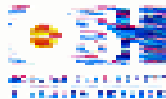


A GUIDE TO

# RESPIRATORY PROTECTION



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# Contents

<i>Introduction</i>	<b>5</b>
<b>1. <i>General Principles of Respiratory Protection</i></b>	<b>6</b>
<b>2. <i>Classification of Inhalation Hazards</i></b>	<b>8</b>
<i>Particulate Contaminants</i>	8
<i>Gaseous or Vapour Contaminants</i>	10
<i>Lack of Oxygen and Confined Spaces</i>	11
<b>3. <i>Criteria for Selecting a Respirator</i></b>	<b>13</b>
<i>Selection Factors: Those that are         contaminant-related</i>	13
<i>Selection Factors: Those that are task-related</i>	14
<i>Selection Factors: Those that are         operator-related</i>	15
<i>Workplace Exposure Standards</i>	16
<i>Respirator Protection Factors</i>	17
<i>Medical Aspects of Wearing a Respirator</i>	18
<b>4. <i>Main Types of Respirator</i></b>	<b>19</b>
<i>Air Purifying Respirators</i>	19
<i>Supplied Air Respirators</i>	19
<i>Self-Contained Breathing Apparatus</i>	19
<b>5. <i>Air Purifying Respirators</i></b>	<b>20</b>
<i>Types of Facepiece</i>	20
<i>Filter Replacement</i>	21
<i>Limitations on Use</i>	24
<i>Filter Identification</i>	24
<i>Particulate Respirators</i>	24
<i>Gas/Vapour Respirators</i>	25
<i>Combination Respirators</i>	27
<i>Powered Air Purifying Respirators</i>	28

<b>6. <i>Airline Respirators</i></b>	<b>29</b>
<i>Fresh Air Hose Respirators</i>	29
<i>Compressed Air Line Respirators</i>	30
<i>Precautions for Normal Use</i>	32
<b>7. <i>Self-Contained Breathing Apparatus</i></b>	<b>33</b>
<b>8. <i>Respiratory Protection Programmes</i></b>	<b>35</b>
<b>9. <i>Some Practical Considerations</i></b>	<b>37</b>
<i>Training and Instruction</i>	38
<i>Face Fitting</i>	38
<i>Supervision in a Dangerous Atmosphere</i>	39
<i>Location</i>	40
<b>10. <i>Respirator Maintenance And Storage</i></b>	<b>41</b>
<i>Inspection</i>	41
<i>Cleaning</i>	41
<i>Final Inspection</i>	42
<i>Storage</i>	42
<b><i>Appendices</i></b>	
<i>Appendix 1: Requirements for Air Quality (Compressors or Cylinders) for Supplied Air Respirators</i>	44
<i>Appendix 2: Filter Comparison</i>	48
<b><i>Glossary of Common Terms</i></b>	<b>49</b>

# Introduction

The Health and Safety in Employment Act 1992 promotes excellence in the management of workplace hazards. The Act places a responsibility on the employer to provide a safe and healthy work environment. Employees have a responsibility to work in a safe manner and not cause harm to any other person.

This booklet examines some common respiratory hazards for which protection is required, and gives guidance to employers and others on the selection, use and care of respirators. It does not provide technical prescriptions or highly detailed information about respirators. Readers requiring this level of detail should refer to the manufacturer's instructions or the appropriate standards. The Australian/New Zealand Standards, AS/NZS 1716: 1994 *Respiratory Protective Devices* and AS/NZS 1715: 1994 *Selection, Use, and Maintenance, of Respiratory Protective Devices*.

It is not possible to set out precise requirements for every industrial situation where there is a respiratory hazard because the factors which have to be considered vary from one workplace to another. Both the user and the supplier should be satisfied that the equipment selected is adequate for the conditions. If in doubt, you should seek technical advice from your equipment supplier or your local branch of the Occupational Safety and Health Service of the Department of Labour (OSH).

# 1. General Principles of Respiratory Protection

Breathing air which contains toxic substances or an atmosphere which has insufficient oxygen to support human life is a very real and common hazard in industry.

The aim is to work in air that is clean and safe. Prevention or control of exposure must always be investigated before using respiratory protection. There are four ways this can be done:

- Avoiding the use of toxic or irritant substances.
- Totally enclosing the process.
- Partially enclosing the process and using local exhaust ventilation.
- Installing adequate ventilation systems and engineering controls.

In emergencies or general situations where these principles cannot be applied, a respirator must be worn. Some substances irritate the eyes and skin, others can be absorbed through the skin. A respirator may give a false sense of security against substances that are rapidly absorbed through the skin or mucous membranes such as eyes. Anyone entering an atmosphere containing materials with these properties needs more than just respiratory protection - their whole body should be protected.



*Effective local exhaust ventilation removes contaminated air from the workplace, avoiding the need for respirators*

## 2. Classification of Inhalation Hazards

Respirators are designed to protect against one or more of the following types of atmospheric hazards in the workplace:

- Particulate contaminants such as dust, fibre, mists, fumes or dirt.
- Gaseous or vapour contaminants, such as solvents.
- Lack of oxygen.

### ➤ Particulate Contaminants

#### Dusts

Dusts are solid particles dispersed in the air and may be respirable or non-respirable. Respirable dust consists of tiny particles in the size range of 0.2-10.0 microns. Often invisible to the unaided eye, the particles are fine enough to penetrate the smallest airways in the lung. Non-respirable dusts are larger in size (usually in excess of 100 microns) and are removed in the nose or upper airways of the lungs.

Respiratory protection is required for different categories of dust:

**Nuisance Dusts:** (inert non toxic) These may cause discomfort (i.e.: cough or phlegm) or minor irritation of the nose and lungs but are usually not toxic and do not permanently damage the lungs. They pass out of the body or remain in the lungs without poisoning the system. Examples are calcium carbonate (limestone dust), starch, and sucrose. NB: if you are unsure about the toxicity of a dust, assume it is toxic and use respiratory protection or engineering control until it is confirmed safe.



**Lung-Damaging Dusts:** Respirable particles of these dusts remain in the lungs where they may damage the tissue. For example, asbestos, crystalline silica (quartz dust) and coal dust.

**Irritant Particles:** Chemically active particulate which cause immediate discomfort, irritating or inflaming the airways to the lungs. Examples are acid or alkaline mists.



*Asbestos is an example of a lung-damaging dust.*

**Fever-Producing Dusts:** Dusts which produce flu-like symptoms, and fever sometimes several hours after exposure. For example, fumes evolved from welding zinc or copper.

**Toxic Dusts:** These pass from the lungs into the blood and may poison the whole body. For example, lead, arsenic and powdered organophosphate pesticides.

**Sensitising Agents:** Particulates in low concentration which may cause an allergic reaction. An example is mould.

## **Mists**

These are fine droplets of liquid dispersed in the air and may contain particles or dissolved

substances. Mists are produced by condensation of a vapour or by atomisation of a liquid. Examples are sodium hydroxide (caustic soda) and chromic acid mist from an electroplating bath.

### **Metallic Fumes**

These are fine particles of metal produced by condensation of the vapour given off by a metal when it is subjected to high temperatures, for example during welding and smelting.

**Note:** Inhaled particles deposited in the mucus in the respiratory airways will enter the body when swallowed.



*Spray painting exposes an operator to mists and vapours.*

### ➤ **Gaseous or Vapour Contaminants**

A gas is a substance that is in the gaseous state under normal conditions of temperature and pressure. Examples are hydrogen sulphide, sulphur dioxide or carbon dioxide.

A vapour is the gaseous form of a substance that is a solid or liquid under normal conditions of temperature and pressure. Examples are organic solvents, such as toluene and trichlorethylene, and inorganic substances such as mercury.

There are three categories of gases and vapours for which different types of respiratory protection is required:

- Acid gases, e.g.: hydrogen chloride and sulphur dioxide.
- Alkaline gases, e.g.: ammonia and diethylamine.
- Organic vapours, e.g.: solvents.

#### ➤ Lack of Oxygen and Confined Spaces

Normal air contains about 21 percent oxygen, but this may be reduced by a chemical reaction or by displacement of the oxygen by another gas. There is often a lack of oxygen in confined spaces such as tanks, vats, reaction vessels, wells, tunnels, silage pits, sewers and deep earthen trenches. When the oxygen level falls below about 18 percent, (although some authorities quote 19.5) special precautions must be taken and a supply of fresh air arranged for anyone entering the danger area.

Before entry into a confined space, it is essential to carry out a full assessment of the likely contaminants and possibility of oxygen deficiency. A decision on the appropriate type of respiratory equipment and other safety factors will then need to be made. For further information, see the *Safety in Confined Spaces* package, available from your local OSH branch office or refer to the AS 2865. *Safety in Confined Spaces*.



*Lack of oxygen is a common condition in confined spaces and special safety procedures must be adopted before and during entry.*

### 3. Criteria for Selecting a Respirator

There are four simple principles of respiratory protection:

- 1) Always select the right respirator for the task e.g. correct filters,
- 2) Always ensure a proper face fit. Fit test if necessary.
- 3) Have an active maintenance program to support the devices in use. Including cleaning, and defect recognition.
- 4) Ensure proper storage of equipment. Best kept in an airtight container.

Three main factors need to be considered when selecting a suitable respirator for a particular situation. They are:

- Contaminant,
- Task, and
- Operator.

Often expert advice and guidance will be needed, but the following points should be considered.

➤ **Selection Factors:** Those that are contaminant-related

- The nature, toxicity, physical form and concentration of the contaminant.
- Whether failure of the device would result in a situation which is immediately dangerous to life or health. (IDLH)
- The need to wear other personal protective equipment, e.g. eye, skin or hearing protection.
- The adequacy of the warning given by the contaminant, e.g. odour threshold.

- The possibility of the contaminated atmosphere being flammable.

➤ **Selection Factors:** Those that are task-related

- Whether the device is for regular use or for emergency or rescue purposes.
- The probable length of time during which the wearer will be in the contaminated atmosphere.
- The expected level of activity and mobility required by the wearer.
- The access and location air source is suitable for breathing.
- The access and location air source is suitable for breathing.
- The need for clear vision and communication.
- The facilities available to maintain the device.



*When exposed to substances such as organophosphate pesticides, which can be absorbed through the skin, operators must wear full protective clothing in addition to a respirator.*

➤ **Selection Factors:** Those that are operator-related

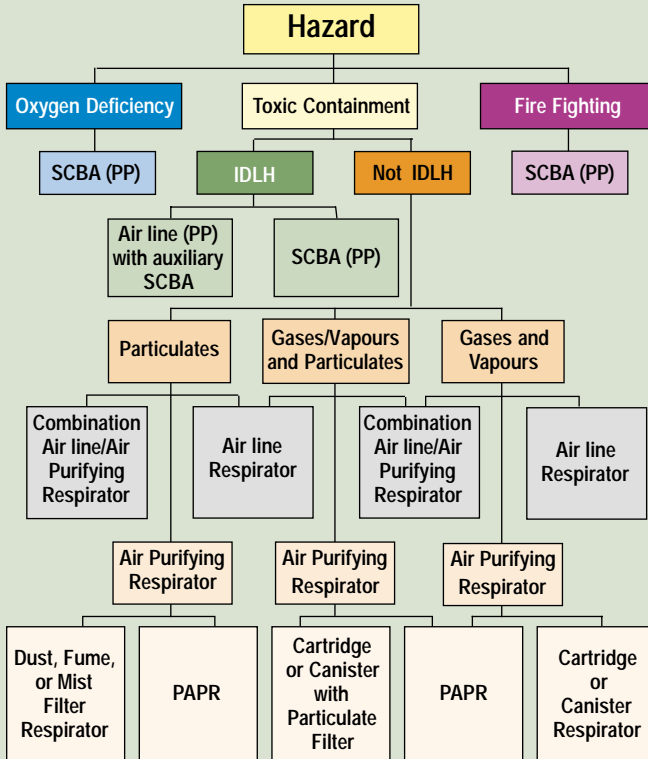
- The effect of the general environment on the operator.
- The importance of facial fit, (the presence of facial hair will adversely affect the fit).
- The comfort afforded by the respirator over extended periods of use.



*A disposable respirator gives protection against wood dust and may be worn with head and eye protection.*

If you have any doubts as to the correct device for a particular situation, you should seek expert advice from the equipment supplier, your OSH branch office or other authority on occupational hygiene.

## Selection of Respirators



*Guide to respirator selection: SCBA = Self-contained breathing apparatus. PP = Positive pressure. Positive pressure systems include pressure demand units. They do not include demand units. IDLH = immediately dangerous to life and health. PAPR = Powered air purifying respirator.*

### ➤ Workplace Exposure Standards

When selecting a respirator to protect against a workplace contaminant, it is necessary to know:

- The physical and chemical properties of the contaminant,
- The concentration of the contaminant in the workplace environment,
- The Workplace Exposure Standard (WES) for the contaminant, and
- The Respirator Protection Factor.



The physical and chemical properties of the contaminant, and its effects on the body, can be ascertained from the most current Material Safety Data Sheet (MSDS) for the substance concerned, or from an appropriate textbook.

A number of sampling methods can be used to ascertain the concentration of an airborne contaminant. The simplest method is to use direct reading detector tubes. A full discussion of environmental monitoring is outside the scope of this booklet, and for further advice or assistance it is recommended you contact your nearest OSH office or authority on occupational hygiene.

Workplace Exposure Standards represent the maximum atmospheric concentration of a contaminant to which most workers can be safely exposed. A full description of these is contained in the OSH publication *Workplace Exposure Standards and Biological Exposure Indices for New Zealand 1992* (available from OSH offices) or a similar publication by ACGIH.

### ➤ Respirator Protection Factors

There is considerable international debate about the usefulness of respirator protection factors, however there is general agreement that they are a theoretical means of estimating the suitability of a respirator for a given situation.

Most respirators have been assigned a Respirator Protection Factor (RPF). The RPF is the ratio between the measured concentration of the contaminant while the respirator is being worn and the Workplace Exposure Standard.

For example a half-mask respirator with filters has an RPF of 10, meaning that it can be safely used in environments containing contaminants at concentrations up to 10 times the WES.

In contrast, a full facepiece respirator with filters has an RPF of 50. This reflects the superior face sealing characteristics of this type of respirator.

### ➤ **Medical Aspects of Wearing a Respirator**

Any type of respirator may impose undue stress on some users. People routinely required to wear respirators should be given the opportunity for a full medical assessment to determine if they are able to wear them safely. There are some medical factors which may preclude or limit the use of respirators:

- People with impaired lung function may experience difficulty with breathing.
- An asthma attack may be made worse or induced in susceptible individuals.
- People with circulatory disease such as heart disease and anaemia may be adversely affected.
- People prone to epilepsy should be aware of the special dangers of wearing a respirator should a seizure occur.
- The wearing of contact lenses or spectacles may restrict the type of respirator that can be worn.
- Psychological factors such as claustrophobia may preclude the wearing of respirators.
- Abnormal facial characteristics such as prominent cheekbones, deep skin creases, lack of nose bridge, etc. may lead to respirator facepiece sealing problems.

## 4. Main Types of Respirator

Respirators can be grouped into three main types: air purifying respirators, airline respirators and self-contained breathing apparatus (SCBA).

### ➤ Air Purifying Respirators

These respirators draw inhaled air through purifying filter. There are two main types:

- A particulate respirator which filters out dusts; and
- A gas respirator which filters out certain gases and vapours.

There are combinations of both types available.

These respirators do not give protection against a lack of oxygen and should only be used when the type and concentration of the contaminant is known.

### ➤ Supplied Air Respirators

Supplied air respirators deliver a supply of clean air from a source outside the contaminated area. Clean air can be supplied either at normal atmospheric pressure or from a higher pressure source, e.g. compressed air supply line or independent supply.

### ➤ Self-Contained Breathing Apparatus

This type of respirator uses a supply of clean air from a source that is carried by the wearer, e.g. compressed air bottle.

It is used to give protection against dangerous breathing hazards such as lack of oxygen, very poisonous contaminants or when the type of hazard is unknown.

**Note:** A more detailed description of these types of devices is provided in the next three sections.

## 5. Air Purifying Respirators

Air purifying respirators can be non-powered with replaceable filters or be completely disposable, (i.e. single use) or they can be powered with filters.

In the non-powered replaceable filter device, air is drawn through one or more filters by the wearer of either a half facepiece, full facepiece or head covering (hood).

Disposable or single use respirators are mostly or entirely made of filter material and are discarded once the filter or sorbent is no longer useable.

Powered-air purifying respirators (PAPR) have an electrically operated blower unit which delivers air through a replaceable filter(s) into the facepiece of the respirator.

### ➤ Types of Facepiece

The different types of facepiece in common use include:

- A half facepiece which covers the mouth, nose and chin only.
- A full facepiece which covers the eyes, nose and mouth.
- A head covering (or hood or helmet) which covers the head and may extend where appropriate to the shoulders. If protective goggles or prescription glasses are worn, a respirator that uses a half facepiece may interfere with them. This problem can be avoided by wearing a full facepiece, a hood, or a helmet respirator instead. Prescription lens glasses can be incorporated into some types of full face piece.

## ➤ Filter Replacement

The service life of a filter depends on the conditions of use. The filter's protective capacity is defined by;

- The consumption of air by the user.
- The humidity of the air.
- The temperature.
- The contaminates in the air.

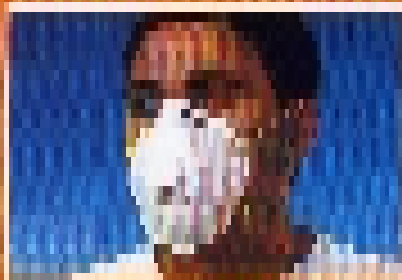
An accurate service life cannot be defined unless these factors are known. The end of the gas filter's efficient life is usually indicated by the user detecting a gradual smell of gas. Particulate filters do not expire, they become clogged, and should be replaced when breathing resistance is detected.

Disposable respirators and replaceable filters on respirators should be replaced:

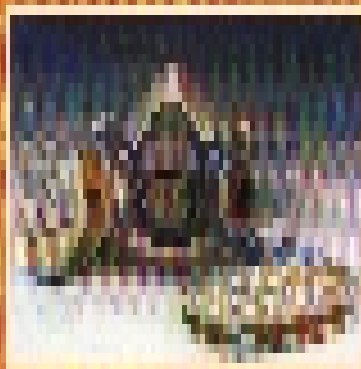
- When the life of the device has elapsed (as recommended by the supplier).
- When difficulty in breathing is experienced.
- When the wearer detects the taste or smell of the contaminant.
- When it is indicated by the experience of the wearer.

**Note:** Most suppliers have access to computer programmes which can calculate filter life. Users are recommended to use this service if available in your area. It is generally not known that filters have an end of service life even if not used or opened. Even if the filter has been stored properly careful consideration should be given to regular replacement.

## Common types of Particulates



Common types of Particulates



Common types of Particulates

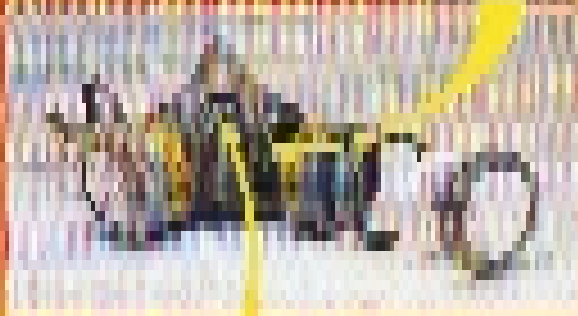
Common types of Particulates

## Classification of Respirators



Full-face respirator (FFR)

FFR



Hood



Small hood

### ➤ Limitations on Use

- The device selected must be suitable for the contaminant encountered.
- The contaminant must be below the maximum concentration for which the device is suitable as defined by the RPF.
- Air purifying respirators should not be used in areas where contaminants present an immediate danger to life and health (IDLH) e.g.: cyanide.
- These respirators must not be used in atmospheres that may be deficient in oxygen.

### ➤ Filter Identification

There is no universal colour code for filters. European and American manufacturers use different colour codes for filter types. You should enquire from the manufacturer or agent as to the suitability of the filter for the contaminant to be protected against. It is most important to make sure that the filter is positively identified as being suitable for a given situation and that you do not depend on a colour code. The supplier can usually provide information but it is the user's responsibility to ensure that the correct filters are used.

### ➤ Particulate Respirators

These filter finely divided solid or liquid particles from the air, i.e. dusts, mists and fumes. The wearer's normal breathing action draws contaminated air through a filter, usually a fibrous material, and the contaminant particles impact and are trapped on the filter fibres.

In some filters, the fibres are treated with an electrically charged resin which helps trap the contaminating particles. A problem with these is that



exposure to heat or high humidity causes the charge to be lost and reduces the filtering efficiency.

The degree of protection depends on the type of filter and the effectiveness of the individual facial seal.

**Class P1 filters:** Should be used for mechanically generated dusts such as sanding, grinding, mining, etc.

**Class P2 filters:** Should be used where protection from thermally generated contaminants is required e.g. in smelting or welding, where metallic fumes produced.

**Class P3 filters:** High-efficiency filters, which used with a full facepiece, which permits a very effective facial seal to prevent highly toxic or irritant particulate contaminants leaking into the respirator. This type of device is used when handling highly toxic dusts or powders, like organophosphate insecticides and radionuclides.

In particularly heavy concentrations of dust, eyes need protection by using a full facepiece, a hood or a helmet respirator.

Where a high dust concentration causes the filter to clog, or when the job does not require great mobility, an air line respirator can be used. (See section 6.)

### ➤ Gas/Vapour Respirators

These respirators use a filter containing an agent which adsorbs or reacts with the contaminant gas or vapour. Filters will usually be designated by a letter or chemical abbreviation indicative of the substance against which protection is intended.

Filters will be classified as:

- Low-adsorption capacity (previously designated as a cartridge). Class AUS.

Filter Comparison					
Contaminant	Australia New Zealand Standards	European Standards	European/ Aus/NZ Colour	US (NIOSH) Name	US (NIOSH) Colour
Organic Vapours	A	A	Brown	Organic Vapour	Black
Acid gases Cl <sub>2</sub> , H <sub>2</sub> S, HCN	B	B	Grey	Acid Gases	White
Acid Gases SO <sub>2</sub>	E	E	Yellow	Acid Gases	White
Organic Vapour/Acid/ Gas combination	ABE	ABE	Brown/ Yellow/Grey	Organic Vapour/ Acid Gas combination	Yellow
Combination Cartridge	ABEK	ABEK	Brown/Grey/ Yellow/Green	Multigas	Olive Green
Ammonia	K	K	Green	Green	
Nitrous Oxides	NO	NO	Blue	-	-
High Vapour Pressure Chemicals (Pesticides)	G	-	-	-	-
Mercury	Hg	Hg	Red	Mercury	-
Low Boiling Solvents	AX	AX	Brown	-	-
Particulate filters	P1	P1	White		-
	P2	P2	White	N95, R95, P95	
	P3	P3	White	N100, R100, P100	Pink

- Low to medium capacity. Class 1.
- Medium-adsorption capacity. Class 2.
- High-adsorption capacity (previously designated as a canister). Class 3.

These classifications reflect only the total capacity of the filter, not the efficiency of the filter against a given contaminant.

There are three types of gas/vapour respirator:

- Half-face filter type (will usually be fitted with a low- or medium-capacity filter).
- Full-face filter type (will usually be fitted with a medium- or high-capacity filter).
- Powered air purifying respirator (fitted with appropriate filters).

**Note:** Because there are a number of systems for identifying and selecting filters for gas/vapour

respirators, your supplier should be able to provide detailed information about the relevant gas/vapour and the level against which each type will provide protection.

Full-face mask respirators can cope with higher levels of gases/vapours because of their superior face sealing characteristics, and they provide eye and face protection as well.

The life of a filter, or disposable respirator in use, depends on the concentration of the contaminant, air temperature and humidity and the work rate of the wearer.

There is sometimes a need to wear gas-tight eye protection when wearing half facepiece respirators in irritant gases, i.e. formaldehyde.

Substances such as acetone, ethylene oxide, and ethanol are organic compounds which boil below 65°C and therefore require special filters such as **AX class**. The service life of filters used with these chemicals is very limited and the selection process should be checked with the supplier.

**Note:** When not in use, filters should remain sealed or in airtight containers or bags to prevent the 'reacting agent' from deteriorating through exposure to the atmosphere.

### ➤ **Combination Respirators**

Where there is a combination of particulate (i.e. dust, mist, fume, etc.) and gas/vapour contaminants, a dual-purpose filter can be used.

Particulate filters or disposable respirators impregnated with a reaction agent to remove vapours in low concentrations are available.

For half- and full-face respirators, the filter can either have an inbuilt particulate pre-filter or a pre-filter attachment.

## ➤ Powered Air Purifying Respirators

These have a battery-powered blower/fan unit which helps air pass through the filtering medium to the facepiece (half facepiece, full facepiece, helmet, hood, etc.)

The positive pressure effect created by the 'powered air' in the facepiece area reduces the possibility of inward leakage and increases comfort. To be fully effective in this regard, the power source supplying the air must be capable of maintaining positive pressure for not less than 4 hours at the design flow rate without the need for replacement.

Powered air purifying respirators may be fitted with filters which remove particulates, gases or vapours. The criteria for selecting these filters are the same as those for other air purifying respirators, except that filters for these devices must be specifically marked as being suitable for powered air purifying respirators. AS 1716 requires the letters PAPR to be incorporated into the class mark, e.g. Class PAPR P1.



*A powered positive pressure respirator has a battery powered fan or blower which draws air through the filter to the facepiece or hood. Devices with the blower unit and filter incorporated into a helmet are also available.*

## 6. Airline Respirators

There are two groups of air line respirators: fresh air hose respirators and compressed air line respirators.

Fresh air hose respirators draw air at atmospheric pressure through an air hose. (Electrically-operated air blowers may be used.) Compressed air line respirators supply air under pressure through an air line.

### ➤ Fresh Air Hose Respirators

Air hose respirators consist of a facepiece connected to an air hose which has its free end anchored in an uncontaminated atmosphere. Air at atmospheric pressure is drawn through the hose by normal breathing. The resistance of the hose to the passage of air limits the length of the hose to about 15 metres. All connections should be tight to prevent contaminated air leaking into the air hose. See your supplier for more detailed information.

When longer hoses are used, air is supplied under slight pressure by a pump, blower or bellows which can be operated by an attendant. Leakage into the apparatus is prevented by a positive-pressure effect.

The blower should be sited so it supplies clean fresh air, through a strainer on the inlet end. Before the face piece is put on, the blower should be operated rapidly to ensure that dust inside is blown out and clean air is being delivered to the facepiece. The ends of the hose should be sealed after use.

An air hose respirator provides clean air from a source remote from the contaminated area.

**Note:** These devices are not commonly used today but some gas utilities still find them preferable.

## ➤ Compressed Air Line Respirators

These consist of an air line from a compressed air source to a breathing tube attached to a facepiece on a wearer. The breathing tube connects with either a half facepiece, a full facepiece, a hood or a helmet. The flow of air to the half- and full-facepiece types may be either continuous or controlled by a demand valve. Where the air supply is also used in the industry process, the compressor should be capable of supplying 170 litres/minute. This is extra to the requirement for air-operated equipment. The calculation should be based on the Free Air Delivery (FAD) to information supplied by the compressor manufacturer.



The continuous flow of air creates a positive pressure inside the facepiece or helmet, which gives greater protection than a demand-type respirator. It also reduces fogging and cools the wearer's face. The flow rate can be adjusted by a belt-mounted regulator.

The demand-flow type lets air into the facepiece only when the worker is breathing in, which conserves compressed air.

Hood and helmet airline respirators are used when the head and neck must be protected. Because the efficiency of this type of respirator depends on maintaining a positive pressure inside the hood, the respirator must fit closely round the neck. Drawstrings or elasticised neckbands should be as tight as comfort allows. Simply tucking the cape or inner bib part of the hood inside your shirt or other garment is not recommended. Pressure warning devices are available and should be considered as an extra safety device. Double action safety type couplers should be used on all connections.

Increasing the air pressure above the manufacturer's recommendations will not necessarily increase the protection. In fact, it may create vortex currents and local areas of negative pressure within the hood, causing inward leakage of the contaminated atmosphere. Also, the extra noise the wearer is subjected to may be unacceptable.

The air intake to the compressors should be sited in an uncontaminated atmosphere. Particular care should be taken to ensure that this requirement is met if a portable air compressor is used to supply breathing air. Compressed air for breathing should comply with **Appendix 1** (Requirement for air quality compressors or cylinders) for air-supplied respirators) of NZSAS 1715:1994 (reproduced on page 44 of this booklet). Oil and water traps by themselves are not sufficient to make compressed air respirable. Seek advice from suppliers. Filters should be changed every six months unless testing indicates more frequent periods.

### ➤ Precautions for Normal Use

- All fresh air hose intakes should be supervised to ensure a continuous supply of fresh air.
- Compressor air intakes should be sited to avoid contamination (particularly by exhaust gases from internal combustion engines).
- Don't let the compressor run hot, as decomposition of the lubricating oils may produce dangerous amounts of carbon monoxide and other harmful substances.
- Remove water and pockets of stagnant air before you use an air line.
- If the air supply is used in a manufacturing process as well as for supplying an air line, take particular care to avoid contamination.
- A pressure regulator must be used with a compressed air line respirator.

Air line respirators provide reliable respiratory protection only if the air supply is continuous and efficient. An air line respirator should only be used in an atmosphere not immediately dangerous to life or health because failure of the air supply will expose the wearer to contaminated air. An exception to this is where the wearer carries an emergency air supply to allow enough time to escape (e.g. self-contained breathing apparatus).



## 7. Self-Contained Breathing Apparatus

Self-contained breathing apparatus (SCBA) lets the wearer work without the restriction of a hose or air line in an atmosphere that is contaminated and/or deficient in oxygen. This type of respirator is suitable for short-term routine work and emergency use. These devices provide air from a source carried by the wearer, allow for most work without unduly impeding the wearer, and can be used in extremes of temperature.

The most widely used SCBA is a compressed air open-circuit device with a compressed air cylinder, an air line to a demand regulator, and a facepiece. These can be supplied in a positive or negative-pressure mode and are usually used in conjunction with a full facepiece. For routine work, the air supply may last in excess of 15 minutes, although for escape use it may be less depending on cylinder size.

Negative-pressure airflow SCBA is prone to leakage through the facial seal, and care must be taken in fitting the facepiece to minimise this. If the SCBA is operated in a positive-pressure mode, leakage is outwards only.

These devices are fitted with a range of safety features to ensure that users are afforded high protection which is necessary when working in heavily contaminated or oxygen-deficient atmospheres.

The use of this type of equipment should be restricted to specially trained and experienced personnel. Keep the breathing apparatus in good operating order. The supplying company can advise you on correct and regular service procedures.



*Self-contained breathing apparatus can be used in regular work to protect against lack of oxygen or an unknown level of toxic contaminants.*

## 8. Respiratory Protection Programmes

Supplying respiratory protection alone does not necessarily protect the worker. For effective and adequate protection, a specific respirator programme should be put in place. A proper hazard control strategy should be established with the primary aim of preventing exposure to contaminants. The Health and Safety in Employment Act 1992 requires employers to minimise the likelihood of a hazard causing harm to employees.

Where feasible, exposure to contaminants should be eliminated by engineering controls. Only when effective engineering controls are not practicable should the use of personal protection be considered.

The following components should form the basis of a respirator programme:

- The programme should be established by management and an individual designated to run it and maintain records.
- Consultation and involvement of employees in the programme may assist with overcoming a reluctance by some workers to wear personal protection.
- An assessment process to identify the risks in the workplace and the most appropriate control methods. This should be kept under continual audit and review.
- Where it is found necessary to use respirators, appropriate medical assessment and health surveillance procedures should be adopted.
- A comprehensive selection process should be adopted, which correctly matches the

protection required to the physical and chemical properties of the contaminants.

- Training and instruction must be provided for those required to wear respirators, including fit testing, cleaning, storage, and maintenance.
- A company policy on the types of approved respiratory protection devices required and issuing policy for this equipment should be formulated.

## 9. Some Practical Considerations

For routine industrial use, respirators should be issued on a personal basis. This helps to eliminate the possibility of infection being transferred from person to person through the facepiece. Personal issue also helps the wearer know when to replace a filter and keep a check on defects. No respirator should be issued unless it has been cleaned and sanitised after its last use.

It is good practice to establish a user recording system, stating the date of issue, the person to whom the device has been issued, defects reported, and maintenance that has been carried out. This record should also show training courses attended. Regulation 69 of the Health and Safety in Employment Regulations 1995 requires every manufacturer and supplier of protective clothing or equipment shall take all practicable steps to ensure that every supplier of such clothing or equipment receives comprehensive and comprehensible information, including, where relevant, detailed instructions, about:

- The use for which the clothing or equipment has been designed ; and
- How to install, adjust, use, clean, maintain, repair, and dismantle the clothing or equipment in accordance with the designer's instructions; and
- Any other matters about which the supplier needs information from the manufacturer in order to be able to carry out any duty of the supplier under this regulation.

## ➤ Training and Instruction

Wearers must be taught the correct way to use respirators, and instructions should cover the following:

- When a respirator should be worn and correct fitting procedures.
- The importance of using a respirator.
- How the respirator works.
- The limits of the respirator.
- How to recognise poor performance or improper functioning.
- The approximate time the respirator will give protection in the particular conditions.
- What procedure to follow if a fault develops when it is being used.
- What to do in an emergency.
- The importance of not removing the facepiece until the wearer is certain that there is no longer any hazard.
- How to store the respirator correctly.
- How to clean and maintain the respirator.

## ➤ Face Fitting

Where facial irregularities or hair interfere with the face seal, a positive-pressure device should be considered.

Facial hair lying between the sealing surface of a respirator facepiece and the wearer's skin will prevent a good seal. Beards, moustaches and sideburns prevent satisfactory sealing. Long hair may also interfere with the operation of exhalation valves. The sealing problem is especially critical when close fitting facepieces are used. The reduction in pressure developed in the breathing zone of these respirators during inhalation may lead

to leakage of contaminant into the facepiece where there is a poor seal. Therefore, individuals who have stubble (even a few days' growth will cause excessive leakage of contaminant), a moustache, sideburns, or a beard which passes between the skin and the sealing surface must not wear a respirator which requires a facial seal.

The manufacturer's instructions about checking the effectiveness of the face seal should be followed. It is essential that respirators are properly fitted to the individual wearer.

Simple qualitative tests are available and should be used as a routine component of any respirator programme.

The facial seal of some respirators can be tested by using a strong smelling organic substance of low toxicity. For example, sodium saccharine (a mist which provides a taste) or banana oil (an odour which is detected by smell) can be sprayed or vaporised around the face piece seal. If the wearer cannot detect the characteristic taste/smell of the substance, then the facial seal is adequate. Testing devices are available from equipment suppliers. Tests relying on the sense of smell have the disadvantage of not working effectively on those individuals who cannot smell the test substance.

### ➤ **Supervision in a Dangerous Atmosphere**

Whenever a respirator is used in an atmosphere which might be dangerous on short exposure, such as a tank, vat, pipe or other confined space, a trained assistant should continually be in contact with the wearer. It is essential that the likely contaminants, their toxicity and concentration and the possibility of oxygen deficiency be known.

Correct safety procedures for entry into confined spaces are described in the publication *Safety in*

*Confined Spaces* published by the Occupational Safety and Health Service of the Department of Labour.

➤ **Location**

Respirators should be located as close as practicable to the working place where they may be needed.

Emergency equipment should be stored close to the danger area (but not in it) in clearly marked locations so that a rescuer can immediately find it.



# 10. Respirator Maintenance And Storage

It is important that all respirators are properly maintained and stored. Someone's life may depend on the respirator's correct functioning and availability.

A regular maintenance and cleaning programme and a designated storage place should be established.

## ➤ Inspection

All rubber parts such as facepieces, mouthpieces, valves, breathing tubes, air hoses, air lines and headbands should be inspected for deterioration such as hardening, cracking or tackiness.

All metal parts should be checked for signs of corrosion, and plastic and glass parts for cracking or breakage.

All filters should be checked for damage and corrosion.

When an air supply system is in use, it should be inspected regularly. Air compressors, air cylinder manifold systems, pressure reducers, pressure release valves, air line filters, condensate traps, air line instrumentation and permanent piping and outlet fittings must be kept in good repair to ensure that air reaching the wearer is uncontaminated.

## ➤ Cleaning

### **Air-Purifying Respirators**

It is essential that the facepiece is kept clean for continued efficient use. To do this, remove the filter units (or hose if fitted) and wash the facepiece in warm water and detergent. **DO NOT WASH THE FILTER UNITS.** Brush the facepiece, if necessary, to remove soil. Rinse in clean warm water and air dry. Reassemble and store. Care should be taken

when using a disinfectant for cleaning the face piece, as it may cause a skin reaction if it is not completely rinsed off.

Each time the respirator is serviced, remove the valves and clean them. The valve seats may need to be scrubbed with a small brush. Valves should be washed in cold or lukewarm water only and quickly dried (moisture allowed to dry slowly on them may interfere with their correct functioning).

### **Air Line and Self-Contained Breathing Apparatus**

Clean the facepieces as described for air-purifying respirators. Hoses should be checked for defects.

Where air filtering or purifying devices are used in air line systems, these must be regularly checked and maintained to ensure good quality air.

Compressed air cylinders must be filled from a recognised safe source, such as dive shops. They must be filled, inspected, tested and maintained in accordance with the requirements of the Dangerous Goods (Class 2 Gases) Regulations, which are administered by OSH. Used or partly used cylinders must be recharged as soon as possible after use. Make sure you follow the manufacturer's instructions when servicing self-contained breathing apparatus.

#### ➤ **Final Inspection**

Carefully check assembled respirators to ensure that all components are in place and that all moisture has been removed from surfaces and crevices.

#### ➤ **Storage**

Respirators should be kept clean and dry and protected from exposure to workplace contaminants when not in use.



Emergency respirators should be stored in a clearly marked site close to the workplace when not in use. Keep them away from oil and exposure to direct sunlight, which causes deterioration of rubber parts. They should not be stored in a tool box or clothing locker. A clean dry box or cupboard is satisfactory.

Facepieces should be stored so that they are not subject to distortion. Do not hang the respirator by its straps as this causes them to stretch, resulting in a poor facial fit. If facepieces are not used very often, store them in plastic bags or other suitable container to protect them from dust and corrosive atmospheres.

It is a good idea to store filters in sealed container bearing the date of the last inspection.

## Appendix 1: Requirements for Air Quality (Compressors or Cylinders) for Supplied Air Respirators

*(Appendix 1 from NZS AS 1715: 1994 Selection, Use and Maintenance of Respiratory Protective Devices).*

### A1 Air Supply

**A1.1 Capacity** The necessary capacity of any air service for personal protection shall be calculated on a minimum requirement of 170 litres per minute for each person measured at the respirator.

**Note:** Where air cooling or encapsulated suits are used additional air will be required and advice should be sought from a competent source.

Air used to supply respirators shall—

- (a) Have no objectionable or nauseous odour; and
- (b) Contain no less than 19.5 percent and not more than 22 percent by volume of oxygen.

Additionally, at 15 C and 100 kPa absolute the air shall

- (i) Contain not more than 11 mg/m (10 p.p.m. by volume) of carbon monoxide;
- (ii) Contain not more than 1400 mg/m (800 p.p.m. by volume) of carbon dioxide;
- (iii) Contain not more than 1 mg/m (1 p.p.m) of oil; and
- (iv) For cylinders, contain not more than 100 mg/m of water when sampled from a cylinder initially filled to a pressure of at least 12 MPa.

**A1.2 Air temperature.** Air supplied from a compressor to a facepiece, hood or helmet should be at a comfortable breathing temperature within the range 15 to 25°C.

**A1.3 Avoidance of stale air or moisture.** Arrangements should be made to avoid the pocketing of stale air in pipelines. The use of ring circuits and controlled draining helps to guard against this hazard.

Couplings should be of the 'snap type' and should be of different design to those used for other compressed air services.

Provision should also be made, at appropriate places, to drain away water from any pipeline. Water traps should be drained prior to using the apparatus.

**A1.4 Warning device.** Where an 'in-line' auxiliary (secondary) air supply has not been provided to guard against primary supply failure, the user of an air-supplied respirator shall be warned by an automatic device whenever an inadequacy in the air supply may represent an immediate hazard to the user.

**A1.5 Compressors** Systems shall incorporate a receiver of sufficient capacity to reduce pulsations from compressor action and reduce compressor overheating. Compressors shall be well maintained and shall not be allowed to run hot, as harmful substances may be produced by the decomposition of the lubricating oils. Filters should be purged or replaced at regular intervals in accordance with the manufacturer's instructions. Consideration should also be given to the use of oil-free compressors.

The air intake to the compressors should be sited in an uncontaminated atmosphere. Particular care should be taken to ensure that this requirement is met if a portable air compressor is being used to supply breathing air.

The use of filters on any air intake should be of secondary importance when compared with the foregoing requirements.

**A1.6 General works air supply systems.** Where the air supply is used in the manufacturing process as well as in the supply of respirable air, particular care should be taken to avoid the risk of contamination.

Where the air supply is used in the manufacturing process and there is a risk of contamination, the air supply should not be used for personal protection unless it has been filtered to provide the air quality defined in Paragraph A1.1.

In every instance it should be ensured that any back pressures from operating plants using the air supply will not cause contamination of the air used for personal protection.

Provision should be made to ensure that the air lines supplying the breathing apparatus receive an adequate supply of respirable air under all plant operating conditions.

Plant air supplies are not suitable for airline respirators unless special precautions have been taken for the elimination of scale, rust, water, oil mist, irritating ingredients and odours. It is preferable that a separate installation be provided for respiratory air purposes, and that it be designed to eliminate the above mentioned contaminants.

## A2 Compressed Oxygen Supply

Compressed oxygen of the dry breathing type should be odourless and contain not less than 99.5 percent by volume of oxygen.

At 15°C and 100 kPa absolute; it should contain—

- (a) Less than 11 mg/m (10 p.p.m. by volume) carbon monoxide; and
- (b) Less than 1400 mg/m (800 p.p.m. by volume) carbon dioxide.

When sampled from a cylinder initially filled to at least 12 MPa, it should contain

- (i) Less than 20 mg/m water; and
- (ii) Less than 1 mg/m (1 p.p.m. by volume) oil.

## Appendix 2: Filter Comparison

Filter Comparison					
Contaminant	Australia New Zealand Standards	European Standards	European/ Aus/NZ Colour	US (NIOSH) Name	US (NIOSH) Colour
Organic Vapours	A	A	Brown	Organic Vapour	Black
Acid gases Cl <sub>2</sub> , H <sub>2</sub> S, HCN	B	B	Grey	Acid Gases	White
Acid Gases SO <sub>2</sub>	E	E	Yellow	Acid Gases	White
Organic Vapour/Acid/ Gas combination	ABE	ABE	Brown/ Yellow/Grey	Organic Vapour/ Acid Gas combination	Yellow
Combination Cartridge	ABEK	ABEK	Brown/Grey/ Yellow/Green	Multigas	Olive Green
Ammonia	K	K	Green	Green	
Nitrous Oxides	NO	NO	Blue	-	-
High Vapour Pressure Chemicals (Pesticides)	G	-	-	-	-
Mercury	Hg	Hg	Red	Mercury	-
Low Boiling Solvents	AX	AX	Brown	-	-
Particulate filters	P1	P1	White	N95, R95, P95 N100, R100, P100	-
	P2	P2	White		
	P3	P3	White		



# Glossary of Common Terms

## Acute

Health effects of rapid onset.

## Air Hose Respirator

A device, with a facepiece or head covering, through which respirable air from a source remote from the workplace is made available to the wearer through an air hose at near atmospheric pressure.

## Air Line Respirator

A device through which air, at greater than atmospheric pressure, from a source of compressed air capable of providing breathing air of the quality defined in Appendix 1, is supplied to the wearer by means of air line.

## Air-Purifying Respirator

A device which filters contaminants from inhaled air.

## Demand Regulator

A device for the controlled release of air or oxygen actuated by a reduction in pressure created by the action of inhalation. The regulation may be such that the pressure inside the facepiece is maintained above atmospheric pressure (positive pressure type) or falls to below atmospheric pressure (negative pressure type) during the inhalation phase.

## Dust

Solid particles suspended in the air as a result of the disintegration of matter. Dust may be generated by mechanical means.

## Fume

Particles forming an airborne suspension. Fuming is usually caused by the heating of a solid to such an extent that it vaporizes and then condenses into small particles in the surrounding air. Fume may be termed a thermally generated particle.

**Note:** Within the context of this guide the term fume does not include vapours, gases or a combination of these.

## Gas

A substance which is airlike. It is neither solid nor liquid at room temperature. The term gas in this standard also includes vapours.

## Immediately Dangerous To Life and Health (IDLH)

Exposure to an atmosphere that poses an immediate adverse effect on health or the ability to escape.

## Mist

Airborne droplets. The droplets may carry substances in solution or particles in suspension. Mists are usually formed by the condensation of vapour but may be produced by the atomization of a liquid (see dust).

## Oxygen-Deficient Atmosphere

An atmosphere which does not contain enough oxygen to fully support the body's metabolic processes. It is generally acknowledged that an atmospheric concentration below 18% by volume is deficient in oxygen.

## Particulates

A generic term used in this Guide to refer to particulate aerosols such as dust, mists, smoke, and fumes.

## Powered Air-Purifying Respirator

A device incorporating a half facepiece, full facepiece or head covering provides the wearer with air filtered through a powered filtering unit, comprising a filter or filters, and an electrically operated blower unit. This respirator is referred to as a PAPR.

## Protection Factor

A measure of the degree of protection afforded by the respirator, defined as the ratio of the concentration of contaminant outside the respirator to that inside the respirator.

## Self-Contained Breathing Apparatus (SCBA)

A portable respirator which supplies oxygen, air or other respirable gas from a source carried by the user.

## Toxicity

A substance's potential to poison. All substances are toxic, their impact depending on how much is required to be harmful (dose), e.g. Beryllium is highly toxic and fresh water is relatively non-toxic.

## Vapour

The gaseous form of a substance which is a solid or liquid at room temperature.