Introduction

Respiratory Protection Programs have become increasingly popular in occupational health and safety due to the ongoing risks of exposure to chemical, biological and/or infections agents in the workplace.

Respiratory Protection Programs apply to numerous workplace industries such as police services, health care, manufacturing and construction. In fact, any worker who may be exposed to a hazardous airborne contaminant measuring above an allowable occupational exposure limit is required to wear respiratory protection.

This guide outlines the suggested elements for Respiratory Protection Programs and strategies to implement for a successful program. Workers will learn how to properly select, use and care for respirators to help ensure their safety against biological, chemical or infectious agents.

This material is also designed for those who are required to wear or enforce the use of respiratory protection in the workplace. This may include workers, supervisors, Respiratory Protection Program Administrators and employers.

After reviewing this document, readers should understand:
- Respiratory related legislation, standards and measures
- The regulatory components of a Respiratory Protection Program (RPP)
- The types of respiratory illnesses and hazards
- How to assess respiratory hazards
- Types of respirators, including air purifying and supplied air respirators
- Respirator selection
- The fit testing process
- Donning and doffing
- The overall care, inspection and storage of respirators

Overview

Depending on the workplace or tasks to be conducted, workers may be exposed to potentially hazardous situations that involve airborne contaminants such as dusts, fumes, mists, gases, vapours, aerosols, airborne pathogens or oxygen deficiency. While it is always preferred that workplace hazards are eliminated or minimized, some instances may arise where workers must also rely on personal protective equipment (like a respirator) to help ensure their health and safety.

The Canadian Standards Association, also known as CSA, requires that a written program is in place for workers who use respiratory protection to protect them from atmospheric hazards. This document is designed to increase awareness of respiratory hazards and the proper use of respirators, and is based upon the current CSA Z94.4 Standard: The Selection, Use and Care of Respirators.

If a regulation (e.g. sandblasting or diving operations) prescribes a particular respirator, the employer must follow the requirements of that regulation.
If an employer identifies a respiratory hazard in the workplace, they must protect the worker by using various control methods, including:

- Substitution of a less hazardous product
- Implementing engineering solutions such as ventilation
- Applying administrative controls such as job sharing, reduced exposure, etc.
- Ensuring proper personal protective equipment is provided

CSA develops standards which are an employer’s best guide for compliance if not specified in legislation is CSA’s Standard Z94.4. In the absence of specific legislation, they can be adopted by the courts as the minimum standard of care.

Z94.4 specifies requirements for the proper selection, use and care of respirators and outlines the essential components necessary for an effective Respiratory Protection Program in the workplace. Similar best practices and industry standards associations originate in the United States. These include:

- The National Institute for Occupational Safety and Health (NIOSH): an American agency, often used in Canada that tests and certifies respirators.
- The Mine Safety and Health Administration (MSHA): tests and certifies respirators with a focus on the mining industry.
- American Conference of Governmental Industrial Hygienists (ACGIH): research and publish occupational exposure limits (OELs) and permissible exposure limits (PELs) for various chemicals, which are sometimes adopted into legislation.
- The National Fire Protection Association (NFPA): sets standards and guidelines adhered to by fire services and HAZMAT operations.

The Z94.4 standard Selection, Use and Care of Respirators is used by health and safety professionals who are required to develop and maintain respiratory protection plans in the workplace.

The overall purpose of the program is to ensure that respiratory protection is used to protect a user from inhaling a hazardous atmosphere when engineering or administrative control measures are not practicable or adequate.

This standard does not address respirators used against infectious agents or nuclear biological chemical agents, nor does it address underwater breathing devices, aircraft oxygen systems, or inhalators and resuscitators. From this point forward, CSA Standard Z94.4 will be referred to as “The Standard”.
Respiratory Protection Program Contents
This standard has ten principle elements that should be incorporated into a workplace Respiratory Protection Plan including:

• Roles and responsibilities
• Hazard assessment
• Selection of the appropriate respirator
• Respirator fit testing
• Training
• Use of respirators
• Cleaning, inspection, maintenance and storage of respirators
• Health surveillance of respirator users
• Program evaluation
• Recordkeeping

Respiratory Protection Policy
Developing a Respiratory Protection Policy is an effective method to ensure workplace parties are aware of their required roles and responsibilities. Respiratory Protection Policies should outline the rationale of the policy, and the scope and guidelines to meet necessary compliance. The policy should be written by the employer and signed by the President or CEO.

Employer Responsibility
The employer must also ensure that a written Respiratory Protection Program includes all ten CSA Standard components, in addition to any required workplace specific procedures as appropriate. The program should be implemented in consultation with the end user, as well as the Joint Health and Safety Committee or representative, if applicable.

To ensure that the program is properly executed and maintained, the employer must also appoint a qualified administrator for the program.

The employer must also ensure that procedures are clearly defined for the following roles and functions:

• Program Administrator
• Respirator User
• Supervisor
• Person Selecting Respirator
• Respirator Fit Tester
• Issuer of Respirators
• Maintenance Personnel
• Healthcare Professional

Please note: there is no requirement that indicates these responsibilities must be “individual roles.”

Program Administrator Responsibilities
The Program Administrator shall be responsible for all requirements of the respiratory program as applicable and shall ensure that:

• Appropriate personnel have been assigned the defined roles of this Standard.
• Assessments for respiratory hazards are conducted by qualified persons.
• A list of accepted respirators for each respiratory hazard is maintained.
• Procedures are established for respirator user screening and where applicable, a medical assessment.
• All respirator users:
  • must complete the user screening
  • must be provided with written instruction and training on the initial use of a respirator
  • must be fit tested prior to initial use
  • must be able to demonstrate ongoing competency in respirator use
  • must receive additional training where required
  • must be fit tested again at designated
intervals or when necessary

- Regular monitoring of proper respirator use is carried out.
- Are able to demonstrate ongoing competency in respirator use.

The **Administrator** must also ensure that:

- The program is reviewed at least annually to assess effectiveness of all its elements.
- Tracking measures are in place to address efficiency of related procedures and training.
- Written instructions and records are maintained.
- A process is developed to review the program ensuring emergency and rescue operations are anticipated.
- The program is updated based on legislation changes, program evaluations, investigation reports and medical surveillance reports.

**Respirator User**

The **Respirator User** also has responsibilities under the Standard. They must:

- Report to their supervisor when there is any condition that can impair their ability to safely use a respirator.
- Maintain clean-shaven conditions to ensure an effective seal, where applicable.
- Ensure the respirator is clean and in good working condition prior to use.
- Perform negative and/or positive air pressure user seal checks after donning a tight-fitting respirator.
- Remove any defective respirator equipment from service and inform supervisor immediately.
- Report to supervisor any condition or change that may impact the ability to use a respirator safely.
- Use the respirator as per the company’s written instructions and training.

**Supervisor Responsibilities**

The **Supervisor** also has duties to fulfill under this standard. These duties include:

- Ensuring the Respiratory Protection Program is monitored in the workplace for compliance purposes.
- Verifying that users can demonstrate competency in the use of the respirator.
- Ensuring that health screening, fit testing and training are complete prior to assigning any task that requires a respirator.
- Ensuring respirators are cleaned, sanitized, inspected, maintained, repaired and stored as required by manufactures instructions as well as company procedures.
- Ensuring respirators are used in accordance with the instructions, the training received and the safe operating procedures established for the workplace.

Supervisors must also ensure that workers who use a tight-fitting respirator maintain a clean-shaven condition to ensure an effective seal, provide details of the type of respirator selected and the anticipated working conditions to be provided to a healthcare professional when conducting a medical assessment, where required.

The **Supervisor** shall work with the **Program Administrator** regarding any user concerns or changes, and report if the use of a respirator contributed to an incident or injury in any way.

We will review the remaining elements of a respiratory program throughout the remainder of this guide.
Section Review

In summary, a Respiratory Protection Program is required when workers are exposed to or likely are to be exposed to hazardous airborne contaminants. The Canadian Standards Association has developed standard Z94.4: The Selection, Use and Care of Respirators, to assist health and safety professionals with the development and implementation of a Respiratory Protection Program.

Other agencies and associations also offer guidelines and best practices that complement the Z94.4 standard.

The Standard indicates that the employer must implement and maintain a Respiratory Protection Program which must include a policy that outlines various components of the program in detail, including the responsibilities of the employer, program administrator, respirator user and supervisor.

Contaminants and Hazards in the Workplace

Routes of Entry

There are four major routes of entry that hazardous chemicals can follow to make their way into the body:

1. Ingestion: Chemicals can be accidentally swallowed if hands, food or cigarettes are contaminated.
2. Absorption: Contaminants can be absorbed through the skin or eyes. This can be extremely hazardous. For example, people who wash their hands with turpentine to remove paint will have traces of the chemical in their urine within 30 minutes.
3. Injection: Though less common in workplaces, it can occur when a sharp object punctures the skin and injects a chemical into the bloodstream.

4. Inhalation: The most common way chemicals enter the body is by breathing.

When it comes to all the way hazards can enter our bodies, inhalation presents the quickest, most common and direct route of entry; we must breathe to survive, and many airborne particles are small enough to enter the respiratory system.

Inhalation

The surface area of the respiratory tract is extremely large and gas exchange in the alveoli (tiny air sacs in the lungs) is almost instantaneous. Consider the affects of carbon monoxide (CO); the CO molecules bond readily to the red blood cells. When oxygen is exhaled most of the CO remains in the blood, leaving less room for oxygen molecules to bond with the red blood cells. As the breathing cycle repeats, chemical asphyxiation eventually occurs, rendering the
body incapable of using the oxygen supply.

**Types of Hazardous Airborne Contaminants**

Workers who are exposed to hazardous airborne contaminants may be at risk of lung disease and other respiratory illnesses. Work spaces within poorly ventilated or confined, closed-in areas are contributing risk factors. Additionally, the type of substances or materials used in the workplace can also cause lung damage or other breathing difficulties.

Such substances include particulates like:

- **Dust** from coal, cotton, silica and talc. Dust can also come from pesticides, drug or enzyme powders and metals. These particulates are produced by physical operations like grinding, crushing and mixing. Dust also comes in organic forms, including flour, sugar, grain and sawdust, as well as non-organic materials like asbestos and radioactive dusts.
- **Mists**, which are aerosols of liquid particles that are suspended in air, are often created by propelling liquid under pressure when performing work with substances like spray paint, lacquers, pesticides, acids and cleaning products.
- **Fumes** from metals being heated and cooled rapidly result in fine, solid particles being carried in the air. These can occur from welding, smelting, manufacturing steel, plastics or rubber.
- **Smoke** is generated by burning, or a chemical reaction that is often concentrated enough to obscure vision. Smoke may consist of gases, vapours, particulates and liquid aerosols.
- **Fibres** from fibreglass, asbestos and other fibrous materials can easily be inhaled and remain lodged deep in the linings of the lungs for several years, resulting in long term, chronic illnesses.

Other hazardous airborne contaminants may come in the form of:

- **Gases**, which exist in a gaseous state, like formaldehyde, chlorine, sulphur dioxide, and ammonias, or
- **Vapours**, a form of gas given off by liquids, including solvents that will irritate the upper respiratory system (nose and throat) before affecting the lungs.

**Bioaerosols**

Bioaerosols are known to be airborne particles, large molecules or volatile compounds that are either living, contain living organisms or were released from a living organism. For example, a liquid droplet may be generated from a cough or sneeze, and solid particles can be produced from sweeping or shovelling activities, causing the particles to suspend in the air. Bioaerosols can cause infection and adverse or allergic reactions which may lead to disease or illness.

**Exposure Effects**

Exposures can also be chemical in nature and are presented in two types of effects. The first is an **acute effect** that occurs when a person is exposed to a hazardous substance in high concentrations which produces serious and immediate effects. An example of an acute exposure is carbon monoxide, where a serious illness or fatality can occur within minutes.

The other type of effect is known as a **chronic effect** which usually develops slowly after exposure to low dose concentrations of a hazardous substance and does not appear until many years later. A good example of a chronic effect is the exposure to asbestos, where an illness may only begin to present up to 40 years after an initial exposure.
Toxic effects on the body can be permanent or reversible and will differ from person to person.

**Gas and Vapour Hazards**
Gas and vapour hazards in particular have very distinctive effects which include:

- **Anaesthetics** that create a loss of feeling.
- **Sensitizers** which cause physiological effects that can result in allergic reactions after repeated exposure.
- **Systemic poisons** that can affect full systems and organs such as the respiratory system.
- **Asphyxiates** which dilute the oxygen supply, and chemical asphyxiates that can render the body incapable of using the oxygen supply, ultimately resulting in suffocation over time.

**Types of Respiratory Illnesses**
Results of exposure to hazardous airborne contaminants can range from very minor irritations or reversible conditions to progressive illnesses or sudden death. According to NIOSH, approximately 70 per cent of all occupational disease deaths are work-related respiratory illnesses and cancers. Respiratory Illnesses include:

- Occupational asthma
- Tuberculosis
- Long or short-term hypersensitivity pneumonitis or inflammation of the small airways of the lungs
- Inhalation fevers that result in short term but debilitating flu-like symptoms
- Metal-induced interstitial lung disease from over exposure to beryllium or hard metals
- Pneumoconioses such as silicosis, asbestosis and coal worker’s pneumoconiosis
- Chronic bronchitis
- Pleural disorders such as benign pleural effusions, pleural plaque or mesothelioma
- Lung cancer

The risk of developing these and other occupational illnesses is much greater to workers who smoke or are exposed to secondhand smoke outside the workplace.

**Assessing Hazards**
Once hazards have been identified, they must be assessed for their level of risk. When it comes to airborne contaminates, hazards can be assessed by considering a variety of standards. For example, the need for respirators is based on the following criteria:

- Immediately Dangerous to Life or Health (IDLH)
- Occupational Exposure Levels (OELs), and
- Oxygen levels

Samples of the workplace atmosphere are tested and the results are reported back to the employer by hazard identification and concentration level. These results are compared against the OEL as prescribed (or identified in a specific regulation) by either federal or provincial jurisdiction.

**Immediately Dangerous to Life or Health (IDLH)**
An immediate danger to life or health is an atmospheric concentration of any substance (toxic, corrosive, or asphyxiate) that poses an immediate threat to life or would cause irreversible or delayed adverse health effects. IDLH’s can also interfere with an individual’s ability to escape from a dangerous atmosphere.
Occupational Exposure Limits (OELs)

Occupational exposure limits provide guidelines to determine the maximum legal limits at which a worker can safely be exposed to a hazardous substance without any adverse health effects as well as the type of personal protective equipment to be used if needed. Exposure values are defined in three types including:

1. Time-weighted average (TWA)
2. Short term exposure levels (STELs)
3. Ceiling exposure value (noted as “C” with concentrations expressed in either parts per million by volume or as milligrams per cubic metre of air)

Using carbon monoxide as an example, the time-weighted average value takes into account that exposure levels may fluctuate throughout a day or a week. Time-weighted average values are calculated over an eight hour period for a daily exposure limit and a 40 hour period for a weekly exposure.

Let’s assume a worker is exposed to carbon monoxide for one (1) hour, three (3) times over an eight-hour period to the following concentrations:

- 22 parts per million in the early morning
- 26.5 parts per million at noon
- 17.75 parts per million mid-afternoon.

Given the average exposure over eight hours, the value is 8.28 parts per million which is below the occupational exposure limit of 25 parts per million (as per ACGIH).

The value is reached by adding the value of each daily concentrations and then dividing by the eight hours worked. So in this case:

- \[22 + 26.5 + 17.75 = 66.25\]
- \[66.25/8 = 8.28125\]

Short term exposure values allow workers to be safely exposed to higher concentrations of hazardous airborne contaminates, but for much shorter periods of time. Using the same example of carbon monoxide, a worker can only be exposed to 100 parts per million for up to 15 minutes. The worker may be exposed to that concentration level up to four (4) times per day, as long as there is a minimum of one (1) hour between exposure times.

And finally, ceiling exposure values are concentrations that must never be exceeded. Ceiling exposure values are used for fast-acting chemicals. For example, the main ingredient in automotive antifreeze, ethylene glycol, has a maximum exposure limit of 100 milligrams per cubic metre.

Ambient air is open or outdoor air and is a blanket of gases surrounding the earth. At ground level, air is a mixture of invisible and odourless gases, mostly nitrogen and oxygen, with smaller amounts of water vapour, argon, carbon dioxide, neon, helium and krypton mixed in.

When an atmosphere is said to be oxygen deficient, it means there is less than 19.5 per cent oxygen by volume in provincially-regulated organisations, and less than 18 per cent oxygen by volume in federally-regulated organisations.

Oxygen Scale

Oxygen levels can determine if an atmosphere is oxygen deficient or oxygen enriched. The maximum “safe” oxygen level is generally 23 per cent, however some jurisdictions allow up to 23.5 per cent. The average concentration in air is approximately 21 per cent. Most provincial jurisdictions consider 19.5 per cent to be the minimum safe level, while federal legislation sets the minimum safe oxygen level at 18 per cent.
At 17 per cent, impaired judgment can be detected and at 16 per cent the first sign of anoxia (lack of oxygen to the organs) begins. Breathing and pulse rates will begin to increase and abnormal fatigue and emotional upset can occur with oxygen levels at 14 per cent. Nausea, vomiting and loss of consciousness can occur with an oxygen level of 10 per cent. And finally, oxygen levels of 6 per cent or less can result in convulsions, respiratory failure and heart failure.

If an atmosphere becomes oxygen rich (above 23 per cent oxygen), extreme fire hazards are possible. Although not discussed in this document, these flammable hazards relate directly to firefighting, hazmat response and operations, as well as confined space entries. Additional training is required in those instances for respiratory protection and respirator use.

Be sure to reference your local legislation requirements for safe oxygen levels.

### Respirators and Mask Types

While there are various masks and respirators to choose from, there are essentially three classifications of respirators:

- **Air-purifying respirators** that are available in powered and non-powered styles
- **Atmosphere supplying respirators**
- A combination of **atmosphere supplying** and **air-purifying respirators**

#### Air-Purifying Respirators (APR)

Air purifying respirators (APRs) provide respiratory protection by physically removing dusts, mists, aerosols, fumes, fibres and other particles (identified in milligrams per cubic metre on a material safety data sheet) from the atmosphere. APRs can also remove gases and vapours by attaching the appropriate chemical cartridge. Additional information on cartridges can be found later in this section.

APRs come in two styles: half-mask and full facepiece. Half-mask respirators have a rubber or silicone face seal which fits over the nose and under the chin. They are fitted with filters or cartridges that purify the air as the user breathes.

#### Air-Purifying Half-mask Respirators

Half-mask APRs are relatively lightweight and offer good protection from many airborne contaminants, providing comfort and safety for the user.
However, air-purifying respirators do have some limitations. They cannot be used for all types of airborne contaminants and are limited by the type and capacity of the filters or cartridges used.

Protection factors offered by these masks are not as good as those provided by a full facepiece air-purifying respirator, nor do they provide any eye or face protection. Proper fit is essential and many factors may affect the face-to-facepiece seal. APRs cannot be used in oxygen-deficient atmospheres or in atmospheres that have high concentrations of contaminants.

Breathing may also become difficult due to the additional effort required to draw air through the purifying media. In addition, APRs cannot be used by personnel with facial hair that comes between the respirator seal and the skin.

Air-Purifying Full Facepiece Respirators

**Air-purifying full facepiece respirators** work on the same principle as half-mask respirators. The facepiece extends around the entire face to cover the eyes, nose, chin and mouth.

Some advantages of full facepiece respirators include the superior seal they provide, therefore offering more protection than half-mask air-purifying respirators. They also protect the eyes and face from irritating vapours, mists and splashed chemicals.

Full facepiece respirators are heavier than half-masks and are often less comfortable for the user to wear. Full facepiece air-purifying respirators cannot be used for all types of air contaminants and are limited by the type and capacity of the filters and cartridges used. Eyeglass wearers must also ensure that temple bars do not interrupt their face-to-facepiece seal. If required, prescription eyewear inserts are available for most brands. Full facepiece air-purifying respirators cannot be used in oxygen-deficient atmospheres or in atmospheres that have high concentrations of contaminants.

Breathing may become difficult because of the additional effort required to draw air through the purifying media. Similar to that of the half-mask, full facepiece air-purifying respirators cannot be used by personnel with facial hair which comes between the respirator seal and the skin.

Full facepiece respirators are used when a greater degree of respiratory protection is needed or when eye and face protection is desirable.

Powered Air-purifying Respirators (PAPRs)

**Powered Air-Purifying Respirators**, commonly referred to as **PAPRs**, feature a portable, battery-powered blower that draws in air through a particulate or chemical filter and blows it into the facepiece. The blower and filter unit may be an integrated part of the facepiece or mounted on the user’s back or belt. Full and half-mask facepieces are available as well as a variety of helmets and hoods.

The advantages of PAPRs arise from the positive pressure provided by the blower forcing air into the face piece, hood or helmet. This eliminates the difficulty in breathing that may come with negative pressure respirators and reduces the importance of a good facial fit.

These units are relatively expensive to purchase and maintain. Use is restricted to battery life and the blower and battery pack must be carried by the user at all times. PAPRs cannot be used by personnel with facial hair (with the exception of hoods and helmet type respirators) that comes
between the respirator seal and the skin and cannot be used in atmospheres that are deficient in oxygen or considered IDLH. Heavy exertion (or breathing) may create negative pressure inside the facepiece, reducing the respirator’s effectiveness.

Gas Masks and CBRN

Gas and CBRN mask respirators are specialized pieces of personal protective equipment typically used for chemical, biological, radiological or nuclear threats, or riot agent applications by the military and civil authorities. They require specific training prior to use.

Things to Remember: APRs

Key points to remember about air purifying respirators:

- Always replace wet elements immediately.
- Do not mix and match parts and/or elements from different manufacturers.
- Do not allow anything to get between your face and the respirator facepiece seal (e.g. facial hair, spectacle arms or harness straps).
- Conduct fit testing and training on a regular basis (refer to Respirator Fit Testing section).

Atmosphere Supplying Respirators

Atmosphere supplying respirators provide breathable air to the user from a stationary source like a compressor or compressed air cylinders. Air-supplied respirators may be equipped with a half or full facepiece, helmet or hood. Breathing air must be high-quality and meet regulatory specifications outlined in CSA Z180.1-00: Grade D of the Compressed Breathing Air and Systems. Uninterrupted air flow maintains positive pressure that decreases the possibility of inward leakage.

Airline respirators may be used for long periods of time and provide a high degree of protection from a variety of air contaminants. They provide minimal breathing resistance and discomfort, are lightweight, low bulk, incur moderate initial cost and have low operating costs. These respirators can be used in oxygen-deficient and other IDLH atmospheres when used in conjunction with a five minute (or greater) self-contained air-supply, often referred to as an escape respirator, or ESCBA.

The disadvantages of an airline respirator can be significant. Loss of the air source eliminates all protection to the user. As a result, it is imperative that an adequate supply of breathable air is available at all times. Minimum protection is provided against skin irritation or absorption, with the exception of some supplied air suits.

Air must also be delivered to the mask or hood through a hose which can be awkward to maneuver and may easily tangle or crimp. Airline respirators cannot be used by personnel with facial hair (with the exception of hoods and helmet type respirators) that comes between the respirator seal and the skin.

Self-Contained Breathing Apparatus (SCBA)

Self-Contained Breathing Apparatuses, or SCBAs, are available in two varieties: open circuit and closed circuit.

Open circuit SCBAs provide the user with clean air from a high pressure cylinder carried on the user’s back. They are equipped with a full face piece and are operated in the positive pressure or pressure demand mode.

Open circuit SCBAs operating in the positive pressure mode provide the maximum degree of protection available from airborne contaminants and provide users relatively free ease of
movement since they carry their air supply with them.

However, open circuit SCBA units are expensive to purchase and maintain and they require the user to carry up to 20 or 30 pounds of equipment on their backs. Open circuit SCBAs also provide no more than 40 minutes of continuous use and personnel with facial hair that comes between the respirator sealing surface and the user’s face cannot use SCBA equipment.

Another form of breathing apparatus is the closed circuit SCBA. The closed circuit SCBA recirculates and generates breathable air by scrubbing exhaled carbon dioxide (CO2) from the system. Closed circuit SCBAs are used primarily in mining and underwater diving applications, and are capable of providing a much longer supply of breathing air to the user.

A closed circuit SCBA can extend duration up to four hours under normal operation but they are very expensive and generate heat during the CO2 scrubbing phase when in operation.

Filter/Cartridges

In addition to the wide variety of respirator types, there are also filters and cartridges used to enhance the effectiveness of respiratory protection. Advanced planning and consideration must be given when choosing a filter or selecting the required cartridge.

Particulate filters provide three levels of filter efficiency:

1. 95 per cent
2. 99 per cent
3. 99.97 per cent

Which are available in three classes/filter types known as N, R and P.

N-Class (Non-Oil)

The N-class represents non-oil containing atmospheres only. This type provides no protection or resistance to oil.

R-Class (Somewhat Resistant to Oil)

R-class filters are resistant to oily atmospheres but must be time monitored with a maximum of eight hours of service.

P-Class (Oil Proof)

The P-class, which stands for oil proof, may be used in oil-containing atmospheres like underground mines and machine shops.

It is important to remember that each class, N, R, and P, offer the three levels of filter efficiency. When choosing a filter, you must first decide on the filter efficiency required for the task.

Next, you must consider if the aerosol contains oil. If not, then any series filter can be used. If oil is determined (or you are unsure), the next factor to consider is whether the filter will be used for more than eight hours. If yes, or you are uncertain, then only the P-series filter can be used. Otherwise R or P series filters can be selected if less than eight hours of use is determined.

N95 Filtering Facepiece

One of the most frequently used respirators is the N95 filtering facepiece. N95 pre-filters can be used in conjunction with chemical cartridges, as well as R pre-filters and standalone P-class filters.

N95’s are non-resistant to oil and filter 95 per cent of particulates and are typically worn to reduce exposure to bioaerosols or droplets.
produced by coughing and sneezing. An N95 filtering facepiece respirator seals tightly and reduces exposure to smaller airborne particles. It forces inhaled air through a filter and must be fit tested to the user.

There are limitations with N95 filtering facepiece respirators:

- They cannot be used in atmospheres containing less than 19.5 per cent oxygen
- They are not for use in IDLH atmospheres
- They cannot be used with facial hair or other conditions that may affect the seal between the face and respirator

**NIOSH Colour Coding System for Chemical Cartridges**

To help select the correct respirator cartridge, NIOSH created a colour coding system.

- Black represents cartridges to be used for organic vapours
- White is used to represent acid gas
- Yellow coded cartridges are used for combined acid gas and organic vapour
- Green coded cartridges are to be used with ammonia or methylamine products
- Olive for multi contaminants
- Magenta is used for all P100 filters

**Air-Purifying (APR Cartridges)**

While air-purifying respirators can be used for protection from a wide variety of respiratory hazards, cartridges and filters are designed to provide protection against a specific type of hazard. The most common types of cartridges are P100 Filter for low level concentrations of certain toxic dusts including asbestos, radio nuclides and silica. P100 can be a stand-alone cartridge or stacked with the following:

- **Organic Vapour Cartridges** that are approved for concentrations not to exceed 1000 parts per million for many organic solvents, petroleum distillates and alcohols
- **Acid Gas/Mist Cartridges** for atmospheres containing low levels of mineral acid gas or mist
- **Ammonia and Methylamine Cartridges** primarily used for ammonia
- **Multi-Contaminant Cartridges** for environments with more than one contaminant present (e.g. organic vapours, acid gasses)
- **Mercury Cartridges** which are standalone only and are used for protection against low levels of metallic mercury vapours

**Change-Out Procedures, Schedules and Service Time**

A qualified person shall establish written procedures and schedules to outline how often cartridges and filters should be changed out based on warnings that determine an end of service time.

A cartridge’s useful service life is based on how long it provides adequate protection from hazardous air contaminants. The service life of a cartridge depends upon many factors, including

- environmental conditions
- breathing rate
- cartridge filtering capacity
- amount of contaminant in the air.

It is suggested that employers apply a maximum use time to the service life estimate to ensure that the change out schedule is based on a conservative estimate. To assist qualified persons when estimating maximum use time limits, manufacturers have produced technical documents
and tools that give instant access to contaminant and concentration data and other customized information.

 Manufacturers also provide visual indicators to identify when a cartridge is clearly saturated and therefore must be replaced.

 Warning properties and breathing resistance are also key indicators that a change out is required. For instance, if the hazard is a gas or vapour, the substance may be detected by smell or taste, letting the user know that there has been a cartridge break through.

 If the hazard is a particulate, then increased breathing resistance through the filter is the main way to determine that a change out is required.

 **Assigned Protection Factors**

 The performance of respiratory protective equipment and the level of protection it provides when being worn in the workplace can be a complex topic. This is in part due to several factors including:

 - The degree of fit with the user
 - The adequacy for the air contaminant and the environment
 - The task at hand
 - The degree of training of the user
 - Whether the equipment is properly maintained and correctly used

 As such, CSA has adopted a table of pre-assigned protection values or ratings that the respirator must provide a worker for a particular task.

 Each type of respirator is given an *Assigned Protection Factor* value which can actually be different for the same type of respirator. The determining factor is the method of fit testing that is conducted in the program.

 In short, an *Assigned Protection Factor* is a measure of the *minimum* level of respiratory protection provided by a properly functioning and fitted respirator to a trained user.

 **Hazard Ratio**

 The *hazard ratio*, on the other hand, is the estimated or measured airborne concentration of a substance divided by the occupational exposure limit.

 Using the example of Malathion (a popular insecticide), let’s assume the airborne concentration of this particular respiratory hazard is 87 milligrams per cubic metre. The occupational exposure limit, according to NIOSH, is 10 milligrams per cubic metre, which calculates a hazard ratio result of 8.7 milligrams per cubic metre.

 We now know that any respirator having an APF (or assigned protection factor) value greater than 8.7 is sufficient to use and is to be fitted with the proper chemical cartridge.

 **Maximum Use Concentration (MUC)**

 *Maximum use concentration*, or *MUC*, is the *maximum* atmospheric concentration of a hazardous substance from which an employee can be expected to be protected when wearing a respirator. It is determined by the Assigned Protection Factor of the respirator or class of respirators and the exposure limit of the hazardous substance.

 The maximum use concentration can be determined mathematically by multiplying the *Assigned Protection Factor* specified for a respirator by the required *Occupational Exposure Limit*, either short-term exposure limit or ceiling limit.
Continuing with the example of Malathion, we now know that the assigned protection factor for a respirator is 10. The occupational exposure limit for Malathion, as listed in the NIOSH Pocket Guide, is 10 milligrams per cubic meter. When these factors are multiplied together the result is 100 milligrams per cubic meter. So, what do you compare this number to?

It is important to note that the user and program administrator are also aware of the IDLH levels listed in the NIOSH pocket guide, and in this case, the IDLH level for Malathion is 250 milligrams per cubic metre.

The maximum use concentration cannot exceed the IDLH level. In our scenario, the MUC of 100 milligrams per cubic meter is well below the allowable threshold of 250 milligrams per cubic meter, therefore a respirator with an APR of 10 is adequate.

When occupational exposure limits are not available for a hazardous substance, the employer must determine an MUC based on relevant available information and informed professional judgment. Remember, air-purifying and supplied-air respirators are not to be used for entry into concentrations of contaminants at or above IDLH levels.

Respirator Selection

Respirator selection requires a correct match between:
- The respirator and the hazard
- The degree or severity of hazard
- The respirator user

The respirator selected must adequately and effectively reduce the exposure to hazardous air contaminates to the respirator user under all conditions of use including any reasonably foreseeable emergency situations. When testing and certifying respirators, most
regulations in Canada do not specify which approval body may be accepted in the provinces or territories. It is only stated that the respirators must be approved. In Ontario, for example, the Ministry of Labour will accept NIOSH, CE (which meet European directives), DIN, and British Kite Marked products, among others that have been approved to a recognized standard.

NIOSH classifications include a series of codes that apply to systems only. For example mask and cartridge, or filter systems. All systems are assigned a testing and certified, or TC number:

- TC - 13F represents self-contained breathing apparatus, or SCBA
- TC - 19C are for supplied-air respirators
- TC - 84A are dust, mist, fume and aerosol respirators
- TC-23C are chemical cartridge air-purifying respirators, or APRs

According to the current CSA Standard, the respirator selection process should be a systematic review of:
- Hazards
- Knowledge of standards
- Types of respirators and their limitations

The Program Administrator shall ensure that the selection of respirators is conducted by qualified personnel. The Standard also provides guidance to help select the appropriate respirator that may be required in different work environments.

Replacement Criteria
Particulate filtering media and chemical cartridges must be replaced when they are no longer effective indicators include:

- When contaminant odour, taste and irritation warning properties are detected
- When administrative control time is expired
- When End of Service Life Indicators are pending.

Respirator Fit Testing

Purpose of Fit Testing
The purpose of fit testing is to verify that the selected make, model and size of a respirator adequately accommodates an individual’s facial characteristics. However, fit testing does not ensure that the user will achieve an adequate fit every time it is worn. Therefore the fit testing process must also verify that the respirator user is capable of donning the respirator properly and able to ensure effective protection during use by conducting a user seal check.

General Considerations
When it comes to respirators and fit testing, there are a few general points to consider:

- Respirators must fit properly in order to provide adequate protection.
- One size generally will not fit all
- Most manufacturers offer different sized
face pieces.

- In some cases, no size from one manufacturer may fit a worker and a different brand may be necessary.
- The user should be clean shaven to ensure an effective seal.
- A person should never be assigned a respirator without completing a qualitative or quantitative fit test.
- The results of fit testing must indicate the user has achieved an adequate seal.

A fit test shall be carried out:

- After user screening and training.
- Prior to initial use of a tight-fitting respirator.
- When changes to a user’s physical condition could affect the respirator (e.g., significant weight loss or gain, changes to facial or dental features, etc.).
- When there is a change to the actual respirator, for example make, model or size.
- When a respirator user experiences continued, significant discomfort, or has difficulty completing a successful seal check.
- When there is a change in personal protective equipment that could affect the respirator.
- At least every two (2) years.

It is imperative that fit testers do not force-fit a respirator. Force-fitting is a process of repeating a failed fit test with the same respirator by readjusting or over tightening the straps until a fit test pass is finally obtained.

**User Seal Check**

A user seal check is an action conducted by the respirator user to determine if the respirator is properly sealed to the face. The user seal check can be conducted by doing one of the following tests:

- Positive pressure test
- Negative pressure test

To conduct a **positive pressure test:**

- Block the exhalation valve, usually located on the bottom of the respirator.
- Gently breathe out;
  - The facepiece should puff slightly away from your face without breaking the seal and stay like that while you hold your breath.

To conduct a **negative pressure test:**

- Block the air inlets; these are usually the filter openings on the sides of the facepiece.
- Try to breathe in;
  - If there are no leaks, the facepiece should collapse slightly and stay like that while you hold your breath.

If a leak is detected, adjust the facepiece or straps and repeat the test until a good fit is achieved. Be sure to test the user seal periodically during use.

**It should be noted that a user seal check shall not be used as a substitute for a quantitative or qualitative fit test.**

**Quantitative vs. Qualitative Respirator Fit Testing**

**Quantitative fit testing** is a test method that uses an instrument to assess the amount of leakage into a respirator to determine fit.

A **qualitative test** is a pass or fail test method that relies on the user’s sensory response to detect a challenge agent in order to determine the fit of the respirator.
Quantitative Fit Testing (QNFT)

During a quantitative fit test, ambient airborne particles are used as the challenge agent. These particles are measured both inside and outside the respirator while the test subject performs a series of exercises described in CSA Z94.4.

The particles may be counted by an optical particle counter (OPC) or condensation nuclei counter (CNC) to determine the quantity of particles inside versus outside the respirator. Examples of these two technologies include the Sibata MT-05C (OPC) and Accufit 9000 (CNC) respirator fit test instruments. The instruments will sample for particles inside and outside the test subject’s mask simultaneously while determining a ratio.

A fit test pass is determined if:

- The ratio is above the minimum test limit
- A high enough fit factor has been achieved
- The user has completed a series of test similar to the qualitative protocol

This method removes any subjectivity on the part of the user and is considered the most reliable method of fit testing.

Qualitative Fit testing (QLFT)

During qualitative fit testing, a challenge agent is introduced under a confined hood in close proximity to the user to determine the integrity of the face to mask seal. The user is required to perform a series of head and body motions typical of normal daily movement. If the aerosol is undetected to the user on completion of testing, the face to mask seal is considered adequate and the test is considered successful. A pass is given to the user with the tested respirator only.

When QLFT is performed, a variety of fit testing challenge agents may be used. The most common types found in the latest CSA Standard are:
- Banana oil, because of its aroma
- Saccharin, a sweet tasting agent
- Stannic chloride (otherwise known as irritant smoke)
- Denatonium benzoate (also known as Bitrex®) which leaves a very bitter taste in the user’s mouth if the mask does not fit properly

Successful Test Results

To help ensure a successful testing process, users should refrain from the following activities for at least 30 minutes prior to testing:

- Smoking
- Ingesting sweet, bitter and/or spicy foods
- Drinking coffee, tea and/or soft drinks

Facial Hair

Individuals shall present themselves for fit testing free from interference of hair where the respirator seals to the skin of the face or neck. Although the rate of facial hair growth varies from person to person, for many this requires being clean-shaven within the previous 24 (or preferably 12) hours to ensure that hair neither infringes on the sealing surface of the respirator, nor interferes with valve or respirator function.

A clean-shaven policy is best implemented through emphasis on its importance during training, through regular reminders and ongoing verification of conformance.

Donning and Doffing N95 Respirators

It is important that appropriate steps are taken when both donning (putting on) and doffing
(removing) a respirator. Before donning, make sure you wash your hands and inspect the integrity of the respirator components, including the shell, straps and metal nose-clip.

To properly don your respirator:

- Pull the bottom strap over your head and position it around your neck, below your ears.
- Pull the top strap over your head so it rests high on the back of your head.
- Cup the nosepiece in your hand with the nosepiece at fingertips, allowing the headbands to hang freely below hands.
- Position the respirator under your chin and place the nosepiece over the bridge of your nose.
- Using both hands, mould the metal nosepiece (if present) to the shape of your nose by pushing inward while moving fingertips down both sides of the nosepiece.

The respirator seal must be checked before each use. To check the fit, place both hands over the respirator and exhale. If air leaks around your nose, readjust the nosepiece as previously described. If air leaks at respirator edges, adjust the straps back along the sides of your head and check again.

If you cannot achieve proper fit, do not enter the contaminated area and advise your manager or supervisor.

When doffing an N95 respirator:

- Pull the bottom strap over your head first.
- With your alternate hand, pull the top strap over your head.
- Holding only the straps, dispose of the respirator.
- Wash your hands.

Donning and Doffing Half-mask and Full-mask Respirators

Before donning a respirator, examine the following:

- Check the facepiece for excessive dirt, cracks, tears or holes, badly worn threads, missing gaskets, etc.
- Inspect the head strap or harness for breaks or loss of elasticity, and/or broken buckles and fasteners. Remove the exhalation valve cover and examine valve for foreign material, human hair dust, etc.
- Look for any cracks, tears or distorted valves.
- Cracks or breaks in the valve body, or missing or defective valve cover.
- Ensure the valve is properly stored in the valve body.
- The air purifying elements must also be examined. This is done by ensuring the:
  - Correct cartridge, canister or filter is used.
  - Loose connections, crossed threading or incorrect installation are avoided.
  - Shelf life date is not expired.

Once you have inspected all elements of the respirator, you can proceed to donning:

- Attach the neck strap.
- Next, place the chin in the chin cup and pull crown straps or head harness across the head.
  - Adjust the strap to ensure a correct fit.
- Perform a positive pressure seal check to identify any leaks.
  - Then, perform a negative pressure seal check to determine if there are any leaks.
- If necessary, readjust the straps and repeat the positive and negative user seal checks.
• Check for good breathing.

When you are ready to remove the respirator:

• Loosen the straps from the top to the bottom, being careful not to damage the elasticity of the straps.
• Grasp the respirator at the bottom and remove upward and away from the head.
• Remove the cartridges and dispose of properly.

The final section of this document includes additional requirements outlined by the Z94.4 CSA Standard, which includes:

• Training
• Cleaning, inspecting, maintaining and storage
• Medical Surveillance
• Health Surveillance
• Program evaluation
• Record Keeping

Additional Requirements of Z94.4

Training requirements are clearly outlined in the Standard. Parties identified in the training matrix are:

• The Program Administrator
• Respirator User
• Supervisor
• Person Selecting Respirator
• Fit Tester
• Maintenance Personnel
• Health Care professional

Specific duties required under The Standard, include:

• Roles and responsibilities
• Selection process
• Respirator User Screening
• Fit testing
• Instruction
• Care and practical use
• Limitations
• Repair and maintenance

The employer must ensure that any person who has responsibilities under the standard must be competent to perform their duties and must ensure that training is delivered by a qualified person.

Cleaning, Inspection, Maintenance & Storage of Respirators

The proper functioning and effectiveness of respirators and ensuring that the devices themselves do not pose a hazard to the user require a regular maintenance and cleaning schedule. It is mandated by the Standard that cleaning and sanitization should be part of the care and maintenance program. Users must follow the manufacturer’s care and cleaning instructions or procedures outlined by the Program Administrator, or the Standard. In general, respirators should be inspected for basic function before each use and cleaned as often as necessary to prevent the occurrence of unsanitary conditions.
It is important to note that organic solvents or abrasive cleaning agents should not be used for cleaning. Regular household disinfectants or sanitizers are acceptable and will not compromise the integrity of the mask materials.

Users shall inspect their respirators before and after each use. Respirator inspection must include:

- Condition of component parts (e.g. facepiece, straps, valves, etc.)
- Tightness of connections
- End of service life indicator
- Shelf life dates
- Proper functioning of regulators, alarms and other warning systems

Inspections logs or records of these inspections must be kept.

Respirators shall be stored in a manner that will protect them against:

- dust
- ozone
- sunlight
- heat
- extreme cold
- excessive moisture
- vermin
- damaging chemicals
- oils or greases
- any other potential hazard that may have a detrimental effect on the respirator

The respirators must also be stored in a manner that prevents deformation of rubber or other elastomeric parts. Emergency and rescue-use respirators should be placed in work areas that are quickly accessed at all times.

### Health Surveillance

Assessing the user’s physiological and psychological abilities is required prior to using a respirator. The respirator user must be able to comfortably wear and effectively use a respirator, regardless of any pre-existing conditions. Should the respirator user or the Program Administrator be concerned that a condition may prohibit the use of a respirator, a medical assessment must be carried out by a healthcare professional. Such conditions may include:

- Breathing difficulties (asthmas, bronchitis, emphysema, etc)
- Lung disease
- Hypertension
- Panic attacks
- Colour blindness or other visual impairments
- Claustrophobia, fear of heights, etc.

The Program Administrator shall establish a procedure and provide documented information to the healthcare professional regarding:

- The work activity
- The workplace environment
- The type of respirator required

Where there are limitations imposed by the healthcare professional, those limitations must be issued in writing, as well as the approval for use of the respirator. Any medical information is maintained by the healthcare professional; all medical documentation submitted to the workplace must be treated as confidential and must be maintained by the Program Administrator.
Program Evaluation

Respiratory Protection Programs should be effectively managed and include mechanisms to routinely review the effectiveness of the program and to apply corrective action as required.

Key elements of a program evaluation to review may include:

- Regulatory requirements
- Management processes
- Documented program procedures
- Examination of records to verify procedures are being followed
- Confirmation the workplace practices comply with program requirements
- Documentation of performance problems and subsequent resolution or corrective action plans
- Stakeholder input to verify worker acceptance
- Proper selection, use and maintenance of respirators
- Effective training
- Proper inspection
- Proper storage and maintenance

These elements can be reviewed by either internal or external resources and can be formal or informal as long as a report or related document verifies the evaluation is conducted on an annual basis (or more often if processes or procedures change).

Record Keeping

It is the responsibility of the Program Administrator to ensure appropriate records are kept of all Respiratory Protection Program activities. This includes:

- All hazard assessments
- Appropriate respirators for the hazards identified and evaluated
- Fit testing results
- Training
- Inspection, maintenance and storage
- Health surveillance
- Program evaluations
Conclusion

A complete Respiratory Protection Program is an essential part of any health and safety plan where airborne hazards exist.

It is recommended that records be maintained for a minimum of 10 years. Both qualitative and quantitative respirator fit testing protocols are described in CSA Z94.4 Selection, Care, and Use of Respirators. Both are acceptable and can be performed by your employer or a service provider with the proper training, equipment and experience, however given the superior results, we highly recommend QNFT.

If you need assistance creating, implementing, or managing your Respiratory Protection or Fit Testing Program, please get in touch with us today.