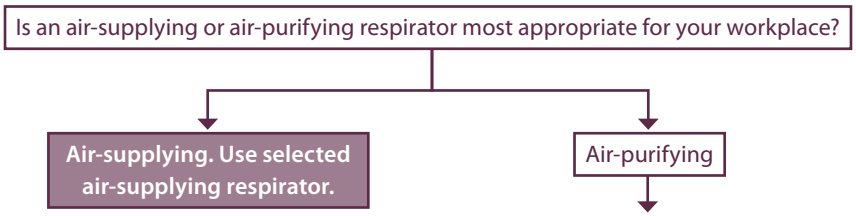
The highest concentration of a specific contaminant that a certain type of respirator can be effective against is called the maximum use concentration (MUC). You are allowed to use air-purifying filters and cartridges up to the MUC. Never use air-purifying respirators when the air contaminant concentration exceeds the MUC.

To find the MUC, multiply the 8-hour TWA limit for the contaminant (found in the WorkSafeBC Table of Exposure Limits, available on the web site—see page iii) by the assigned protection factor for the respirator being considered (Step 6). For example, the 8-hour TWA limit for ammonia is 25 ppm. The assigned protection factor for an air-purifying half-facepiece (elastomeric) respirator is 10. Therefore, the MUC is 25 x 10 = 250 ppm. This respirator can be used up to a concentration of ammonia of 250 ppm in the workplace. If the workplace concentration is greater than 250 ppm, choose a respirator with a higher assigned protection factor (see Step 2 for workplace concentration).

Each time you select a respirator with a higher protection factor, calculate the MUC again. Repeat this until the air contaminant concentration in the workplace is less than or equal to the MUC with the respirator you have chosen. The selected respirator may be either air-purifying or air-supplying, depending on the contaminant concentration and the MUC.

In Step 4, you checked that the contaminant concentration was less than the IDLH concentration. It is very important that Step 4 has been followed properly because it is possible for the MUC to be greater than the IDLH concentration. Remember that if the contaminant concentration is equal to or greater than the IDLH concentration, you must not use an air-purifying respirator.

Step 9: Identify the general classification of respirator required

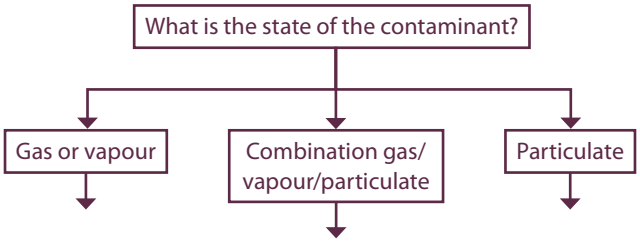


Based on the information in the previous steps, decide whether you need an air-supplying or air-purifying respirator:

- If an air-supplying respirator is appropriate, proceed to Step 13 and consider any special requirements.
- If an air-purifying respirator is appropriate, complete Steps 11–13.

Keep in mind any special requirements. For example, section 12.135 of the Occupational Health and Safety Regulation states that if a spray operation (such as painting or coating) involves a sensitizer (such as diisocyanates), then an air-supplying respirator must be used.

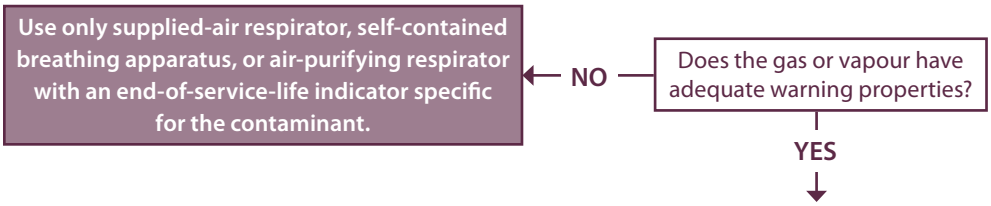
Step 10: Consider the state of the contaminant



For air-purifying respirators, consider the state of the contaminant (gas or vapour only, combination gas/vapour/particulate, or particulate only). This will help you decide both the type of respirator and the filter, cartridge, or canister/cartridge combination required.

If the contaminant is a gas or vapour (either alone or in combination with a particulate), proceed to Step 11. If the contaminant is a particulate only, proceed to Step 12.

Step 11: Consider the warning properties



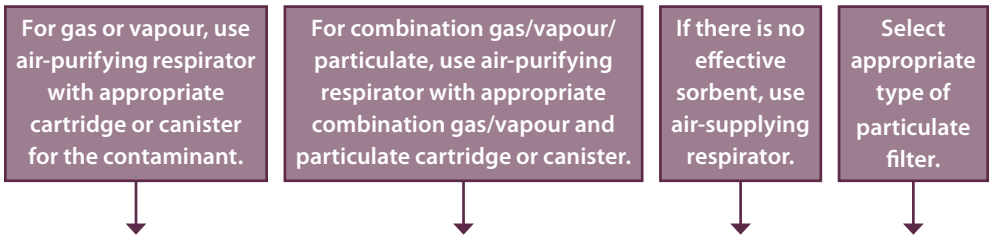
By this step, you are looking at an air-purifying respirator for a gas or vapour or for a combination gas/vapour/particulate. In order to know if this type of respirator is suitable, you must find out if the contaminant has warning properties that will let you know (by smell, taste, or breathing irritation) if the cartridge is no longer working. See pages 24–26 for more information on warning properties. (Note that warning properties do not need to be considered with escape respirators.)

If the contaminant does not have adequate warning properties, you can use:

- An air-supplying respirator.
- An air-purifying respirator with an end-of-service-life indicator specific for the contaminant (if one is available).
- An air-purifying respirator, provided the cartridges are "changed out" on a regular basis (e.g., once per half-shift or full-shift) according to a schedule prepared by a qualified person. In preparing the schedule, the qualified person uses the manufacturer's product information or derives an estimate based on a knowledge of the effectiveness of the cartridge and conditions on the worksite.

If the contaminant has adequate warning properties, proceed to Step 12.

Step 12: Select an appropriate filter or cartridge



Depending on the state of the contaminant (gas, vapour, particulate, or combination of these), select an appropriate filter, cartridge, or canister.

Cartridges are available for a wide range of contaminants. Each type of cartridge protects against only certain types and concentrations of gases, vapours, and/or particulates. Read the label on the cartridge or the manufacturer's instructions carefully, and make sure you are using the right cartridge for the contaminant in your workplace. If there is more than one contaminant, you must have the right cartridge or filter to protect against all contaminants in the workplace.

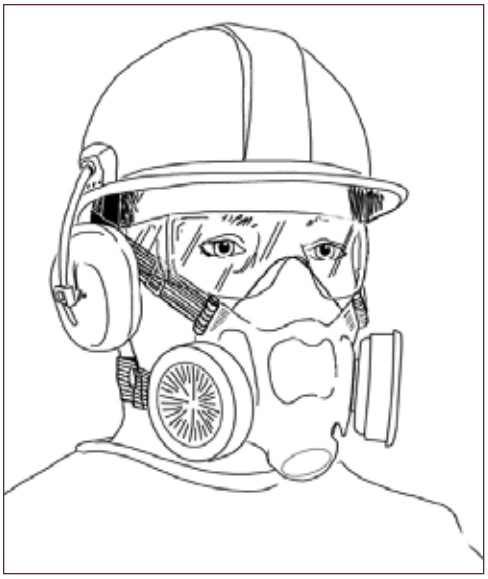
For particulates, there are nine different classes of filters. See pages 21–23 for more information on selecting the right filter.

Workers who have questions about cartridges or filters should contact their supervisor. Supervisors should contact the safety supply representative, the manufacturer, or the distributor.

There is no effective sorbent for some contaminants—for example, nitrogen dioxide, nitrous oxide, and nitric oxide. With these contaminants, you must select an air-supplying respirator.

Step 13: Consider special requirements

For any respirator selected, consider special requirements, including the worker's comfort, ease of breathing, communications, vision, and movement. Also consider the worker's ability to perform work using the respirator, potential for fatigue, and confidence in the respirator's level of protection. Once the respirator has been selected, ensure that a sufficient number of respirator sizes and models are provided to correctly fit and meet the special requirements of each user.



When choosing a respirator, consider all the other protective equipment that will be worn.

When choosing a respirator, think about all the personal protective equipment worn by the worker. Is the respirator compatible with glasses, goggles, hard hats, face shields, welding hoods, and other such gear? Can the worker communicate easily and perform the job without removing the respirator? Must the respirator be worn in a hot environment, or worn for an extended period of time, or during strenuous activity? (In the last case, a good choice would be a lightweight respirator with low breathing resistance, or a powered air-purifying respirator to reduce the worker's breathing effort.)

Workers should be asked their opinion regularly about:

- Comfort
- Resistance to breathing
- Fatigue
- Blocking of vision
- Trouble with communications
- Trouble with movement
- Ability to do their job
- Their confidence in the respirator's ability to protect them from the contaminants in the workplace

Make sure you have considered any other personal protective equipment needed if the contaminant can irritate the skin or be absorbed through the skin.

Respirator selection information form (sample)

Process/operation information

Work area location _____

Work area characteristics (open area, confined space) _____

Location of hazardous area relative to safe area _____

Work description/operation _____

Anticipated length of time that respirator will be used _____

Worker activity level (light, moderate, or heavy) _____

Information for each breathing hazard

Step 1: Oxygen level _____ % (if below 19.5%, air-purifying respirators cannot be used)

Steps 1, 2: Air contaminant and concentration _____

Step 3: 8-hour TWA limit _____

Step 4: IDLH concentration _____

Step 5: Can contaminant cause eye irritation? _____

Step 5: Can contaminant irritate skin or be absorbed through skin? _____

Step 6: Respirators under consideration and assigned protection factors _____

_____

Step 7: Hazard ratio (minimum protection factor) _____

Step 8: Maximum use concentration (MUC) _____

Step 9: Air-supplying or air-purifying respirator? _____

Step 10: State of contaminant _____

Step 11: Adequate warning properties (odour, irritation, etc.)? _____

Recommended approved respirator(s) _____

_____

Recommended approved filter or cartridge _____

_____

Other protective equipment required _____

_____

3 Using your respirator safely

Safe respirator use is everyone's responsibility

Part 3 contains information about:

- Medical assessment
- Tips for safe respirator use
- Seal checks and fit tests
- Caring for respirators, including inspection, cleaning, storage, maintenance, and repair
- Filter and cartridge replacement schedules

Read this part if you are:

- A worker with responsibility for using your respirator correctly, inspecting your respirator before use, or cleaning, maintaining, and storing your respirator
- A supervisor with responsibility for ensuring that workers use respirators correctly as required and ensuring that respirators are properly cleaned, inspected, maintained, and stored
- An employer with responsibility for providing and maintaining the appropriate respirators, ensuring that workers use them when required, and ensuring that respirators are well maintained and function properly

Medical assessment

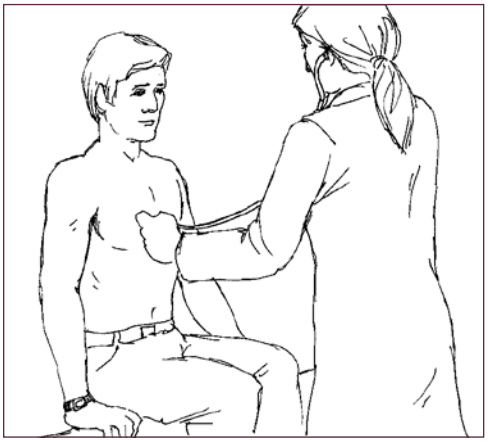
Some health problems may prevent you from using a respirator. If you, your supervisor, or your employer has any doubt or concern about your ability to use a respirator, you should be examined by a doctor knowledgeable in occupational health.

The doctor will need information about:

- The type of work to be done
- The types and concentrations of contaminants present
- The work environment and work conditions, including potential extremes of temperature and humidity
- The type of respirator to be used
- The duration of use

On the basis of this information, the doctor will advise the employer only whether you can use a respirator. The doctor cannot disclose any of your personal medical information without your informed consent.

Medical conditions that may prevent you from using a respirator include, but are not limited to:



Some health problems may prevent a worker from using a respirator.

- Claustrophobia
- Problems with breathing during normal work activities
- A history of breathing problems such as asthma, emphysema, bronchitis, or shortness of breath
- High blood pressure or heart disease
- Use of medications with side effects that might affect lung or heart function or cause drowsiness or lowered alertness
- Diabetes
- Seizure disorders
- Facial skin problems
- Physical factors that make it hard to put on or adjust the respirator, such as arthritic or missing fingers or a limited range of motion in the upper body
- Past problems with respirator use

In addition, if you have facial injuries or facial scars, or if you wear dentures, it could be difficult to fit you with a respirator. If you have prescription glasses, you will need special frames to use with certain types of full-facepiece respirators. An impaired or non-existent sense of smell may prevent you from detecting when a contaminant is leaking into the facepiece. These factors should be taken into account when fitting and using a respirator.

Tips for safe respirator use

The following pages contain essential information for using your respirator. Read the section that describes the type of respirator you are using. If you want more information about how your respirator works, read the appropriate section under "Types of respirators" on pages 13–32.

Essential information about air-purifying respirators

Air-purifying respirators use a filter or cartridge to clean the air before you breathe it into your lungs. As air passes through the filter or cartridge, the contaminant is removed. You must use the correct type of filter or cartridge for the specific contaminant in your workplace.

What to do if your respirator malfunctions

If you detect an odd smell or taste, get a headache, or feel dizzy while wearing an air-purifying respirator fitted with a gas and vapour cartridge, these could be signs that the respirator is not protecting you. Leave the work area immediately and inform your supervisor.

Check that your respirator is being used and worn correctly:

- You are clean-shaven where the respirator seals with your face so that air does not leak in through the sides, top, or bottom of the facepiece; through broken valves; or through cracks in the facepiece, filter, or cartridge. **If air leaks in from the outside, it won't be cleaned and you will breathe contaminated air.**
- The facepiece seals correctly with your face (perform a seal check) to keep out contaminants.
- The cartridge is the correct one for the hazard.
- The cartridge is not saturated or "used up." If the cartridge is saturated, it cannot remove any more contaminant, and the contaminant will leak through. This is called *breakthrough*. Immediately replace the cartridge if you think breakthrough is occurring. (See pages 79–80 for information on replacement schedules.)

You may need to check that the concentration of the contaminant is not above the maximum use concentration for the cartridge. Use the appropriate method of testing for contaminant concentration.

Do not return to the work area until you are sure you have identified and fixed the problem. If you have problems again after returning to work, leave the area and report the problem to your supervisor.

How to use filters and cartridges safely

Always read the NIOSH labels for your cartridge or filter prior to use to make certain that you are using the one that is:

- Correct for your application
- For use with the respirator you have been fitted for and trained to use

Respirators labelled for protection against particulates only must not be used for gases or vapours. Respirators labelled for protection against gases and vapours only must not be used for particulates.

You must use the same manufacturer for both the respirator and the filter or cartridge to ensure that the parts are compatible and fit correctly. Some filters and cartridges screw into the facepiece; others snap on. Filters and cartridges are not interchangeable among brands and models of respirators.

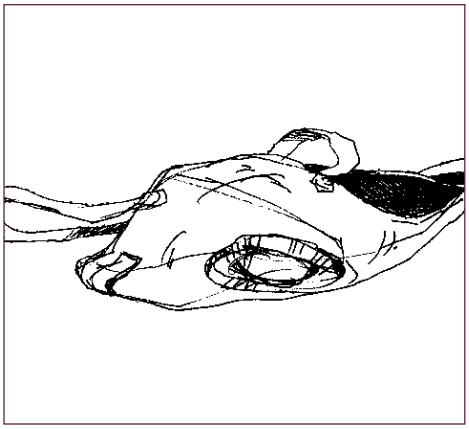
Gas and vapour cartridges

- Don't use them in oxygen-deficient situations (less than 19.5% oxygen).
- Don't use them to protect against dusts, mists, and fumes unless they are combination gas/vapour and particulate cartridges.
- Don't use them to protect against very toxic gases or vapours, such as ethylene oxide or cyanides.
- Don't use them when the contaminant concentration in the workplace is above the maximum use concentration (see the manufacturer's instructions or Step 8 on page 42).
- Don't use them when the gases or vapours have poor warning properties—with diisocyanates and methanol, for example—unless approved by a qualified person (e.g., an occupational hygiene professional who calculates a change-out schedule).
- Don't use them to protect against gases and vapours that are not readily removed by chemical cartridges—for example, nitrogen dioxide, nitrous oxide, and nitric oxide.

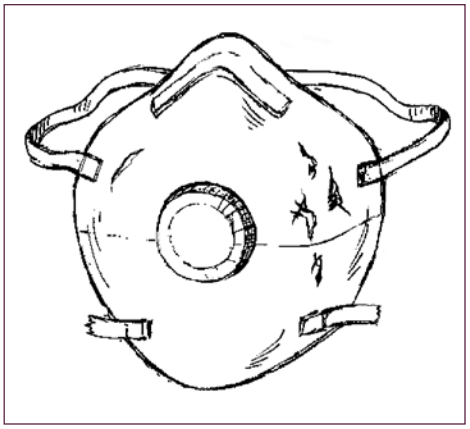
Filtering facepiece respirators

- Don't stretch the respirator over the top of a hard hat. This warps the facepiece and stretches the straps.
- Don't fold respirators that aren't designed to be folded. Folding creases the filter, and as a result, the filter may not seal properly with your face.

- Don't cut off the bottom or top strap. The respirator needs both straps to seal with your face.
- Don't wear a damaged or distorted respirator or one with holes in the filter. Throw it away and get a new one.



You may not get a good seal if you fold or crease a filtering facepiece.



Do not use a respirator that is damaged or does not have both top and bottom straps.

Essential information about air-supplying respirators

A supplied-air respirator must have sufficient airflow to provide the rated level of protection. The required airflow for tight-fitting facepieces is 115 litres per minute (4 cubic feet per minute); for loose-fitting facepieces, the flow must be 170 litres per minute (6 cubic feet per minute). Follow the manufacturer's instructions to make sure you have the proper airflow.

If you do not have a proper airflow, it is easier for contaminants to enter the facepiece. This can happen if the air supply hose is too long, the hose diameter is incorrect, or the pressure specified by the manufacturer is not maintained at the point of attachment. **Note that the maximum length of hose allowed is 90 metres (300 feet).**

Quality of compressed air

Compressed breathing air supplied for equipment such as SCBAs and supplied-air respirators must be tested at least annually. The air quality must meet the requirements of *CSA Standard CAN/CSA-Z180.1-00, Compressed Breathing Air and Systems.*

Compressed breathing air can easily become contaminated, either by contaminants drawn into the air intake or by the compressor itself. The air the worker inhales will contain the contaminants found at the compressor's air intake unless the compressor has an in-line filtering system. Always follow the manufacturer's instructions for maintaining the filters at recommended intervals to prevent the breathing air from becoming contaminated.

To avoid drawing in contaminated air, place the compressor's air intake in a clean area. Do not place the air intake in areas where the compressor can draw in car exhaust or exhaust from other combustion systems, such as furnaces or fuel-fired space heaters. Other work activities in the area can also produce contaminants near the air intake. These could include vapours from painting, dusts from sanding or grinding, or fumes from welding.

The compressor itself can add contaminants to the breathing air. The most common type of air compressor system uses oil to lubricate the air compressor. The system can contaminate the breathing air with particulate matter (including oil mist) and hydrocarbons. With oil-lubricated compressors, suitable in-line air-purification filters should be installed to ensure acceptable breathing air quality. These filters remove odours, oil mist, and water vapour. Always follow the manufacturer's instructions for maintaining the filters at recommended intervals.

Under some conditions, such as overheating, it is also possible for oil-lubricated compressors to generate carbon monoxide. These compressors should be equipped with high-temperature automatic shut-off and carbon monoxide alarms to warn of possible contamination. Using a non-lubricated compressor eliminates the problem of carbon monoxide contamination by the compressor.

For other precautions to prevent contamination of breathing air, refer to *CSA Standard CAN/CSA-Z180.1-00, Compressed Breathing Air and Systems.*

Fitting your tight-fitting respirator

To protect you, your respirator must prevent you from breathing the contaminated air around you. All respirators with tight-fitting facepieces must be checked to make sure they fit properly. When it fits properly, this type of respirator forms a good seal on your face. This seal is necessary to prevent contaminated air from leaking in past the sides, top, or bottom of the respirator and then being inhaled. If you wear a respirator with a half-facepiece or full-facepiece, take the time to make sure your respirator fits properly and forms an effective seal with your face.

Every time you put your respirator on, you must do a **seal check** for fit. In addition, when you are first fitted with your respirator, you will do a **fit test**, which must be repeated at least once a year.

This section describes how to test the fit of the following types of **air-purifying respirators:**

- Non-powered air-purifying respirators
- Powered air-purifying respirators (PAPRs) that use a half-facepiece or full-facepiece

Additional information on fitting your air-purifying respirator may be found in the manufacturer's instructions.

For checking the seal and testing the fit of all **air-supplying respirators,** follow the procedures set out in *CSA Standard CAN/CSA-Z94.4-02, Selection, Use, and Care of Respirators,* or in the manufacturer's instructions, or by NIOSH or OSHA. All SCBA tight-fitting positive-pressure respirators require annual fit testing. Testing is done in a negative-pressure mode even though the SCBA is actually used in a positive-pressure mode. Check with the manufacturer or supplier for the appropriate fit testing method and equipment required. Typically, an air-purifying element is attached to the positive-pressure port of the facepiece. You can use any of the qualitative or quantitative fit tests described in the following pages.

Putting on your respirator

When fitting a new respirator, try on several brands and sizes. Different brands will fit slightly differently on your face.

Respirator manufacturers usually have small, medium, and large facepieces available. Adjust the straps so that the respirator fits tightly but does not dig into your face or leave red marks on your skin. The respirator should feel snug but comfortable.

Take the time to form a proper grip over the nose.

Procedure for putting on a filtering facepiece respirator

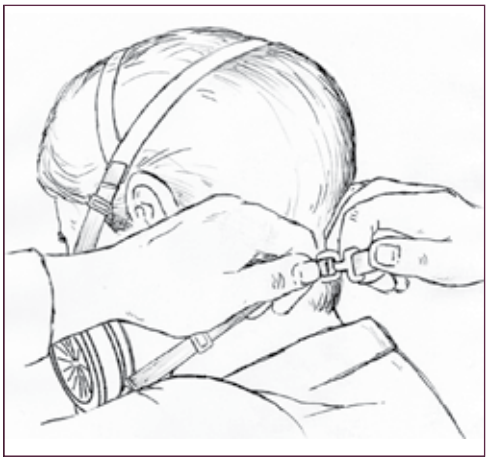
Position the straps correctly, one above the ears and over the crown of the head, and the other below the ears and around the neck. If the respirator has adjustable straps, you can tighten or loosen them without removing the respirator. If there is a metal nosepiece, mould it around your nose to obtain a proper seal.

Procedure for putting on an elastomeric half-facepiece respirator

The respirator should fit tightly but it should not be uncomfortable or leave red marks on your face.

1. *Hold the mask over your nose and chin. Position the head strap above your ears and over the crown of your head, and adjust it.*

2. *Position the neck strap below your ears and around your neck.*



3. *Fasten the clasp of the neck strap.*

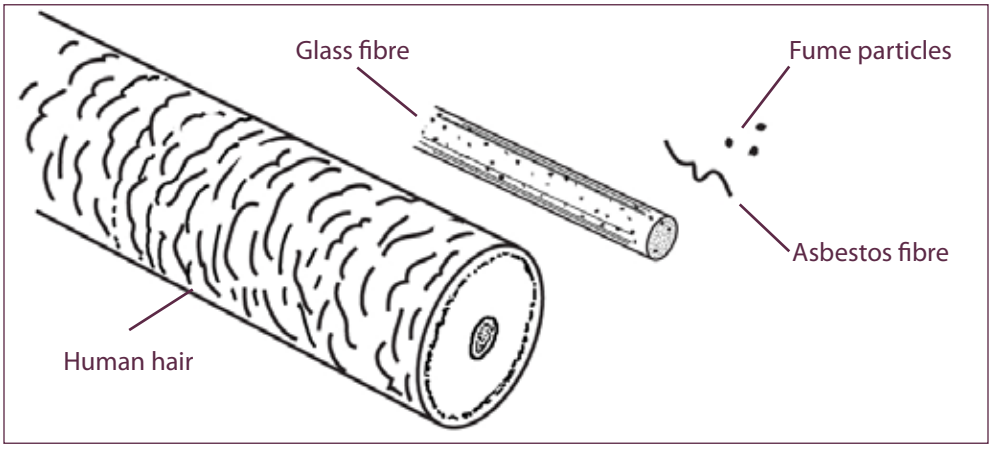
4. *Adjust the neck strap.*

Preventing interference with the respirator seal

Where your respirator seals with your face, nothing must come between the respirator and your skin. Eyeglass frames, head coverings, beards, sideburns, and stubble must not interfere with the seal.

You **must** be clean-shaven where the respirator seals with the face. Some workers think the clean-shaven rule is too strict. "Does it really matter if there's a bit of stubble on my face?" The answer is yes. It matters a lot. Stubble prevents the mask from forming a good seal with the face.

Stubble may seem small, but it is huge when you compare it with dust, mist, fibres, fume particles, and gas and vapour molecules. Stubble under the respirator seal creates plenty of room for contaminants to enter the mask.



Relative sizes of a human hair, a glass fibre, an asbestos fibre, and fume particles. If there is enough room for a hair between the skin and the respirator, there is room for many contaminants to enter.

The need to be clean-shaven applies only to those respirators that depend on a tight seal between the face and the facepiece. Respirators such as loose-fitting hoods or helmets that do not require a tight face seal may be an appropriate alternative for workers with facial hair such as many mustaches or beards.

If you have prescription eyeglasses, you may need to obtain special frames to use with a full-facepiece respirator so that your glasses do not affect the seal. Contact lenses can be worn with a full-facepiece if all of the following precautions are taken:

- The employer is notified that contact lenses will be worn.
- The worker puts on the respirator in an atmosphere that does not cause the eyes to be irritated and that does not cause irritating gases or vapours to be absorbed by the contact lens.
- The worker does not wear contact lenses when the eyes are irritated or inflamed. If the respirator is necessary for planned work or in the event of an emergency, alternative corrective eyewear that does not interfere with the seal should be used with the respirator.

User seal check

When you are satisfied that you have found a respirator that fits, there are two simple checks to test the seal. You must do one of these checks each time you put on your respirator:

- Negative-pressure user seal check
- Positive-pressure user seal check

General instructions for each type are given on the following pages. There are many different types of respirators. With some models, it may be difficult to cover either the inhalation or the exhalation valve, so you can choose to do either a negative- or a positive-pressure seal check.

If the respirator is to be used with any other personal protective equipment—such as goggles, hearing protection, or a hard hat—all seal checks must be done while you are wearing this equipment.

Cover the filtering facepiece to do the seal check. If you do not have a good seal, reposition the respirator and adjust the nosepiece or straps.

Remember that a seal check must be done **each time** you put on your respirator. Before doing any seal check, make sure your respirator has all its inlet and exhaust valves. Make sure that all inlet and exhaust valves are in good condition and lie flat. Doing these checks will help you tell whether you have a good seal and whether the valves are in place and working.

You can do a seal check with a filtering facepiece respirator. Follow the manufacturer's instructions. One method is to cover the facepiece with your hands or place a modified plastic cup to cover the facepiece (available from the manufacturer). If there is a valve, it must be blocked off. When you inhale, the filtering facepiece should collapse slightly on your face (negative-pressure seal check) if there is a good seal. When you exhale, you should feel no air escaping (positive-pressure seal check). Contact the manufacturer for more information about doing seal checks for these respirators.

Negative-pressure user seal check

This test is called a negative-pressure user seal check because you create a slightly negative air pressure inside the respirator facepiece by inhaling. Follow these instructions:

For a negative-pressure seal check, close off the inlet openings with your palms and inhale gently.

1. Put on the respirator and other associated personal protective equipment. Tighten the head straps until the respirator feels snug but comfortable. Wear the respirator for a few minutes so that it will warm up and conform to your face better.
2. Close off the inlet openings of the cartridges or filters by covering them gently with the palms of your hands, a piece of plastic, a special adapter, or gloves. (In some cases, you may have to remove the cartridges so you can cover the inlet valves.) If you are carrying out this test while wearing a PAPR or an air-supplied respirator, close off or disconnect the hose to stop the airflow.
3. Breathe in slightly to create a vacuum.
4. Hold for 10 seconds.
5. If you have a good seal, the facepiece should collapse slightly against your face and stay collapsed. No air should leak into the facepiece past the sides, top, or bottom.

If the facepiece doesn't collapse and stay collapsed, there is an air leak. Check the exhalation valve(s) and try repositioning the respirator on your face and adjusting the head straps. Carry out the negative-pressure seal check again. If you cannot get a seal after a few attempts, try on another size, make, or model of respirator. Repeat the check until you find a respirator that passes the seal check.

Positive-pressure user seal check

This test is similar to the negative-pressure user seal check except that you breathe out slightly while gently covering the exhaust valve with your palm. This creates positive pressure in the facepiece. If you have a good seal, the facepiece will bulge or puff out slightly from your face. Again, no air should leak past the sides, top, or bottom of the respirator.

1. Put on the respirator and other associated personal protective equipment. Tighten the head straps until the respirator feels snug but comfortable. Wear the respirator for a few minutes so that it will warm up and conform to your face better.
2. Close off the exhaust valve opening by covering it with the palm of your hand.
3. Breathe out **slightly** to force air into the facepiece.
4. Hold for 10 seconds.
5. If you have a good seal, the facepiece should bulge out and stay out. No air should leak out of the facepiece past the sides, top, or bottom.

For a positive-pressure seal check, cover the exhaust valve and breathe out slightly.

If the air does leak out, check the inhalation valves and try repositioning the respirator on your face and adjusting the head straps. If you cannot get a seal after a few attempts, try on another size, make, or model of respirator. Repeat the check until you find a respirator that passes the seal check.

Note that the configuration of some air-purifying respirators may make it impossible to conduct an effective positive-pressure check without dislodging the facepiece. Consult the manufacturer's instructions to see whether the positive-pressure user seal check applies to the respirator.

After the respirator has passed either the positive- or the negative-pressure user seal check, another test of the seal, called a fit test, must be done and the results recorded.

When fit tests are performed, workers must be clean-shaven and must wear all other protective equipment that they need, such as goggles and hard hats. Prescription eyeglasses must not interfere with the seal of the respirator (specialty eyeglasses are available). Ideally, fit tests should be done under operating conditions similar to those that workers would experience at the worksite.

Fit testing is done:

- When the worker is first fitted with a tight-fitting respirator (either half-facepiece or full-facepiece), before the respirator is worn in a hazardous area
- At least annually, or more frequently in some occupations such as asbestos abatement work
- If a worker has had a major weight loss or gain, has been fitted with dentures, has undergone facial surgery, or has had broken facial bones
- If a worker switches from a half-facepiece to a full-facepiece respirator or another brand or model of respirator
- If a change in work conditions changes the type or model of respirator used (for example, when a change in equipment results in an increase in the concentration of a contaminant)

There are two types of fit testing: qualitative and quantitative.

Qualitative fit testing: In qualitative fit testing, workers with poorly sealing respirators will detect an irritant, an odour, or a taste when exposed to a test agent. Overviews of four qualitative fit tests are provided later in this section. These are not complete descriptions of the procedures. A complete description can be found in *CSA Standard CAN/CSA-Z94.4-02, Selection, Use, and Care of Respirators.*

Quantitative fit testing: In quantitative fit testing, specialized equipment is used to actually measure the amount of the test agent leaking into the facepiece. The concentration of the test agent outside the facepiece is compared with the concentration inside the facepiece to determine the level of protection provided by the respirator. This procedure is not outlined in this manual but is described in *CSA Standard CAN/CSA-Z94.4-02.*

Qualitative fit testing

A qualitative fit test relies on a person's ability to detect a particular test agent by odour, taste, or irritation. The test agent is released near the person wearing the respirator. If the agent in the air leaks into the facepiece of the respirator, it will be detected and the worker will know that the seal is not tight enough. If it cannot be detected, then the seal is good.

The fit tests may be grouped according to three types of response:

- Irritation fit test (irritant smoke)
- Odour fit test (isoamyl acetate, also called banana oil)
- Taste fit test (bitter aerosol; saccharin)

The following pages give only an overview of these fit tests, not complete descriptions of the procedures. You must follow the complete protocol for any of these fit tests found in *CSA Standard CAN/CSA-Z94.4-02, Selection, Use, and Care of Respirators.* Refer to any health and safety information in the standard and in the manufacturer's MSDS. You can also ask your fit test kit supplier for additional instructions.

Ensure that selection of the fit test agent takes into account any medical assessment of individual workers (see page 52). If there are any health concerns resulting from a worker's reaction to a test agent in the threshold screening, do not continue with the fit test for that agent. Use an alternative agent or consider a loose-fitting respirator that does not require a fit test.

Keep in mind that air-purifying respirators clean the surrounding air before the worker inhales it. These respirators must therefore be equipped with the right filter or cartridge to remove the test agent from the air that is being inhaled. This enables the worker to react to the test agent only when it leaks in past a poor seal.

The following procedures apply to all qualitative fit tests, no matter which test agent is used. See page 57 for the respirators covered by these fit tests.

Respirator selection

The employer should first determine what types of respirator are appropriate for the contaminant(s) and workplace concentration (see pages 33–46). The worker should be allowed to select from a variety of sizes and models of these respirators. The worker should choose the respirator that is most comfortable and that he or she would use most consistently.

Threshold screening

Before doing the fit test and before putting on the respirator, the worker is given a threshold-screening test to make sure he or she can detect the selected test agent. Some workers may not be sensitive to the chemicals in the test. If the worker does not respond to the selected test agent, an alternative test agent or method is chosen.

User seal check

The worker should put on the respirator and perform a successful user seal check before doing the fit test.

Fit test exercises

The following fit test exercises apply to all qualitative fit tests. These exercises are intended to simulate actual workplace wearing of the respirator and to challenge the seal of the respirator during the test. The worker should wear the respirator for at least 10 minutes before doing the fit test exercises.

There are six exercises, and each must be performed for a prescribed amount of time. *CSA Standard CAN/CSA-Z94.4-02, Selection, Use, and Care of Respirators,* prescribes 30 seconds for each exercise.

1. Normal breathing (regular)
2. Deep breathing (deep and regular)
3. Turning the head from side to side (take care not to bump the respirator on the shoulders)
4. Nodding the head up and down (take care not to bump the respirator on the chest)
5. Talking out loud—use "Rainbow Passage" (an appendix to *CSA Standard CAN/CSA-Z94.4*) or count out loud
6. Normal breathing (regular)

If there is any leakage, try on different sizes or models of appropriate respirators, repeating the six exercises each time, until a successful test has been completed.

Irritant smoke fit test

In this test, a worker wearing a respirator is exposed to an irritating smoke (stannic chloride). If the respirator fits properly, no smoke will leak

into the facepiece and be detected by the worker. If smoke does leak in, it will cause an involuntary reaction in the worker, such as coughing. It is important to follow instructions carefully to avoid exposing workers to any unnecessary smoke irritation. The smoke can be irritating to the eyes and airways.

Do not place a hood or bag over the head of the test subject. The test must be performed in a location with sufficient ventilation to prevent contamination of the work area and ventilation system.

Irritant smoke tests must be conducted with facepieces equipped with combination organic vapour/acid gas (OV/AG) and "100" (HEPA) filter cartridges. After the respirator has passed the fit test, the facepiece can be fitted with the appropriate filter or cartridge necessary for protection in the workplace.

An irritant smoke fit testing kit can be purchased from suppliers of safety equipment. These kits contain glass tubes of irritant smoke-forming compounds and a small rubber bulb. The bulb forces air through the glass tube. **Only stannic chloride smoke tubes can be used for the irritant smoke test.**

Use a well-ventilated room or area to carry out the irritant smoke tests (both threshold screening and the fit test).

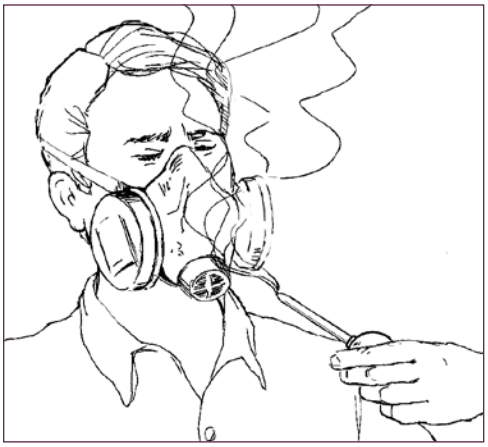
Caution: This test agent may be an irritant to the worker being fit tested or to the tester. Do not use this test agent to fit test workers with respiratory sensitivities. The tester should consider wearing a respirator if a number of fit tests are being performed.

Irritant smoke threshold screening

1. Break off both ends of the smoke tube and insert one end into the rubber bulb (watch for the other exposed sharp end).
2. Squeeze the bulb to force air through the tube and produce smoke.
3. Warn the worker that the smoke can be irritating and that he or she should keep eyes closed throughout the test.
4. Carefully direct a **small** amount of the smoke in the worker's direction.
5. Discard used tubes in sharps containers at the end of the test.
6. After the worker coughs, proceed with the fit test procedure outlined on the next page.

Irritant smoke fit test procedure

The worker should put on the respirator and all other personal protective equipment, such as eye protection or a hard hat. A successful seal check must be done before the fit test.



Workers should keep their eyes closed during the irritant smoke test.

1. While the worker performs the first fit test exercise on page 66, pass the smoke stream around the perimeter of the facepiece. You should direct the smoke at the facepiece seal, starting with the smoke stream about 30 cm (12 in.) away from the respirator. Go around the seal a total of three times, gradually bringing the smoke to within 5 cm (2 in.) of the respirator. If the worker does not detect the stream of smoke by coughing, continue with the next fit test exercise. Repeat this step for each of the six exercises.
2. Because the smoke can be irritating, do not direct puffs of smoke at the eyes, and keep the smoke tube at least 5 cm (2 in.) away from unprotected skin. Ask workers to keep their eyes closed if they are being fitted with a half-facepiece.
3. If the worker does not cough, no smoke has leaked into the facepiece and the respirator has passed the fit test.

Caution: Testers must be careful with the sharp, broken end of the smoke tube. Coughing workers may unexpectedly jab themselves if they make sudden movements. The fit tester may wish to cover the broken end of the tube with a short length of tubing. Always discard used tubes in sharps containers at the end of the test.

Bitter aerosol taste fit test

In this test, a worker is exposed to a spray containing denatonium benzoate. It has an extremely bitter taste. The worker wears a respirator equipped with any particulate filter and puts on a test enclosure or hood that covers the head and shoulders. The fit tester exposes the worker to the bitter aerosol by spraying the test solution into the enclosure. Because it is a very bitter solution, it can be easily detected by the worker if it leaks through the face seal. If the worker cannot taste the bitter aerosol after the predetermined number of squeezes, it means that the respirator fits properly.

A bitter aerosol fit testing kit can be purchased from suppliers of safety equipment. These kits contain pre-mixed solution as well as instructions for administering the fit test.

Workers should not eat, drink (except plain water), smoke, or chew gum for at least 15 minutes before taking the bitter aerosol fit test.

Before conducting the test, make sure the worker being fit tested can detect the bitter taste by performing a threshold screening check. The threshold screening should be done under a test hood, and the worker being tested should not wear a respirator.

Caution: This test agent may affect workers with respiratory sensitivities.

Bitter aerosol threshold screening

1. Instruct the worker to breathe through a slightly open mouth with the tongue extended.
2. Ask the worker to let you know when a bitter taste can be detected.
3. Insert a nebulizer containing the threshold check solution into an opening located at the front of the test hood. Direct the spray away from the worker's breathing zone.
4. Rapidly squeeze the bulb of the nebulizer 10 times and ask if the worker can taste the bitter aerosol.
5. If the worker cannot taste the bitter aerosol, rapidly squeeze the nebulizer bulb 10 more times and ask again if the worker can taste it. If the response is still negative, squeeze the nebulizer bulb 10 more times.
6. Once the worker reports tasting the bitter taste, proceed with the fit test. If the worker cannot detect the bitter taste after 30 squeezes, perform a different fit test.

Bitter aerosol fit test procedure

The worker should put on the respirator and all other personal protective equipment, such as eye protection or a hard hat. A successful seal check must be done before the fit test.

1. Prepare a solution made of bitter aerosol and salt solution in warm water and pour the solution into a nebulizer.
2. Have the worker put on a test hood while wearing the respirator. The front portion of the hood should be clear of the respirator and provide sufficient room for free head movement.
3. Instruct the worker to breathe through a slightly open mouth with the tongue extended. Ask the worker to let you know if a bitter taste can be detected.
4. Insert the nebulizer filled with prepared solution into the opening in the test hood directly in front of the worker's nose and mouth. Direct the spray away from the worker's breathing zone.

5. Firmly squeeze the bulb of the nebulizer containing the test solution either 10, 20, or 30 times, depending on the worker's sensitivity to the bitter aerosol (as determined by threshold screening).
6. Instruct the worker to perform the six fit test exercises and tell you if a bitter taste can be detected.
7. Every 30 seconds, replenish the aerosol concentration by squeezing the nebulizer bulb half the number of squeezes used previously (i.e., use 5, 10, or 15 squeezes). Squirt the solution into the test hood.
8. If the worker reports tasting the bitter aerosol, the respirator has failed the fit test. If the worker cannot detect the bitter aerosol, the respirator has passed the fit test.

For more detailed information on this test, refer to Appendix B2 of *CSA Standard CAN/CSA-Z94.4-02.*

Saccharin solution aerosol fit test

This test is similar to the bitter aerosol solution fit test. Instead of using a bitter-tasting aerosol, the fit tester exposes the worker to the sweet taste of saccharin. The threshold screening and the fit test are done in a test enclosure or hood that covers the head and shoulders.

A bitter or sweet solution is sprayed into the test hood for the bitter aerosol or saccharin fit test.

The saccharin solution threshold screening is identical to that of the bitter aerosol, except that the worker must demonstrate the ability to detect the sweet taste of the test agent.

For the fit test, a worker wears a respirator equipped with any particulate filter. The tester sprays the test solution into the test hood, directly in front of the worker's nose and mouth. If the worker cannot detect a sweet taste after either 10, 20, or 30 squeezes, it means that the respirator fits properly. Workers should not eat, drink (except plain water), smoke, or chew gum for at least 15 minutes before taking the saccharin solution aerosol fit test. Workers who eat or drink something sweet before the test may not be able to detect the taste of saccharin and must not be allowed to undergo the fit test.

Isoamyl acetate (banana oil) fit test

This test is similar to the bitter aerosol and saccharin fit tests in that the threshold screening and the fit test are done in a test enclosure. A worker wearing a respirator is exposed to a compound called isoamyl acetate (known as banana oil), which smells strongly like bananas. Before starting the test, you must make sure the person being fit tested can smell the banana oil. If the worker cannot smell the banana oil, perform the fit test using another test agent. For complete instructions on how to conduct this test, refer to *CSA Standard CAN/CSA-Z94.4-02, Selection, Use, and Care of Respirators.*

Since the banana oil test uses a vapour, it can only be used to fit test air-purifying respirators that take a cartridge. The respirator should be fitted with an organic vapour cartridge. After the respirator has passed the fit test, attach the appropriate filter or cartridge for the workplace contaminant.

Fit testing records

Fit testing must be done at least annually, and written records of the results must be kept. Records should also be kept of repeat fit testing done at other times (see page 64).

A sample fit test form is shown on pages 72–73. At a minimum, the following information should be recorded and retained on file:

- Name of worker fit tested
- Date of fit test
- Specific make, model, style, and size of respirator
- Type of test done and test agent used (e.g., irritant smoke, banana oil, bitter aerosol, or saccharin for qualitative tests)
- Results of fit tests (pass/fail)
- Comments on test difficulties
- Name of fit tester

Respirator fit test form (sample)

Name of worker:	Date:

Does the worker wear:

❑ Eyeglasses ❑ Contact lenses ❑ Dentures ❑ Facial hair

If yes to any of the above, discuss how the respirator seal will be affected. (Workers must be clean-shaven where the respirator seals with the face.)

Does the worker have any medical concerns about wearing a respirator?

❑ Yes ❑ No

If yes, refer worker for a medical assessment.

Fit test procedure

Fit testing must be repeated annually to ensure that a proper face seal is maintained.

Check when completed successfully:

❑ Correct positioning of respirator and strap adjustment
❑ Negative- or positive-pressure user seal check

Qualitative fit tested using:

❑ Irritant smoke with HEPA/organic vapour cartridges
❑ Bitter aerosol with particulate filter
❑ Isoamyl acetate (banana oil) with organic vapour cartridges
❑ Saccharin with particulate filter
❑ Other _____

❑ Pass ❑ Fail

Quantitative fit testing:

❑ Pass ❑ Fail

Respirator(s) fit tested by worker:

When a worker wears different makes and models of respirators, fit testing must be done on each make and model of respirator and the results recorded. The worker should also wear all other required personal protective equipment, such as hearing and eye protection, while undergoing the test.

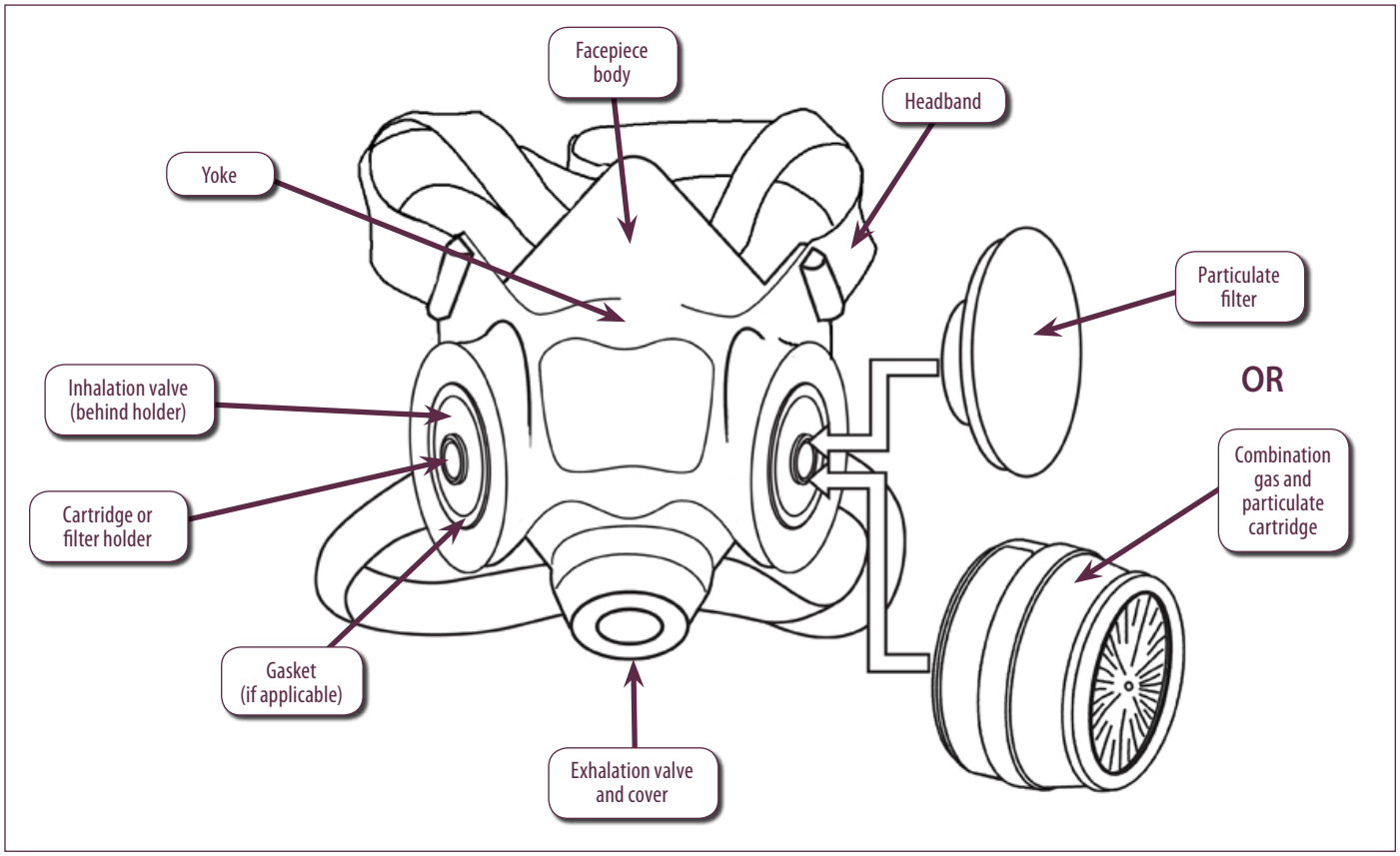
1. Make/model/size _____/_____ / _____
2. Make/model/size _____/_____ / _____
3. Make/model/size _____/_____ / _____

Respirator fit test form (sample)	
Points discussed with worker: ❑ Respirator selection ❑ Respirator limitations ❑ Storage and maintenance ❑ Cartridge dating, change frequency, and limitations ❑ Where to get replacement parts	
Fit test date	Next fit test date
Fit tested by	
Comments	
I, the undersigned, have been fit tested and counselled in the use, limitations, and maintenance of the above-noted respirator(s). Worker's signature: Date:	

Caring for your respirator

Your health—even your life—may depend upon your respirator. Don't toss it in a corner to collect dust until the next time it's needed. A respirator must be well maintained to work properly. Clean it regularly, inspect it for damage, and replace missing parts.

Respirators must be maintained according to the manufacturer's instructions. The manufacturer includes full instructions for inspection and maintenance with each respirator sold. Refer to the manual or instruction sheet provided with your respirator.



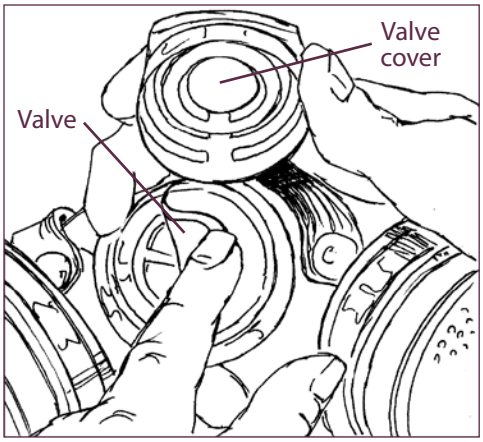
The basic parts of a typical half-facepiece respirator are shown. Two common options are illustrated on the right. Both sides of the respirator would take the same type of filter or cartridge.

Inspection

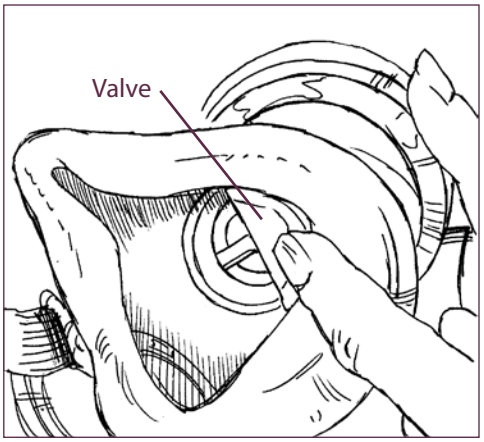
Missing valves. Cracked or warped facepieces. Used-up cartridges. Frayed and knotted head straps. These are just a few problems that can mean your respirator is not protecting you.

Inspect your respirator before each use and during cleaning. Check for damaged or worn parts. The rated level of protection provided by a respirator may not be achieved if any of the required components are not present or if the wrong components have been substituted. Check the following basic respirator parts:

- **Facepiece:** Look for any warping, and check for dirt, holes, tears, and cracks. The rubber or silicone should be flexible, not stiff.
- **Yoke:** Some respirators have a yoke across the facepiece front that strengthens and supports the facepiece. Check for cracks. Plastic yokes will crack from too much bending. Weak points may show up as black lines on aluminum yokes.
- **Inhalation and exhalation valves:** Make sure the valves are there! Inspect the valve and the valve seat for cracks, tears, dirt, and curling. The valves should be very flexible and lie **flat**. Missing, curled, or damaged valves won't stop contaminated air from entering the respirator and being inhaled. Make sure that the exhalation valve cover is present.



Check that the exhalation valve is present and in good working order.



Check that the inhalation valves are present and in good working order.

- **Head straps:** Look for breaks or tears. Stretch the straps to test the elasticity. Replace any straps that have knots in them. Make sure all fasteners are present and work properly.
- **Cartridge and filter holders:** If the respirator uses a snap-on mount to hold the cartridges or filters, all sealing surfaces must be clean. If the respirator uses a screw mount, the threads must not be worn. If the respirator uses gaskets, make sure they are present.
- **Cartridges and filters:** Look for cracks and other damage such as dents and holes. Replace filters or cartridges if they are heavily coated with paint or other material. Make sure you are using the correct type of filter or cartridge for the hazard. The wrong type of cartridge, or cartridges that are used up, will make the respirator useless.

If inspection shows that any parts of the respirator are missing or defective, or if the respirator is not serviceable for any other reason, it must not be used until it has been repaired.

The sample inspection checklist on pages 77–78 can be adapted for your use, depending on the type of respirator you use.

Respirator inspection checklist

Air-purifying respirators

Filtering facepiece

Check for:

- ❑ Holes in the filters
- ❑ Worn-out (torn, no longer elastic) or missing straps
- ❑ Missing or curled valves (if the respirator has them)
- ❑ Folds, creases, or distortion in the facepiece

Air-purifying respirators with replaceable cartridges or filters

Check the **facepiece** for:

- ❑ Dirt
- ❑ Cracks, tears, holes
- ❑ Warped surfaces
- ❑ Broken fittings (for example, strap holders)
- ❑ Cracked, scratched, or loose-fitting lenses in full-face models
- ❑ The presence of filter seal gaskets (if the respirator has gaskets)

Check the **head straps** for:

- ❑ Wear and tear
- ❑ Lack of elasticity, knots
- ❑ Broken or faulty buckles

Check the **valves** for:

- ❑ Soap residue or dirt on valves or on the valve seat
- ❑ Cracks, tears, hardening, or warps in the valves or the valve seat
- ❑ Missing or damaged valve cover
- ❑ Valves that are curled under the valve seat

Check that the **cartridges and/or filters** are:

- ❑ Made by same manufacturer as the respirator
- ❑ The right ones for the hazard
- ❑ Fitting securely in the facepiece (threads are not worn)
- ❑ Free from cracks or dents
- ❑ Marked with the date they were put into service

Powered air-purifying respirators (PAPRs)

In addition to the previous checklist items, check the:

- ❑ Condition of battery pack, wires, and connections
- ❑ Airflow (does it meet manufacturer's specifications?)
- ❑ Condition of breathing tube (if respirator has one)

Respirator inspection checklist

Air-supplying respirators

The following is a basic checklist for air-supplying respirators. Refer to the manufacturer's instructions for details about your specific equipment.

For both supplied-air (airline) and SCBA, check the **compressed breathing air supply system** for:

- ❏ Damage to air supply lines and hoses, attachments, and end fittings
- ❏ Correct operation and condition of regulators
- ❏ Location of compressor and air intake (must be in contaminant-free areas)
- ❏ Correct regulator and flow control valve settings
- ❏ Whether breathing air from the compressor meets air quality standards
- ❏ Whether air pressure and volume are within manufacturer's specifications for the length of airline
- ❏ Tight connections between the compressor, the airline, and the facepiece
- ❏ Whether compressor maintenance record is present and up-to-date
- ❏ Whether filtration system, carbon monoxide monitor, high temperature alarm, and water trap, if present, are in good condition and operating properly

On **supplied-air (airline) respirators**, perform all the pre-use checks in the manufacturer's instructions and check:

- ❏ For cracks or breaks in the faceshield
- ❏ That an emergency escape device is included, if required
- ❏ Condition of facepiece straps, gaskets, and valves

On **self-contained breathing apparatus (SCBA)**, perform all the pre-use checks in the manufacturer's instructions, as well as the following.

Check the **regulator** for:

- ❏ Condition of connections
- ❏ Emergency bypass test
- ❏ Low pressure alarm on SCBA
- ❏ Positive-pressure regulator test

Check the **air cylinder** for:

- ❏ Physical damage (dents or corrosion)
- ❏ Date of last fill
- ❏ Date of last hydrostatic test
- ❏ How much air the cylinder contains (it must be fully charged)

Filter and cartridge replacement schedules

Filters and cartridges should be replaced regularly according to a predetermined "change-out" schedule. Don't wait until you have difficulty breathing or can smell or taste the contaminant to change the filter or cartridge. Date all cartridges and filters when you open them so you will know when they were put into service. Do not use cartridges or filters of unknown age.

Check with the manufacturer for information about the service life of filters and cartridges. However, some factors change the service life:

- If the work involves fast movement or heavy labour, the service life is shorter than if the work is slower or less physical. (More air moves through the filter during heavy work.)
- Very low concentrations of contaminants increase service life. (Reducing concentration by a factor of 10 will increase service life by a factor of 5.)
- Humidity above 85% will reduce service life by 50%.

Many manufacturers offer assistance in determining the expected life span for filters and cartridges under various conditions.

When to change filters

The following table provides guidelines from NIOSH on when filters need to be changed, according to the class of filter.

Filter replacement schedule		
N Class (Not resistant to oil)	**R Class** (Resistant to oil)	**P Class** (Oil-Proof)
Change filter when: • It becomes damaged, soiled, or difficult to breathe through **or** • The total mass loading* of the filter reaches 200 mg (100 mg per filter for dual-filter respirators) **or** • Oil particulates are present (change to R or P Class)	Change filter when: • It becomes damaged, soiled, or difficult to breathe through **or** • The total mass loading* of the filter reaches 200 mg (100 mg per filter for dual-filter respirators) **or** • It undergoes 8 hours of continuous or intermittent use where oil particulates are present	• If the filter is used in an atmosphere with non-oil particulates or both oil and non-oil particulates, change filter when it becomes damaged, soiled, or difficult to breathe through. • Contact the respirator manufacturer or supplier for service life information.

* mass loading: the amount of particulate deposited on the filter

When to change cartridges

Gas and vapour cartridges have a limited life span. Cartridges should be marked with the date that they are first used or put into service. They must be replaced according to a pre-set schedule. Contact the respirator manufacturer or supplier for the replacement schedule.

In addition, replace the cartridge right away if you experience any breakthrough warning signs. Make sure you know what to expect from the contaminant that may be present at your worksite. Your cartridge needs to be replaced if:

- You smell or taste the contaminant through your respirator
- Your throat or lungs feel irritated

Cleaning

Employers are responsible for providing cleaning materials and for giving workers time to clean their respirators properly.

Reusable respirators need to be cleaned regularly to remove dirt and kill bacteria, especially when they are shared by different people. If the respirator is shared, clean it when you have finished using it. Respirators that have not been cleaned are unpleasant to wear and can cause skin rashes at the seal. Aftershave lotions and powders can also cause skin irritation, so don't use these products on your face where it touches the respirator.

The following is an example of a cleaning and sanitizing procedure for half-facepiece and full-facepiece respirators. For more details, see the cleaning and sanitizing procedures in the manufacturer's instructions.

1. Remove the filters or cartridges from the respirator facepiece. The filters or cartridges must not become wet or damp. Wipe the cartridge exterior with a damp cloth if necessary. Do not clean the cartridge interior. If the filters or cartridges are heavily coated with paint or other material, replace them.
2. Remove the head straps, gaskets, and valves from the facepiece. Carefully wash the facepiece in warm water. Water that is too hot can warp the facepiece. If possible, use a mild soap designed to kill bacteria. Use a soft scrub brush to remove stubborn material.

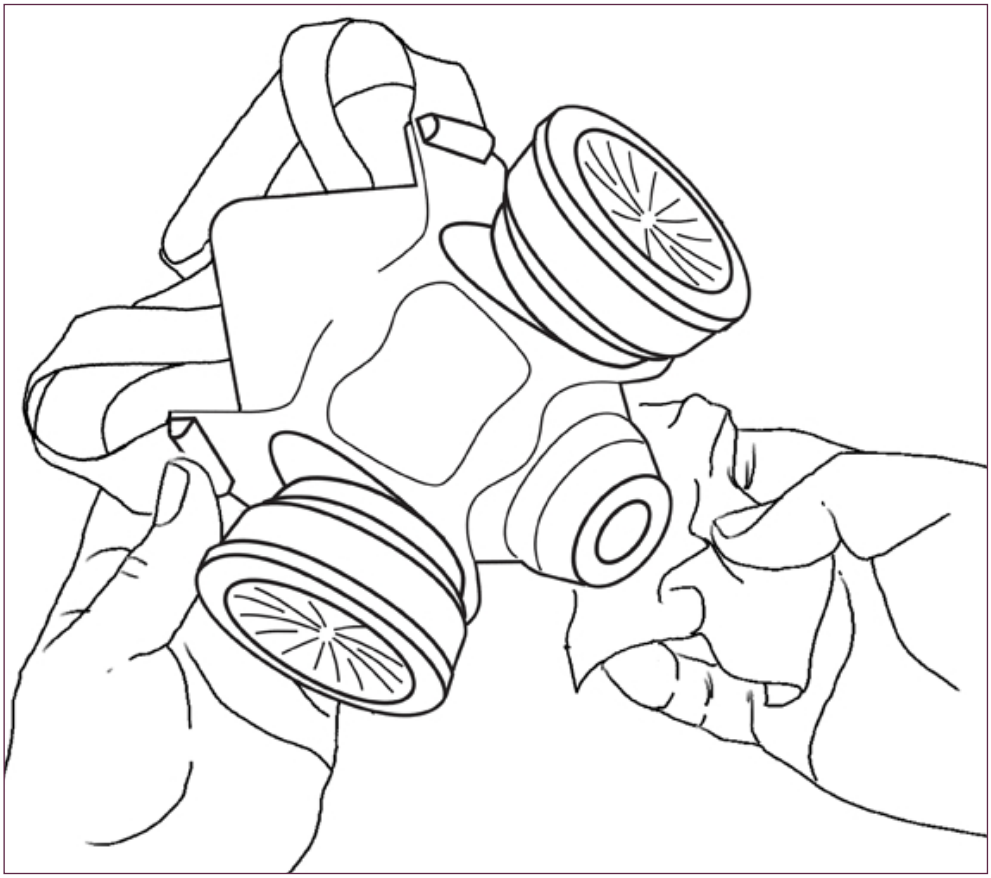
Never use solvents such as turpentine or gasoline to clean the facepiece because these liquids can damage plastic and rubber parts. Commercial respirator cleaning solutions, kits, and related products are available through safety equipment suppliers.

3. Rinse the facepiece in clean, warm water to remove any soap residue. (Soap left on the facepiece can cause skin rashes and seal the valves shut.)
4. If you're not using an antibacterial soap, soak the facepiece in a disinfecting solution for at least two minutes. You can follow the manufacturer's recommendation or you can make your own solution daily. For example, add 30 millilitres (2 tablespoons) of household bleach to 4 litres (1 gallon) of water. Remove the facepiece and rinse it again with warm water. Wash off all disinfectant as it can cause skin rashes.
5. Dry the facepiece on a clean surface or hang it from a line. Make sure that the facepiece will not become distorted. If you dry it with a cloth, use a soft, lint-free cloth.
6. Wash valves and any gaskets carefully. Allow them to air dry. Make sure the valves dry **flat**. Replace any curled or damaged valves with new ones.
7. Reassemble the respirator, making sure all pieces, especially the valves and gaskets, are in their correct positions. Reattach the filters or cartridges. Your respirator is now ready for use.

After you take a coffee or lunch break, you may want to do a quick cleanup of your respirator. Hypo-allergenic wipes can be purchased for this purpose. Use them to wipe the facepiece seal and the inside of the facepiece before putting the respirator on. Avoid hanging your respirator on your arm or leaving it in a dusty environment during breaks.

Sharing respirators should be discouraged. However, if workers have to share respirators, it is especially important to enforce strict cleaning and maintenance. Ideally, workers should have their own respirators because they would then be much more likely to wear and take care of them.

Sample schedule for cleaning and disinfecting respirators	
Type of use	**Schedule for cleaning and disinfecting**
Exclusive use by one worker	As needed to keep respirator sanitary
Shared by workers	Before being worn by different workers
Emergency use	After each use
Used for fit testing and training	After each use



Use a moist wipe to clean the facepiece when a quick touch-up is needed.

Be aware of other routes of exposure

Respirators control only the airborne contaminants that you inhale. You can also be exposed to these hazardous materials in other ways.

You can swallow some hazardous materials. If you spray pesticides, you may get some on your clothing. The pesticide may be transferred to your hands when you take off your hat, for example. You may then swallow the pesticide when you start to eat. To avoid swallowing hazardous materials, wash your face and hands before taking coffee or lunch breaks. This will prevent contaminants on your skin from being transferred to food and cigarettes.

Some other hazardous materials can be absorbed into your body through the skin. To avoid this type of exposure, make sure you wear all required personal protective equipment — such as gloves and coveralls — to protect you on the job.

Respirators used with highly toxic particulates such as asbestos and hantavirus require special decontamination and disinfecting procedures. For details, read the manufacturer's instructions and see the following WorkSafeBC publications:

- *Safe Work Practices for Handling Asbestos*
- *A Hantavirus Exposure Control Program for Employers and Workers*

Storage

Too often, respirators are left out to get dirty or damaged at the end of the workday. Storing your respirator properly will protect it from chemicals, strong sunlight, and extreme heat or cold.

Keep your respirator clean by storing it in a plastic bag. NIOSH "100" (HEPA) filters used for highly toxic particulates should be sealed with tape to contain the contaminants.

- Store your respirator in a safe place such as a cabinet or locker. Do not store it with your tools—they can damage the respirator.
- When storing your respirator, position it so that the facepiece, hoses, and head straps are not bent or stretched out of shape.
- Don't fold respirators that aren't designed to be folded.
- Some cartridges can continue absorbing moisture and contaminants from the surrounding air after you take the respirator off. Store your respirator in a resealable plastic bag before putting it away. This will stop the cartridges from absorbing contaminants and getting used up. It will also keep the respirator clean and dust-free.
- If you are using "100" (HEPA) filters for highly toxic particulates such as asbestos or hantavirus, seal the filters with duct tape before taking the respirator off your face. This will prevent any toxic dust from shaking loose from the filters and getting into the air or onto the facepiece during handling.
- Remove the tape from the filters **after** you have put the respirator back on. When discarding old "100" (HEPA) filters, seal them with tape to keep the contaminant in the filter.

Maintenance and repair

Respirators need to be properly maintained to remain effective. Follow the manufacturer's instructions to ensure the best possible protection.

You can do simple maintenance on your respirator—such as replacing valves or clamps—yourself. Make sure any replacement parts you use are specifically approved by the manufacturer for the model you are using. Using unapproved parts voids the NIOSH approval for the respirator (this refers to all respirator parts, including straps, cartridges, valves, regulators, hoses, and seals). Employers must provide an adequate supply of respirator

parts or extra respirators to ensure that only well-maintained respirators are used. Any non-functioning or defective respirators must be tagged as "out of service" and be removed from use until repaired.

More complicated maintenance and repair on respirators must be done by qualified people. For example, the manufacturer or another trained person must repair powered air-purifying respirators (PAPRs) and air-supplying systems that include regulators and monitoring and alarm devices. If respiratory equipment is not repaired properly, it may become ineffective or malfunction. In some cases, even minor modifications can significantly change the performance of the respirator. Make sure only specially trained people repair these types of respirators.

The employer must maintain a record of maintenance for air-supplying respirators, powered air-purifying respirators, and sorbent cartridges and canisters. The sorbent cartridges and canisters should be checked regularly for expiry dates and to make sure they are sealed and stored properly.

Proper maintenance of SCBA respirators is essential

Self-contained breathing apparatus (SCBA) respirators are used to protect workers in dangerous and IDLH conditions. To ensure that workers can rely on this equipment, it is essential that all maintenance and inspections be carried out according to the manufacturer's instructions accompanying each SCBA. Inspections usually include a visual inspection and periodic hydrostatic testing of the air cylinder.

A major hazard that is often overlooked is allowing previously filled air tanks to stand unused for long periods. In the presence of moisture, the metal in the cylinder wall will oxidize and use up the oxygen inside the tank. Oxygen concentrations as low as 5% have been found in tanks as a result of this. Do not use air tanks that were filled longer than 12 months ago.

Only people trained and certified by the manufacturer of the specific SCBA are authorized to repair or maintain the parts of the system that affect flow and function. For example, inspection, re-assembly, and repair of SCBA regulators must be done by qualified people. Deaths and close calls have resulted when untrained people have repaired regulators improperly.

4 Setting up an effective respirator program

About respirator programs

A respirator program is a formal plan for using respirators at a specific worksite. You cannot simply hand out respirators and expect workers to use them properly. If respirators are necessary to protect workers, then an effective respirator program will:

- Help protect the workers' health and prevent illnesses related to breathing hazards in the workplace
- Promote more effective use of respirators
- Make it easier to comply with WorkSafeBC requirements

If respirators are used at a workplace, a respirator program must be in place. Ideally, one person in the organization should be designated as the program administrator and have overall responsibility for the program. Parts of the program can be delegated to others, but the final authority for running the program should rest with one administrator. It is important that whoever is assigned the responsibility for respirators has the knowledge to perform the job.

A sample respirator program is provided in the appendix on pages 99–115.

Exposure control plans and confined space entry programs

Some employers may also be required to develop an exposure control plan and/or a confined space entry program.

The requirements for exposure control plans are listed in section 5.54 of the Occupational Health and Safety Regulation.

The requirements for confined space entry programs are listed in section 9.5 of the Regulation.

Section 8.5 of the Occupational Health and Safety Regulation lists six essential elements of a respirator program:

- Statement of purpose and responsibilities
- Written procedures for selection, use, inspection, cleaning, maintenance, and storage of respirators
- Instruction and training
- Medical assessment of respirator wearers, where required
- Documentation
- Program review

Statement of purpose and responsibilities

A written statement of purpose acknowledges the need for and scope of the respirator program. It is important that the workers understand the purpose of the program and know their own responsibilities as well as those of others in the organization.

The purpose of a respirator program is to ensure that the respirators provide workers with effective protection against the airborne contaminants to which they may be exposed, as well as against oxygen deficiency.

The employer, supervisors, and workers all have responsibilities to ensure that workers are protected from breathing hazards. The general health and safety responsibilities of employers, supervisors, and workers in the workplace are defined in the *Workers Compensation Act*. Requirements specific to respirator equipment are listed in sections 8.2–8.9 and 8.32–8.45 of the Regulation.

Employer's responsibilities

The employer's general occupational health and safety responsibilities as applied to respirators include:

- Implementing a written respirator program and designating a respirator program administrator
- Ensuring that the worksite is evaluated for breathing hazards
- Eliminating or minimizing all breathing hazards
- Providing and maintaining the respirators needed for any airborne hazard present at the worksite, and ensuring that the workers use the respirators when required

- Providing time and materials for workers to clean their respirators
- Providing supervisors with the education and training necessary to ensure that workers use respirators safely
- Providing workers with the education, training, and supervision necessary for safe use of respirators
- Developing emergency evacuation procedures and ensuring that supervisors and workers receive appropriate training in any workplace where workers may need to be rescued or evacuated because of breathing hazards
- Ensuring that all illnesses or injuries resulting from breathing hazards and requiring medical aid are reported and recorded
- Requiring a medical assessment if there is a concern about a worker's ability to wear a respirator

Program administrator's responsibilities

The program administrator is responsible for managing the respirator program. The program administrator must:

- Take responsibility for all aspects of the respirator program
- Ensure that the program meets the requirements of the CSA Standard
- Ensure that respiratory hazards in the workplace are assessed by a qualified person
- Make sure that a list of respirator types used in the workplace is maintained
- Ensure that all workers required to wear respirators are properly trained to wear and maintain their equipment
- Ensure that the respirator program is reviewed on an annual basis
- Maintain written records as required by the CSA Standard

Supervisors' responsibilities

Supervisors play a crucial role in worksite safety. They must ensure the health and safety of all workers under their direct supervision. Supervisors are responsible for ensuring that:

- Workers are aware of breathing hazards
- Respirators are available when required
- Workers use respirators correctly as required
- Respirators are properly cleaned, inspected, maintained, and stored

In addition, supervisors should be alert to situations that could interfere with the safe use of respirators, including:

- Other protective equipment or clothing that may interfere with respirator use
- Changes in working conditions that may result in exposure to higher concentrations or to new contaminants
- Problems experienced by workers during respirator use, such as discomfort, skin irritation, or breakthrough of contaminants causing breathing difficulty

Because of their knowledge of the workplace, supervisors can also play an important role in:

- Identifying breathing hazards and making suggestions as to how they can be eliminated
- Being alert to changes in the workplace that could require a change in the type of respirators being used

Workers' responsibilities

Workers have a responsibility for their own safety as well as that of their co-workers. Workers have the following responsibilities related to respirators:

- Understanding and following safe work procedures
- Using respirators as instructed
- Understanding the limitations of the respirators they are using and following the manufacturer's instructions carefully
- Inspecting their respirators before use
- Immediately reporting any equipment malfunction or other problem to their supervisor
- Properly cleaning, maintaining, and storing respirators if these responsibilities have been assigned to them
- Reporting all symptoms related to respirator use to their supervisor or first aid attendant
- Reporting unsafe or harmful conditions
- Notifying the supervisor if they have medical concerns about using a respirator

Written procedures

Well-written procedures explain how certain tasks are to be done and who will do them. Written procedures serve as a useful reference for employers, supervisors, and workers. The process of writing procedures helps ensure that the unique characteristics of the worksite are considered. All procedures should be kept together, and a copy should be filed with the joint health and safety committee or worker health and safety representative.

You must include written procedures for at least the following aspects of respirator use:

- Selection
- Use
- Inspection
- Cleaning
- Maintenance
- Storage

If the written procedures are provided elsewhere, such as the manufacturer's instructions or in this manual, you can simply reference those procedures and who is responsible for them.

Respirator selection

The type of hazard, the level of the contaminant, and the working conditions dictate what type of respirator can be worn. Improper selection can lead to serious injuries or fatalities. Purchase and use only respirators that are approved by the National Institute for Occupational Safety and Health (NIOSH) or that have been accepted for use in writing by WorkSafeBC.

Your respirator program should list the approved respirators (make and model), the type of cartridge or filter (for air-purifying respirators), and the contaminants they protect against.

For more information on respirator selection, see pages 33–46.

Respirator use

Written procedures for respirator use should state important conditions of use, such as the following:

- Under what circumstances the assigned respirator must be used (routine use and escape respirators)

- The need for a user seal check each time a tight-fitting respirator is put on, and for an annual fit test
- With tight-fitting respirators, that the worker must be clean-shaven and must not wear glasses or protective equipment that interferes with the seal
- When a worker must leave a work area in the event of respirator problems (such as breakthrough, a leak in the facepiece, a change in breathing resistance, dizziness, or eye irritation)
- Procedures for working in IDLH (immediately dangerous to life or health) situations, if applicable, including the requirement for standby rescue personnel

Inspection

List the procedures for inspecting respirators before use. List who is responsible for any other regular inspections and how often the inspections are to be done. For more information on inspecting respirators, see pages 75–76.

Cleaning

Put in writing when respirators are to be cleaned and disinfected and who is responsible for cleaning. For more information on cleaning procedures and schedules, see pages 80–83.

Maintenance

Written procedures for the care and maintenance of respirators should include:

- Responsibilities for minor repairs
- Responsibilities for major repairs
- Criteria for removing defective respirators from service

For more information on maintenance and repair, see pages 84–85.

Storage

Written procedures should describe the proper storage of respirators and responsibilities for storage, including accessible storage of emergency respirators.

For more information on storing respirators, see page 84.

Instruction and training

Every worker who may be required to wear a respirator in either routine or emergency situations must be trained in the proper use of the respirator. Workers must be completely trained before they use a respirator in a hazardous area.

The instruction and training component should include:

- The breathing hazards that are or may be present at the specific worksite and their potential effects on the workers' health
- The capabilities and limitations of the selected respirator
- Inspection and maintenance procedures
- Cleaning and storage methods
- Putting on the respirator
- Doing a user seal check and fit test (with tight-fitting respirators)
- Proper use of the respirator in routine and emergency situations, including what to do if the respirator malfunctions

Annual retraining will ensure that workers are prepared to use the appropriate respirators safely when the need arises. Keep records of all training sessions, the dates the sessions were held, and who attended.

Medical assessment

If a worker is required to use a respirator and there is any doubt about the worker's ability to use it because of medical reasons, the worker must be examined by a doctor who can advise the employer of the worker's ability to wear a respirator. A re-assessment should be performed if there is any change in the worker's health status that might affect respirator use.

The respirator program should state that medical assessment will be provided when required.

Documentation

The program should state who will be responsible for keeping the records up-to-date. The employer must maintain a record of:

- Fit test results
- Worker instruction
- Maintenance records for air-supplying respirators, powered air-purifying respirators, and sorbent cartridges and canisters

- The manufacturer's instructions for the respirators used and for any accessories such as cartridges and breathing air compressors
- Annual tests of compressed breathing air for supplied-air respirators

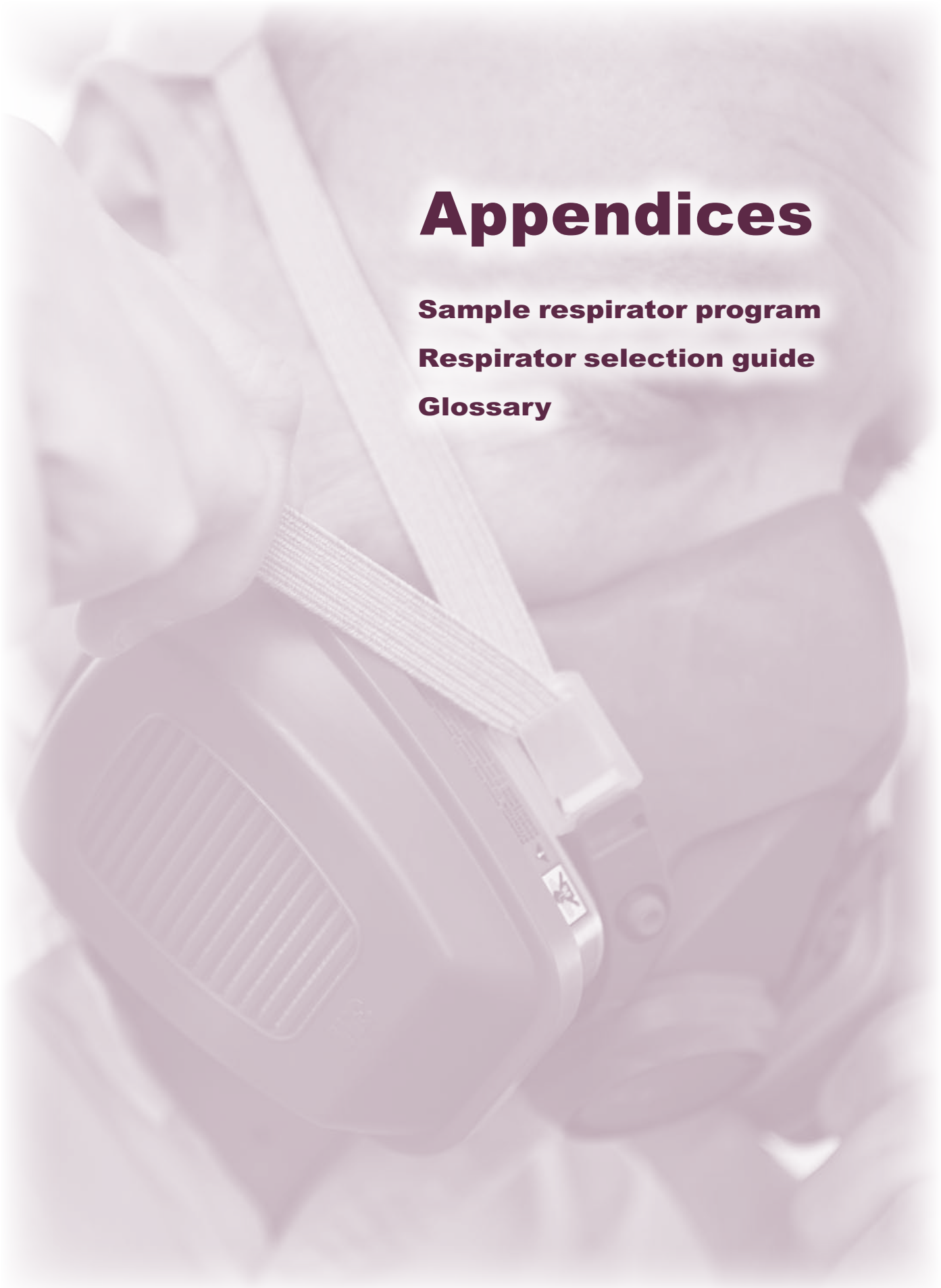
Program review

The respirator program must be evaluated annually in consultation with the joint health and safety committee or worker health and safety representative. The annual review must:

- Assess exposure control measures to ensure that they are still effective
- Determine the need for further control measures
- Evaluate training and instruction
- Assess the adequacy of exposure monitoring data and assess the need for further monitoring
- Ensure the adequacy of the fit test program

In addition, it is good practice to have an ongoing review process to identify any problems and correct them as they come up. Here are some suggestions for carrying out a review of your program:

- Consult with supervisors and workers and get their opinion on the respirators currently in use. Do the respirators interfere with other personal protective equipment? Do the respirators hamper communication or restrict workers' vision?
- Observe actual working conditions.
- Keep informed about new respirators available on the market that could correct or alleviate problems.
- Be aware of technological advances that may make it possible to engineer contaminants completely out of the work area, eliminating the need for respirators altogether.
- Be alert to changes in the workplace such as the use of new materials or processes that could change the concentration of contaminants or introduce new contaminants, requiring the use of a different type of respirator. If the airborne concentration of a contaminant increases, a respirator with a higher assigned protection factor may be necessary. If new contaminants are present, air-purifying respirators may require a different kind of filter or cartridge.



Appendices

Sample respirator program

Respirator selection guide

Glossary

Sample respirator program

Purpose

[***Company name***] has determined that our workers in [***locations/departments***] are potentially exposed to the following respiratory hazards during routine operations:

The purpose of this program is to ensure that respirators used by our workers provide effective protection against airborne contaminants in our workplace(s).

Note that before considering respirators as a way to control exposure, the employer is required to first consider engineering or administrative controls to eliminate or minimize the risk of exposure. Examples of such controls include ventilation, enclosing the process, substituting less hazardous products, and other effective means.

Responsibilities

Employer

The employer is responsible for:

- Implementing a written respirator program and designating a respirator program administrator
- Ensuring that the worksite is evaluated for breathing hazards
- Eliminating or minimizing all breathing hazards
- Providing and maintaining respirators needed for any airborne hazard present at the worksite, and ensuring that workers use the equipment when required
- Providing time and materials for workers to clean their respirators
- Providing supervisors with the education and training necessary to ensure that workers use respirators safely
- Providing workers with the education, training, and supervision necessary for safe use of respirators

- Developing emergency evacuation procedures and ensuring that supervisors and workers receive appropriate training in any workplace where workers may need to be rescued or evacuated because of breathing hazards
- Ensuring that all illnesses or injuries resulting from breathing hazards and requiring medical aid are reported and recorded
- Requiring a medical assessment if there is a concern about a worker's ability to wear a respirator

Program administrator

The program administrator ***[insert name]*** is responsible for:

- Assessing the type and amount of exposure
- Selecting the appropriate respirators
- Implementing training and instruction programs
- Administering the overall program, including the maintenance of records
- Reviewing the program on an annual basis

Supervisors

Supervisors are responsible for ensuring that:

- Workers are aware of breathing hazards on the worksite(s)
- Respirators are available when required
- Workers use respirators correctly as required
- Workers are clean-shaven
- Respirators are properly cleaned, inspected, maintained, and stored
- Workers are aware of any equipment or clothing that may interfere with respirator use
- Working conditions are monitored in order to alert supervisors of exposure to higher concentrations of a contaminant or a new contaminant
- Workers are aware of potential issues that may develop during respirator use, such as discomfort, skin irritation, or breathing difficulty
- The program administrator is notified of concerns or conditions that might affect workers' respiratory protection

Workers

Workers are responsible for:

- Understanding and following safe work procedures
- Using their respirators as instructed
- Understanding the limitations of their respirators and following the manufacturers' instructions
- Inspecting their respirators before use
- Immediately reporting any equipment problems to their supervisors
- Properly cleaning and storing their respirators

Respirator selection

The selection of a respirator must be appropriate to the contaminant, its concentration, and the level of protection provided by the respirator (i.e., the protection factor and maximum use concentration).

Only respirators bearing NIOSH/MSHA (U.S. Mine Safety and Health Administration) approval or other respirators acceptable to WorkSafeBC will be provided to workers.

The following respirators are available to workers and are to be worn for the work activities listed below.

Work activity	Contaminants	Type of respirator

Always read cartridge or filter labels and instruction manuals prior to use and be certain the correct cartridge or filter is selected.

For example: a) organic vapour cartridge respirators do not provide adequate protection against isocyanate-based automotive paints; b) only fume-rated particle masks provide protection against welding fumes.

Respirator fitting

To fit properly and provide protection, respirators that are designed to fit the face, such as rubber half-masks, must have an effective seal.

Workers using this type of respirator must be clean-shaven in the area where the respirator seals with the face (i.e., no visible stubble). Workers will receive a fit test once a year (see the "Respirator fitting procedures" section).

[***insert name***] will arrange fit testing and keep records of the results of these tests.

Worker training

Every worker who may have to wear a respirator will be trained in the proper use of the respirator. Both the worker and his/her supervisor receive this training. This training includes:

- Description of the type and amount of exposure
- Description of the respirator
- The intended use and limitations of the respirator
- Proper wearing, adjustment, and testing for fit
- Cleaning and storage methods
- Inspection and maintenance procedures

This training is repeated as often as necessary, at least annually, to ensure that workers remain familiar with the proper use of the respirators. A record will be kept of this training.

The training program is evaluated at least annually by ***[insert name]*** to determine that it continues to be effective.

Always refer to the respirator instruction manual for information.

Proper use of respirators

Corrective eyewear or other equipment must not interfere with the seal of the respirator.

No covering can be used that passes between the respirator facepiece and the wearer's face.

Respirators will be inspected before and after every use. Straps, valves, cartridges, other respirator parts, and general cleanliness will be checked. See the respirator instruction manual.

User seal checks will be performed, where applicable, by respirator users each time they put on their respirators.

High contaminant levels and other factors such as high humidity can affect filters or cartridges. Workers noting a resistance to breathing, a smell or taste of chemicals within the respirator, or an irritation shall immediately leave the work area and report to their supervisor. After an investigation rules out other reasons, such as failure of ventilation systems, respirators shall be checked and new filters or cartridges installed.

When wearing respirators, workers experiencing any of the following must leave the contaminated area:

- Nausea
- Dizziness
- Eye irritation

- Unusual odour or taste
- Excessive fatigue
- Difficulty breathing

The program administrator will determine whether or not a worker may be allowed to wear a respirator. Where there is any doubt on the part of the worker or program administrator about the worker's ability to wear a respirator, the worker is to be examined by a physician. Certain medical conditions, such as lung disease (e.g., asthma or emphysema) or heart disease, may affect the worker's ability to wear a respirator.

Cleaning, maintenance, and storage of respirators

Respirators will be maintained, cleaned, and stored as described by the manufacturer's instructions. Where respirators are shared, they will be cleaned and sanitized after each use. Follow the manufacturer's recommendations for sanitizing.

The following procedure can be used to clean and sanitize most respirators:

1. Remove any filters, cartridges, or canisters.
2. Wash the respirator (and associated parts) in warm water mixed with a mild detergent (or a mild detergent plus bleach).
3. Rinse the respirator in clean, warm water.
4. Wipe the respirator with disinfectant wipes (70% isopropyl alcohol) or a sanitizing foam to kill germs.
5. Air dry in a clean area.
6. Reassemble the respirator (e.g., replace the cartridges).
7. Place in a clean, dry plastic bag (or other container).

Defective respirators shall not be used. If during an inspection a worker discovers a fault or defect in a respirator, he/she will bring it to the attention of the supervisor. The worker or supervisor will attempt to repair the defective respirator. If the respirator cannot be repaired, it will be given to the program administrator. The program administrator will then:

- Perform a simple fix, such as the replacement of a valve or head strap, or
- Take the respirator out of service until it can be repaired, or
- Dispose of the defective respirator and provide a new one

A supply of replacement parts, filters, cartridges, etc. is available at ***[location]***.

After inspection, cleaning, and necessary repairs, respirators will be properly stored in plastic bags, storage cabinets, or lockers.

Respirator fitting procedures

User seal checks

When you are satisfied that you have found a respirator that fits, there are two simple checks to test the seal. You must do at least one of these checks each time you put on your respirator.

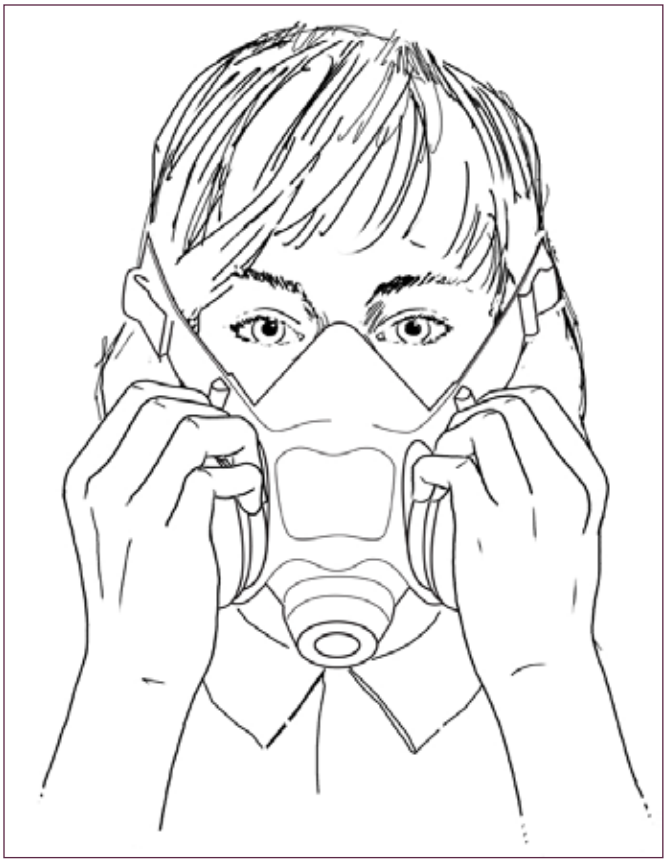
Before doing any seal check, make sure your respirator has all its inlet and exhaust valves. Make sure that the valves are in good condition and lie flat. Doing these checks will help you tell whether you have a good seal and whether the valves are in place and working.

If the respirator is to be used with any other personal protective equipment—such as goggles, hearing protection, or a hard hat—all seal checks must be done while you are wearing this equipment.

Negative-pressure user seal check

This test is called a negative-pressure user seal check because you create a slightly negative air pressure inside the respirator facepiece by inhaling. Follow these instructions:

1. Put on the respirator and other associated personal protective equipment. Tighten the head straps until the respirator feels snug but comfortable. Wear the respirator for a few minutes so that it will warm up and conform to your face better.
2. Close off the inlet opening of the cartridges or filters by covering them gently with the palms of your hands, a plastic bag, a special adapter, or gloves (in some cases, you may have to remove the cartridges so you can cover the inlet valves). If you are carrying out this test while wearing a PAPR or an air-supplied respirator, close off or disconnect the hose to stop the airflow.
3. Breathe in slightly to create a vacuum.
4. Hold for 10 seconds.
5. If you have a good seal, the facepiece should collapse slightly against your face and stay collapsed. No air should leak into the facepiece past the sides, top, or bottom.



For a negative-pressure seal check, close off the inlet openings with your palms and inhale gently.

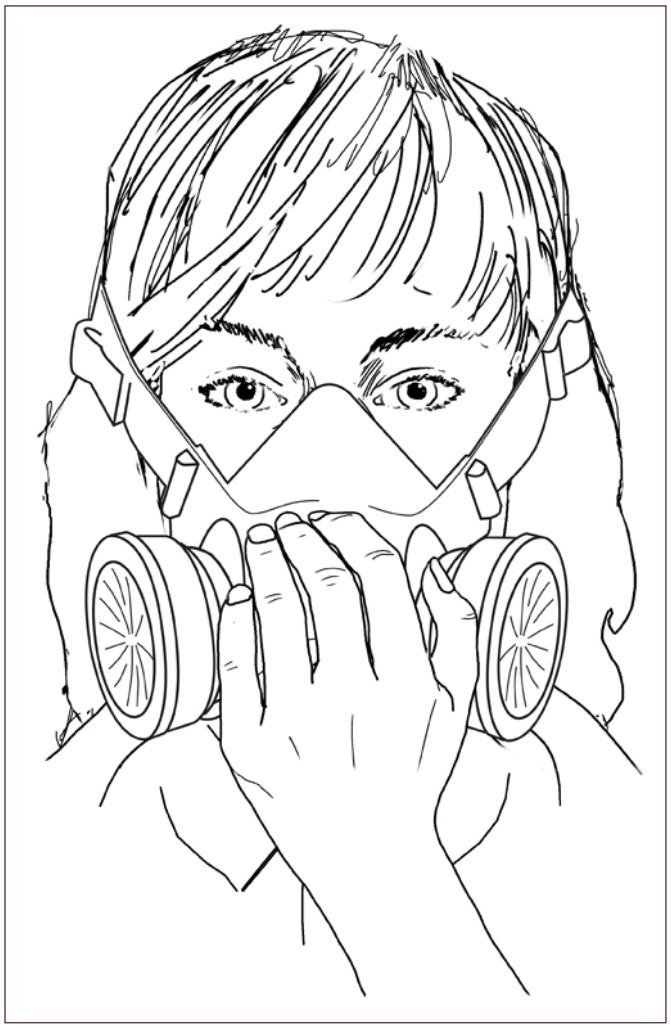
If the facepiece doesn't collapse and stay collapsed, there is an air leak. Check the exhalation valve(s) and try repositioning the respirator on your face and adjusting the head straps. Carry out the negative-pressure seal check again. If you cannot get a seal after a few attempts, try another size, make, or model of respirator. Repeat the check until you find a respirator that passes the seal check.

Positive-pressure user seal check

This test is similar to the negative-pressure user seal check except that you breathe out slightly while gently covering the exhaust valve with your palm. This creates positive pressure in the facepiece. If you have a good seal, the facepiece will bulge or puff out slightly from your face. Again, no air should leak past the sides, top, or bottom of the respirator.

1. Put on the respirator and other associated personal protective equipment. Tighten the head straps until the respirator feels snug but comfortable. Wear the respirator for a few minutes so that it will warm up and conform to your face better.
2. Close off the exhaust valve opening by covering it with the palm of your hand.
3. Breathe out **slightly** to force air into the facepiece.
4. Hold for 10 seconds.
5. If you have a good seal, the facepiece should bulge out and stay out. No air should leak out of the facepiece past the sides, top, or bottom.

If the air does leak out, check the inhalation valves and try repositioning the respirator on your face and adjusting the head straps. If you cannot get a seal after a few attempts, try on another size, make, or model of respirator. Repeat the check until you find a respirator that passes the seal check.



For a positive-pressure seal check, cover the exhaust valve and breathe out slightly.

Note that the configuration of some air-purifying respirators may make it impossible to conduct an effective positive-pressure check without dislodging the facepiece. Consult the manufacturer's instructions to see whether the positive-pressure user seal check applies to the respirator.

Fit testing

After the respirator has passed either the positive- or the negative-pressure user seal check, another test of the seal, called a fit test, must be done and the results recorded.

When fit tests are performed, workers must be clean-shaven and must wear all other protective equipment that they need, such as goggles and hard hats. Prescription eyeglasses must not interfere with the seal of the respirator (specialty eyeglasses are available). Ideally, fit tests should be done under operating conditions similar to those that workers would experience at the worksite.

There are two types of fit testing: qualitative and quantitative. In qualitative fit testing, workers with poorly sealing respirators will detect an irritant, an odour, or a taste when exposed to a test agent. In quantitative fit testing, specialized equipment is used to actually measure the amount of the test agent leaking into the facepiece.

Our workplace utilizes qualitative fit testing procedures.

Irritant smoke fit test

In this test, a worker wearing a respirator is exposed to an irritating smoke (stannic chloride). If the respirator fits properly, no smoke will leak into the facepiece and be detected by the worker. If smoke does leak in, it will cause an involuntary reaction in the worker, such as coughing. It is important to follow instructions carefully to avoid exposing workers to any unnecessary smoke irritation. The smoke can be irritating to the eyes and airways.

Caution: This test agent may be an irritant to the worker being fit tested or to the tester. Do not use this test agent to fit test workers with respiratory sensitivities. The tester should consider wearing a respirator if a number of fit tests are being performed.

Irritant smoke threshold screening

1. Break off both ends of the smoke tube and insert one end into the rubber bulb (watch for the other exposed sharp end).
2. Squeeze the bulb to force air through the tube and produce smoke.
3. Warn the worker that the smoke can be irritating and that he or she should keep eyes closed throughout the test.
4. Carefully direct a small amount of the smoke in the worker's direction.
5. Discard used tubes in sharps containers at the end of the test.
6. After the worker coughs, proceed with the fit test procedure.

Irritant smoke fit test procedure

The worker should put on the respirator and all other personal protective equipment, such as eye protection or a hard hat. A successful seal check must be done before the fit test.

Irritant smoke tests must be conducted with facepieces equipped with combination organic vapour/acid gas (OV/AG) and "100" (HEPA) filter cartridges. After the respirator has passed the fit test, the facepiece can be fitted with the appropriate filter or cartridge necessary for protection in the workplace.

Do not place a hood or bag over the head of the test subject. The test must be performed in a location with sufficient ventilation to prevent contamination of the work area and ventilation system.

Use a well-ventilated room or area to carry out the irritant smoke tests (both threshold screening and the fit test).

The following exercises shall be performed while the respirator seal is being challenged by the smoke:

- Normal breathing.
- Deep breathing. Be certain breaths are deep and regular.
- Turning head from side to side. Be certain movement is complete.
- Nodding head up-and-down. Be certain motions are complete. Alert the test subject not to bump the respirator on the chest. Have the test subject inhale when his/her head is in the fully up position.
- Talking. Slowly and distinctly, count backwards from 100.
- Normal breathing.

Each exercise shall be performed for one minute.

1. While the worker performs the first fit test exercise (above), pass the smoke stream around the perimeter of the facepiece. You should direct the smoke at the facepiece seal, starting with the smoke stream about 30 cm (12 in.) away from the respirator. Go around the seal a total of three times, gradually bringing the smoke to within 5 cm (2 in.) of the respirator. If the worker does not detect the stream of smoke by coughing, continue with the next fit test exercise. Repeat this step for each of the six exercises.
2. Because the smoke can be irritating, do not direct puffs of smoke at the eyes, and keep the smoke tube at least 5 cm (2 in.) away from unprotected skin. Ask workers to keep their eyes closed if they are being fitted with a half-facepiece respirator.
3. If the worker does not cough, then no smoke has leaked into the facepiece, and the respirator has passed the fit test. Fill out the fit test record.

Caution: Testers must be careful with the sharp, broken end of the smoke tube. Coughing workers may unexpectedly jab themselves if they make sudden movements. The fit tester may wish to cover the broken end of the tube with a short length of tubing. Always discard used tubes in sharps containers at the end of the test.

Bitter aerosol taste fit test

In this test, a worker is exposed to a spray containing denatonium benzoate. It has an extremely bitter taste. The worker wears a respirator equipped with any particulate filter and puts on a test enclosure or hood that covers the head and shoulders. The fit tester exposes the worker to the bitter aerosol by spraying the test solution into the enclosure. Because it is a very bitter solution, it can be easily detected by the worker if it leaks through the face seal. If the worker cannot taste the bitter aerosol after the predetermined number of squeezes, it means that the respirator fits properly.

A bitter aerosol fit testing kit can be purchased from suppliers of safety equipment. These kits contain pre-mixed solution as well as instructions for administering the fit test.

Workers should not eat, drink (except plain water), smoke, or chew gum for at least 15 minutes before taking the bitter aerosol fit test.

Before conducting the test, make sure the worker being fit tested can detect the bitter taste by performing a threshold screening check. The threshold screening should be done under a test hood, and the worker being tested should not wear a respirator.

Caution: This test agent may affect workers with respiratory sensitivities.

Bitter aerosol threshold screening

1. Instruct the worker to breathe through a slightly open mouth with the tongue extended.
2. Ask the worker to let you know when a bitter taste can be detected.
3. Insert a nebulizer containing the threshold check solution into an opening located at the front of the test hood. Direct the spray away from the worker's breathing zone.
4. Rapidly squeeze the bulb of the nebulizer 10 times and ask if the worker can taste the bitter aerosol.
5. If the worker cannot taste the bitter aerosol, rapidly squeeze the nebulizer bulb 10 more times and ask again if the worker can taste it. If the response is still negative, squeeze the nebulizer bulb 10 more times.
6. Once the worker reports tasting the bitter taste, proceed with the fit test. If the worker cannot detect the bitter taste after 30 squeezes, perform a different fit test.

Bitter aerosol fit test procedure

The worker should put on the respirator and all other personal protective equipment, such as eye protection or a hard hat. A successful seal check must be done before the fit test.

1. Prepare a solution made of bitter aerosol and salt solution in warm water and pour the solution into a nebulizer.
2. Have the worker put on a test hood while wearing the respirator. The front portion of the hood should be clear of the respirator and provide sufficient room for free head movement.

3. Instruct the worker to breathe through a slightly open mouth with the tongue extended. Ask the worker to let you know if a bitter taste can be detected.
4. Insert the nebulizer filled with prepared solution into the opening in the test hood directly in front of the worker's nose and mouth. Direct the spray away from the worker's breathing zone.
5. Firmly squeeze the bulb of the nebulizer containing the test solution either 10, 20, or 30 times, depending on the worker's sensitivity to the bitter aerosol (as determined by threshold screening).
6. Instruct the worker to perform the six fit test exercises and tell you if a bitter taste can be detected.
7. Every 30 seconds, replenish the aerosol concentration by squeezing the nebulizer bulb half the number of squeezes used previously (i.e., use 5, 10, or 15 squeezes). Squirt the solution into the test hood.
8. If the worker reports tasting the bitter aerosol, the respirator has failed the fit test. If the worker cannot detect the bitter aerosol, the respirator has passed the fit test.

Saccharin solution aerosol fit test

This test is similar to the bitter aerosol solution fit test. Instead of using a bitter-tasting aerosol, the fit tester exposes the worker to the sweet taste of saccharin. The threshold screening and the fit test are done in a test enclosure or hood that covers the head and shoulders.

The saccharin solution threshold screening is identical to that of the bitter aerosol, except that the worker must demonstrate the ability to detect the sweet taste of the test agent.

For the fit test, a worker wears a respirator equipped with any particulate filter. The tester sprays the test solution into the test hood, directly in front of the worker's nose and mouth. If the worker cannot detect a sweet taste after either 10, 20, or 30 squeezes, it means that the respirator fits properly.

Workers should not eat, drink (except plain water), smoke, or chew gum for at least 15 minutes before taking the saccharin solution aerosol fit test. Workers who eat or drink something sweet before the test may not be able to detect the taste of saccharin and must not be allowed to undergo the fit test.

A bitter or sweet solution is sprayed into the test hood for the bitter aerosol or saccharin fit test.

Isoamyl acetate (banana oil) fit test

This test is similar to the bitter aerosol and saccharin fit tests in that the threshold screening and the fit test are done in a test enclosure. A worker wearing a respirator is exposed to a compound called isoamyl acetate (known as banana oil), which smells strongly like bananas. Before starting the test, you must make sure the person being fit tested can smell the banana oil. If the worker cannot smell the banana oil, perform the fit test using another test agent. For complete instructions on how to conduct this test, refer to *CSA Standard CAN/CSA-Z94.4-02, Selection, Use, and Care of Respirators.*

Since the banana oil test uses a vapour, it can only be used to fit test air-purifying respirators that take a cartridge. The respirator should be fitted with an organic vapour cartridge. After the respirator has passed the fit test, attach the appropriate filter or cartridge for the workplace contaminant.

Respirator selection information form

Process/operation information

Work area location:	
Work area characteristics (open area, confined space, etc.):	
Location of hazardous area relative to safe area:	
Work description/ operation:	
Anticipated length of time that respirator will be used:	
Worker activity level (light, moderate, or heavy):	

Information for each breathing hazard

Step 1:	Oxygen level (if below 19.5%, air-purifying respirators cannot be used)	%
Steps 1, 2:	Air contaminant and concentration	
Step 3:	8-hour TWA limit	
Step 4:	IDLH concentration	
Step 5:	Can the contaminant cause eye irritation?	
Step 5:	Can the contaminant irritate skin or be absorbed through the skin?	
Step 6:	Respirator under consideration and assigned protection factors	
Step 7:	Hazard ratio (minimum protection factor)	
Step 8:	Maximum use concentration (MUC)	
Step 9:	Air-supplying or air-purifying respirator?	
Step 10:	State of contaminant	
Step 11:	Adequate warning properties (odour, irritation, etc.)?	

Recommended approved respirator(s):
Recommended approved filter or cartridge:
Other protective equipment required:

Respirator inspection checklist for air-purifying respirators

Filtering facepiece

Check for:	☐ Holes in the filters
	☐ Worn-out (torn, no longer elastic) or missing straps
	☐ Missing or curled valves
	☐ Folds, creases, or distortion in the facepiece

Air-purifying respirators with replaceable cartridges or filters

Check the facepiece for:	☐ Dirt
	☐ Cracks, tears, holes
	☐ Warped surfaces
	☐ Broken fittings (for example, strap holders)
	☐ Cracked, scratched, or loose-fitting lenses (full-face models)
	☐ The presence of filter seal gaskets (if the respirator has gaskets)
Check the head straps for:	☐ Wear and tear
	☐ Knots, lack of elasticity
	☐ Broken or faulty buckles
Check the valves for:	☐ Soap residue or dirt on valves or on the valve seat
	☐ Cracks, tears, hardening, or warps in the valves or the valve seat
	☐ Missing or damaged valve cover
	☐ Valves that are curled under the valve seat
Check that the cartridges or filters are:	☐ Made by the same manufacturer as the respirator
	☐ The correct type for the hazard
	☐ Fitting securely in the facepiece (threads are not worn)
	☐ Free from cracks or dents
	☐ Marked with the date they were put into service

Powered air-purifying respirators (PAPRs)

In addition to the previous checklist items, check the:	☐ Condition of battery pack, wires, and connections
	☐ Airflow (does it meet manufacturer's specifications?)
	☐ Condition of breathing tube (if respirator has one)

Respirator fit test form

Name of worker:	Date:

Does the worker wear/have:

☐	Eyeglasses	☐	Contact lenses
☐	Dentures	☐	Facial hair

If yes to any of the above, discuss how the respirator seal will be affected (workers must be clean-shaven where the respirator seals with the face). Other comments regarding counselling on eyeglasses, dentures, contact lenses, and facial hair:

Does the worker have any medical concerns about wearing a respirator?

☐ Yes ☐ No

If yes, refer worker for a medical assessment.

Fit test procedure

Fit testing must be repeated annually to ensure that a proper face seal is maintained.

Check when completed successfully:

- ☐ Correct positioning of respirator and strap adjustment
- ☐ Negative- or positive-pressure user seal check

Qualitative fit testing using:

- ☐ Irritant smoke with HEPA/organic vapour cartridges
- ☐ Bitter aerosol with particulate filter
- ☐ Isoamyl acetate (banana oil) with organic vapour cartridges
- ☐ Saccharin with particulate filter
- ☐ Other _____

Qualitative fit testing:

- ☐ Pass
- ☐ Fail

Quantitative fit testing:

- ☐ Pass
- ☐ Fail

Respirator(s) fit tested by worker

When a worker wears different makes and models of respirators, fit testing must be done on each make and model of respirator and the results recorded. The worker should also wear all other required personal protective equipment, such as hearing and eye protection, while undergoing the test.

Make/model/size			
Make/model/size			
Make/model/size			

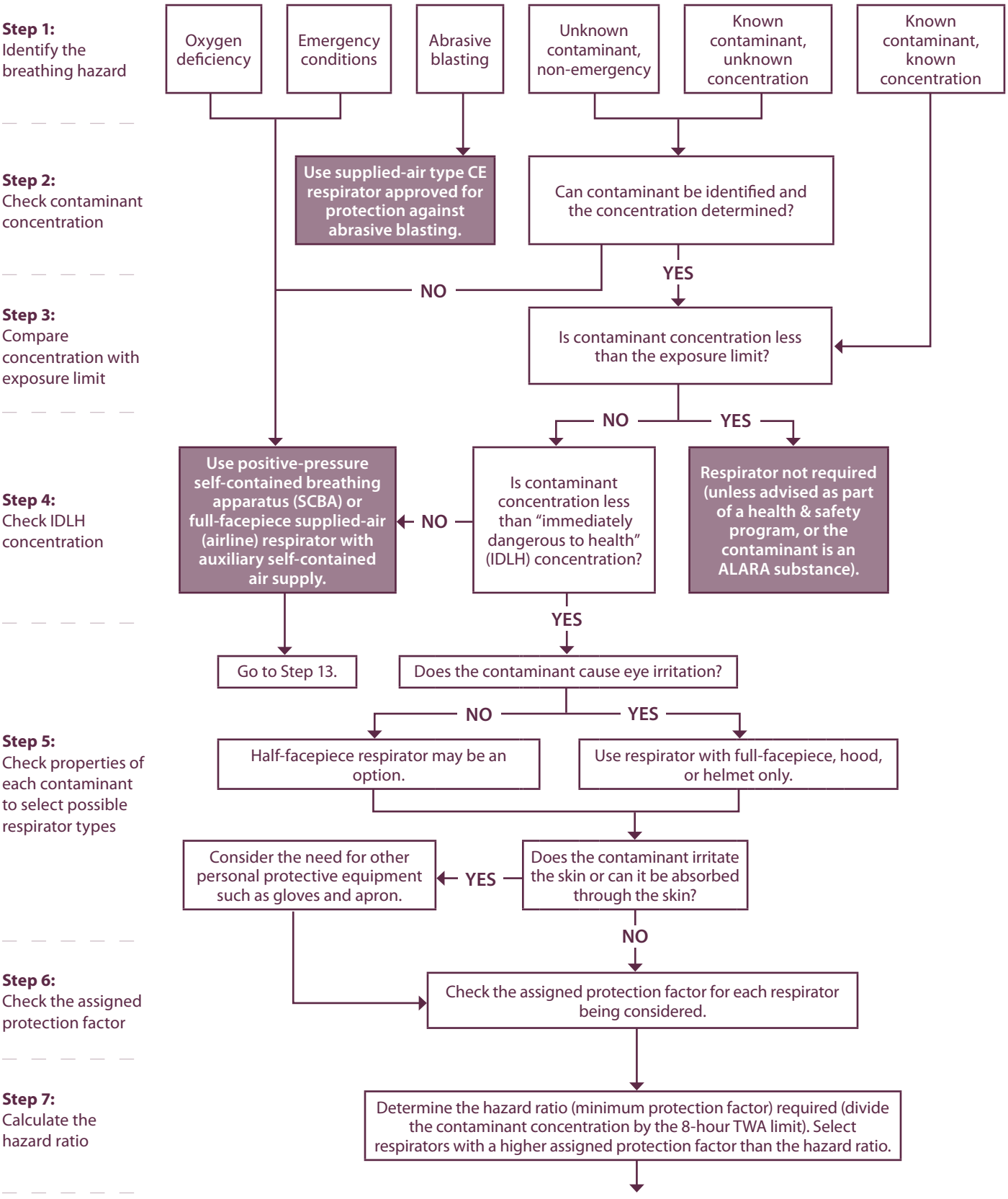
Points discussed with the worker

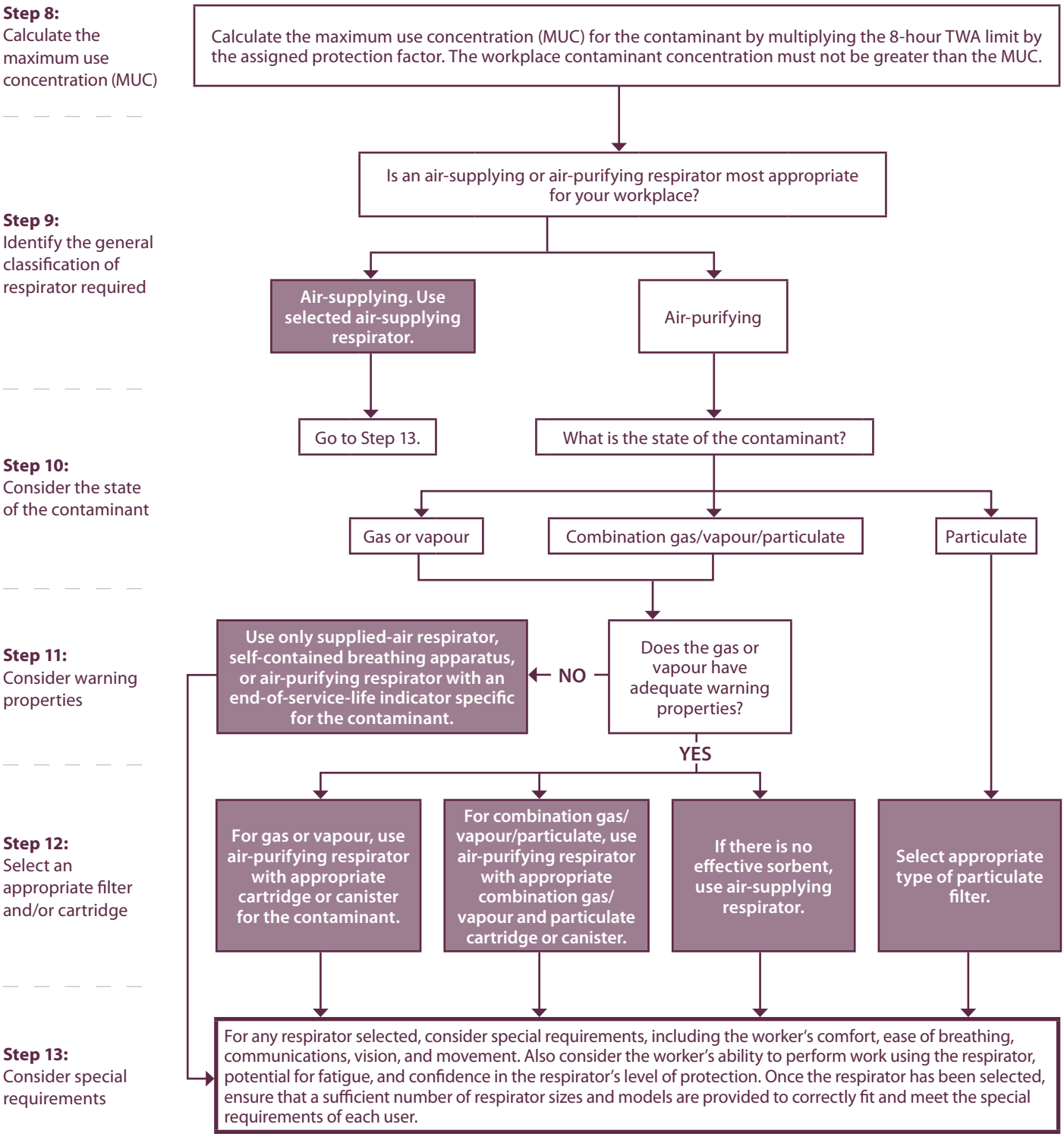
- ☐ Respirator selection
- ☐ Respirator limitations
- ☐ Storage and maintenance
- ☐ Cartridge dating, change frequency, and limitations
- ☐ Where to get replacement parts

Fit test date:	**Next fit test date:**
Fit tested by:	

Comments:

Respirator selection guide




Step 8:
Calculate the maximum use concentration (MUC)
Calculate the maximum use concentration (MUC) for the contaminant by multiplying the 8-hour TWA limit by the assigned protection factor. The workplace contaminant concentration must not be greater than the MUC.
Step 9:
Identify the general classification of respirator required
Is an air-supplying or air-purifying respirator most appropriate for your workplace?
Air-supplying. Use selected air-supplying respirator.
Air-purifying
Go to Step 13.
Step 10:
Consider the state of the contaminant
What is the state of the contaminant?
Gas or vapour
Combination gas/vapour/particulate
Particulate
Step 11:
Consider warning properties
Does the gas or vapour have adequate warning properties?
NO
Use only supplied-air respirator, self-contained breathing apparatus, or air-purifying respirator with an end-of-service-life indicator specific for the contaminant.
YES
Step 12:
Select an appropriate filter and/or cartridge
For gas or vapour, use air-purifying respirator with appropriate cartridge or canister for the contaminant.
For combination gas/vapour/particulate, use air-purifying respirator with appropriate combination gas/vapour and particulate cartridge or canister.
If there is no effective sorbent, use air-supplying respirator.
Select appropriate type of particulate filter.
Step 13:
Consider special requirements
For any respirator selected, consider special requirements, including the worker's comfort, ease of breathing, communications, vision, and movement. Also consider the worker's ability to perform work using the respirator, potential for fatigue, and confidence in the respirator's level of protection. Once the respirator has been selected, ensure that a sufficient number of respirator sizes and models are provided to correctly fit and meet the special requirements of each user.

Glossary

8-hour TWA limit — The time-weighted average (TWA) concentration of a substance in air which may not be exceeded over a normal 8-hour work period.

Aerosol — Particulate matter suspended in air; includes *dust*, *fumes,* and *mists*.

ALARA — **A**s **l**ow **a**s **r**easonably **a**chievable; in reference to a substance, ALARA means that measures must be taken to keep a worker's exposure to a level as low as is reasonably achievable.

ANSI — American National Standards Institute.

Assigned protection factor — See *Protection factor.*

Breakthrough — The penetration of a contaminant through an air-purifying cartridge or canister when the cartridge or canister is saturated with the contaminant.

Compressed air — Air under pressure that exceeds 15 pounds per square inch or 103 kPa. See also *Respirable (compressed) air.*

Contaminant — A harmful or irritant material, or nuisance dust, foreign to the normal composition of a substance, or a material that varies the normal proportions of components in a mixture such as air.

Confined space — A space such as a tank, silo, storage bin, process vessel, sewer, or other enclosure not designed or intended for human occupancy.

Or an area, other than an underground working (such as a tunnel or shaft), that

(a) is enclosed or partially enclosed
(b) is not designed or intended for continuous human occupancy
(c) has limited or restricted means of entry or exit that may complicate the provision of first aid, evacuation, rescue, or other emergency response service, and
(d) is large enough and so configured that a worker could enter to perform assigned work

Controlled product — A product, material, or substance specified by regulations made pursuant to section 15(1)(a) of the *Hazardous Products Act* (Canada) as products, materials, and substances included in any of the classes listed in Schedule II of that Act.

CSA	Canadian Standards Association.
Dust	Fine solid particles dispersed in air that have been formed by mechanical means such as grinding, crushing, blasting, or drilling.
Elastomeric	Made of natural or synthetic rubber or rubber-like plastic.
End-of-service-life indicator	A built-in indicator to tell the user when to replace a cartridge or canister; available with some air-purifying cartridges and canisters for use with contaminants that have poor warning properties.
Exposure limit	The maximum concentration of a contaminant that workers are allowed to be exposed to without respiratory protection, as set out in the Occupational Health and Safety Regulation. See also *8-hour TWA limit*.
Fibre	A thread-like solid particle that is several times longer than it is wide.
Fit check	See *Seal check*.
Fit test	A quantitative or qualitative test to check a respirator's fit by detecting leakage of a test compound into the facepiece. Fit tests must be performed in accordance with procedures found in *CSA Standard CAN/CSA-Z94.4-02, Selection, Use, and Care of Respirators*, or other procedures acceptable to WorkSafeBC.
Fume	Solid particles formed as a result of vaporization and condensation of a material. Produced when solid material (such as metal or plastic) is heated, causing some of the material to boil off, cool in the air, and condense into tiny solid particles.
Gas	A state of matter, not liquid or solid at ordinary room temperature and air pressure; a gas occupies the space and volume of the area that encloses it.
Hazard ratio	The airborne concentration of a substance divided by its 8-hour TWA limit.
Hazardous	Refers to the existence or potential existence of an unsafe or harmful condition, substance, or circumstance.

Hazardous atmosphere	Any atmosphere that is oxygen-deficient or that contains an airborne toxic or disease-producing contaminant in concentrations exceeding the legally established exposure limit.
HEPA filter	**H**igh **e**fficiency **p**articulate **a**ir filter meeting the specifications of a nuclear-grade filter, providing a 99.97% filtration efficiency at a particle size of 0.3 micrometres. For respirators, a HEPA filter is a NIOSH 100 series filter (N, R, or P class).
IDLH atmosphere	An atmosphere containing a substance at a concentration that is immediately dangerous to life or health (IDLH) because it impairs a worker's ability to escape without serious injury or irreversible health effects.
Lower explosive limit (LEL)	The concentration of a gas or vapour below which a flame does not spread on contact with a source of ignition.
Material safety data sheet (MSDS)	A document that provides detailed information on a controlled product, including product identification and use, hazardous ingredients, physical data, fire and explosion data, reactivity data, toxicological properties, preventive measures, first aid measures, and preparation data. Also defined as a document disclosing the information referred to in section 13(a)(i) to (v) of the *Hazardous Products Act* (Canada) and section 12 (1) to (3) of the *Controlled Products Regulations* (Canada).
Maximum use concentration (MUC)	The concentration determined by multiplying the 8-hour TWA limit for an air contaminant by the assigned respirator protection factor selected from Table 8-1 of the Occupational Health and Safety Regulation, or as otherwise determined by WorkSafeBC.
Mist	Tiny airborne drops of liquid, usually formed when liquid is sprayed, shaken, mixed, or stirred.
NIOSH	National Institute for Occupational Safety and Health (U.S.).
Odour threshold	The lowest concentration of a contaminant in the air that can be detected by smell; usually given as a range based on individuals' differing abilities to detect odours.
OSHA	Occupational Safety and Health Administration (U.S.).

Oxygen-deficient	Describes an atmosphere in which there is less than 19.5% oxygen by volume, or in which the partial pressure of oxygen is less than 16.3 kPa (122 mm Hg).
Protection factor	A value assigned to a particular class of respirators that is the anticipated level of protection that would be provided to a properly fitted user (see Table 8-1 of the Occupational Health and Safety Regulation).
Respirable (compressed) air	Compressed breathing air supplied for equipment such as an SCBA (self-contained breathing apparatus) and a supplied-air respirator that meets the requirements of *CSA Standard CAN/CSA-Z180.1-00, Compressed Breathing Air and Systems*, or another standard acceptable to WorkSafeBC. See also *Compressed air.*
Seal check	A negative- or positive-pressure check of a respirator's fit, performed in accordance with the respirator manufacturer's instructions. Also called a fit check.
Sorbent	A material (such as charcoal) that removes toxic gases and vapours as air is inhaled through a cartridge or canister.
Supervisor	A person who instructs, directs, and controls workers in the performance of their duties.
Vapour	The gaseous form of a substance that is normally liquid or solid at room temperature.
Warning property	A property of a contaminant—such as smell, taste, or irritation—that alerts a respirator user when the cartridge or canister is saturated and needs to be replaced.
WHMIS	Workplace Hazardous Materials Information System (see sections 5.3 to 5.19 of the Occupational Health and Safety Regulation).

Notes

Notes

Notes

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