

Australian/New Zealand Standard™

Respiratory protective devices



AS/NZS 1716:2012

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Australian/New Zealand Standard™

Respiratory protective devices

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PREFACE

This Standard was prepared by the Joint Australian/New Zealand Standards Committee SF-010, Occupational Respiratory Protection to supersede AS/NZS 1716:2003.

This Standard was revised with the objective of incorporating some improvements but keeping these to a minimum, in light of current work still under way by ISO (International Organization for Standardization) in the field of respiratory protective devices.

The changes that have been made are mostly editorial or to clarify and improve existing testing procedures for exhalation resistance as well as include specific requirements for full facepieces used in extreme environments by fire and emergency services (special use facepieces).

It is anticipated that a new series of ISO Standards will be published in the next few years that will incorporate major developments that will address most, if not all, concerns highlighted in the previous edition. When such ISO Standards are published, it is planned that they be adopted as the next revision of AS/NZS 1716.

Advice on the selection, use and maintenance of respiratory protective equipment is not covered by the Standard but given in AS/NZS 1715, *Selection, use and maintenance of respiratory protective equipment*.

The terms 'normative' and 'informative' have been used in this Standard to define the application of the appendix to which they apply. A 'normative' appendix is an integral part of a Standard, whereas an 'informative' appendix is only for information and guidance.

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STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard

Respiratory protective devices

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard specifies requirements for respiratory protective devices (respirators) intended to provide, according to type, varying degrees of protection against atmospheres containing substances which may be harmful if breathed; also, with certain types, to provide protection against atmospheres which may be deficient in oxygen. It does not purport to give guidance on the selection, use and maintenance of respirators. This is covered in AS/NZS 1715.

The Standard specifies requirements, performance and testing criteria to be observed in the manufacture of respirators.

The Standard does not apply to respirators for use in aircraft, for operations under water (see AS/NZS 2299 series), or for life support respirators used for medical purposes or resuscitation (see AS 2488).

1.2 OBJECTIVE

The objective of this Standard is to provide minimum performance and testing criteria to be observed in the manufacture of respiratory protective devices.

1.3 APPLICATION

Every respirator shall comply with the general requirements of Sections 2, 3 and 12, and with the specific requirements of the particular section applicable to the respirator type, as follows:

Particulate filter respirators.....	Section 4.
Gas and vapour filter respirators	Section 5.
Powered air-purifying respirators.....	Section 6.
Escape respirators—filtration type	Section 7.
Air-hose and air-line respirators.....	Section 8.
Compressed air self-contained breathing apparatus	Section 9.
Compressed oxygen self-contained breathing apparatus	Section 10.
Chemical oxygen self-contained self-rescuers	Section 11.

1.4 REFERENCED DOCUMENTS

AS	
1349	Bourdon tube pressure and vacuum gauges
2030	Gas cylinders (series)
2488	Resuscitators intended for use with humans
4484	Gas cylinders for industrial, scientific, medical and refrigerant use—Labelling and colour coding

- AS IEC
 61672 Electroacoustics—Sound level meters
 61672.1 Part 1: Specifications
- AS/NZS
 1020 The control of undesirable static electricity
 1337 Personal eye protection
 1337.1 Part 1: Eye and face protectors for occupational applications
 1715 Selection, use and maintenance of respiratory protective equipment
 1801 Occupational protective helmets
 2299 Occupational diving operations (series)
 4067 Firefighters' helmets
 60079 Explosive atmospheres
 60079.1 Part 1: Equipment protection by flameproof enclosures 'd'
 60079.11 Part 11: Equipment protection by intrinsic safety 'i'
- MP 87 Australian/New Zealand Certification Scheme for explosion-protected electrical equipment (ANZEx Scheme)
 MP 87.1 Part 1: Product Certification Program—Basic rules and procedures
- BS
 2577 Methylene blue particulate test for respirator canisters (obsolescent)
 3928 Method for sodium flame test for air filters (other than for air supply to I.C. engines and compressors)
- EN
 136 Respiratory protective devices. Full face masks. Requirements, testing, marking
 13274 Respiratory protective devices—Methods of test
 13274-7 Part 7: Determination of particle filter penetration
- National Coal Board (NCB)
 Specification No. 245: Fire and electrical resistance properties of supported and unsupported sheeting, 1985. (UK)

1.5 DEFINITIONS

For the purpose of this Standard, the definitions below apply.

1.5.1 Air-hose respirator

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

1.5.2 Air line

Tubing used to provide respirable air from a source of compressed air at a maximum pressure of 10 bar.

1.5.3 Air-line respirator

A device capable of providing respirable air to the wearer, from a source of compressed air at greater than atmospheric pressure, by means of an air-line.

1.5.4 Air-purifying respirator

A device which filters contaminants from inhaled air.

1.5.5 Breathing tube

A flexible tube connected to a facepiece or headcovering through which breathable gas enters at a pressure slightly above or below atmospheric pressure.

1.5.6 Chemical oxygen (KO₂) self-contained self-rescuer

A device which generates oxygen by means of a chemical reaction for use by a wearer during escape from a contaminated atmosphere or one lacking in oxygen.

NOTE: This does not include devices for work, rescue or diving applications.

1.5.7 Combination filter respirator

A device combining the filtration capabilities of gas or particulate filters or both. The filters may be a single unit (integral) or consist of separate filters to form one unit (combination).

1.5.8 Demand valve

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.

1.5.9 Disposable respirator

A respirator device for which maintenance is not intended and which is designed to be discarded after excessive resistance, sorbent exhaustion, physical damage or end of service life renders it unsuitable for use.

1.5.10 Escape type respirator

A device for emergency escape from a respiratory hazard, e.g. fire.

1.5.11 Extended usage period

The time, in minutes that a chemical oxygen self-contained self-rescuer (when tested on a closed-circuit breathing machine) continues to produce oxygen past the rated duration, when tested and assessed in accordance with this Standard.

1.5.12 Filtration type escape respirator

A device incorporating filters which removes certain particulates and gases or vapours from the air inhaled by the wearer for a limited period during escape from a respiratory hazard.

1.5.13 Flow regulator

A device for controlling air flow.

1.5.14 Full facepiece

A close fitting device to cover the eyes, nose and mouth and be secured in position by suitable means. Such devices are also known as 'full face masks.'

1.5.15 Gas filter respirator

A device consisting of a half facepiece, full facepiece, head covering or mouthpiece with a filter which removes certain gases or vapours from the air to be inhaled by the wearer for a limited period. It may also incorporate a filter to remove particulates.

1.5.16 Half facepiece

A close fitting device to cover the nose, mouth and chin and be secured in position by suitable means.

1.5.17 Head and face covering

A hood, faceshield, visor, or helmet covering all or part of the head and extending where appropriate to the shoulders or waist. It may include sleeves and is secured in position by suitable means.

1.5.18 Mouthpiece

A device designed to be held in the mouth and through which all air passes.

1.5.19 Nominal effective life (NEL)

The time in minutes, for a compressed air self-contained breathing apparatus to provide protection to the wearer at a usage rate of 40 L/min and at cylinder pressures above 1 MPa, when tested as described in Clause 9.2.

1.5.20 Nominal duration

The time, in minutes, that a chemical oxygen self-contained self-rescuer is effective, as specified by the manufacturer.

1.5.21 Nose clip

A device designed to occlude the nostrils to prevent air inhalation. Used in conjunction with a mouthpiece.

1.5.22 NTP

Normal temperature and pressure, i.e. 23°C and 101.3 kPa respectively.

1.5.23 Particulate filter respirator

A device consisting of a half facepiece, full facepiece or head covering with particulate filter which removes finely divided solids or liquid matter from the air to be inhaled by the wearer. The filter medium may be replaceable or be an integral part of the construction.

1.5.24 Powered air-purifying respirator

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

1.5.25 Rated duration

The time, in minutes, that a chemical oxygen self-contained self-rescuer is able to deliver breathable gas to a wearer within a suitable range of temperature, humidity, breathing resistance, and carbon dioxide and oxygen content, when tested and assessed in accordance with this Standard.

1.5.26 Regulatory authority

A minister of the Crown, a government department or commission, or a statutory or public authority having power to issue regulations, orders or other instructions having the force of law in respect of any subject covered by this Standard.

1.5.27 Respirator

A personal respiratory protective device which is designed to prevent the inhalation of contaminated air.

1.5.28 Safety coupling/connector

An air-line coupling/connector which requires at least two deliberate actions to separate the coupling or connector.

1.5.29 Self-contained breathing apparatus (SCBA)

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

1.5.30 Shall

Indicates that a statement is mandatory.

1.5.31 Should

Indicates a recommendation.

1.5.32 Single use low-boiling point filter

A category of filter intended to be used solely against low boiling point organic compounds during a single eight-hour shift, where the total logged period of use does not exceed the minimum specified absorption time of the filter. It is intended that the filter be discarded after such a period of use.

1.5.33 Supplied-air respirator

A device which supplies air to the wearer from a source other than the ambient atmosphere.

1.5.34 Supplied-oxygen respirator

A device which supplies gaseous oxygen from a source of liquid or compressed oxygen carried by the wearer.

NOTE: Liquid oxygen sets, which supply oxygen from a source of liquid oxygen carried by the wearer, are no longer covered by the requirements of this Standard.

1.5.35 Work sets

Self-contained breathing apparatus designed for general entry to or working in an area with airborne contaminants or oxygen deficiency.

1.6 NOMINAL VALUES AND TOLERANCES

Unless otherwise specified, the values stated in this Standard are expressed as nominal values.

Except for temperature limits, values that are not stated as maxima or minima shall be subject to a tolerance of $\pm 5\%$.

Unless otherwise specified, temperature limits in this Standard shall be subject to a tolerance of $\pm 1^\circ\text{C}$.

Unless otherwise specified, the ambient temperature for testing shall be $23 \pm 3^\circ\text{C}$.

NOTES:

- 1 A table for the conversion of various pressure units is included as Appendix M.
- 2 Volumetric flow rates are measured at atmospheric pressure unless otherwise specified.

1.7 UNITS FOR GAS AND VAPOUR CONCENTRATIONS

Gas concentrations in this Standard are expressed in parts per million (p.p.m.) by volume. The following equation can be used to convert from p.p.m. to mg/m^3 :

$$\text{Concentration in } \text{mg}/\text{m}^3 = \frac{\text{molecular weight} \times \text{concentration in p.p.m.}}{24.45}$$

where

$$24.45 = \text{molar volume in litres at } 25^\circ\text{C and } 101.3 \text{ kPa}$$

It should be noted that gravimetric units of mg/m^3 are affected by temperature and pressure variations and, when used in this Standard, are expressed relative to standard conditions of 25°C and 1 atmosphere (atm), where 1 atm = 101.3 kPa.

1.8 APPLICATION OF DESIGN AND CONSTRUCTION REQUIREMENTS

The requirements and corresponding tests of Section 2 and 3 that apply for complete assembled respirators are summarized in Appendix P, Tables P1 and P2.

The relevant clauses, in addition to those given in Table P1, for each type of respirator that specify either laboratory performance or simulated work are summarized in Table P3. The tests for those performance criteria are summarized in Tables P4 and P5.

SECTION 2 DESIGN AND CONSTRUCTION OF ASSEMBLED RESPIRATORS

2.1 GENERAL REQUIREMENTS

2.1.1 Assembled respirators

Assembled respirators shall be made up of components which have been tested together as a system.

The apparatus shall be constructed from durable components, and the vital parts of the apparatus shall be protected so as to prevent damage and excessive wear during normal use. All parts shall be finished smooth and free from sharp edges and from irregularities that could be a potential hazard or cause discomfort to the wearer.

2.1.2 Materials

Respirators should be made of materials able to withstand storage and usage in environments that are likely to be encountered.

Material which may come in contact with the skin should be non-staining, soft, pliable and not likely to cause skin irritation. Such material shall not taste or smell offensive.

Material from the filtering medium released by air flowing through the filter shall not constitute a hazard or nuisance to the wearer.

2.1.3 Filters

Where appropriate, filters shall be readily replaceable without requiring the use of special tools and shall be designed or marked to prevent incorrect assembly.

When the filter is designed to be used with a twin filter facepiece only it shall not be possible to connect the filter to a single filter facepiece unless, by doing so, the respirator assembly would also comply with the requirements for a single filter respirator.

The particulate filter of a combined gas and particulate respirator shall be on the influent side of the gas filter.

The mass of the replacement filter (or filters) shall not exceed—

- (a) 300 g when it is to be directly connected to a half facepiece; and
- (b) 500 g when it is to be directly connected to a full facepiece.

2.1.4 Shelf life

Each component part of the respirator should have a nominal shelf life of at least five years when properly stored, unless otherwise specified by the manufacturer.

2.1.5 Combined protective equipment

Personal protective equipment which incorporates respirators, safety helmets and eye protectors shall comply with the relevant requirements of Australian or Australian/New Zealand Standards for such equipment, e.g. AS/NZS 1337.1, AS/NZS 1801 and AS/NZS 4067.

All respirators with eye coverings, excluding hood-type respirators, shall meet the requirements for low impact strength in accordance with AS/NZS 1337.1. Abrasive blasting helmets shall meet the requirements for high impact in accordance with AS/NZS 1337.1.

Where rigid or semi-rigid construction of respirator head covering does not comply with the requirements of AS/NZS 1801, the device shall be marked with a suitable warning note. (See Section 11.)

2.1.6 Noise level

If supplied with head coverings, powered respirators and air-supplied respirators shall be tested for noise level in accordance with Appendix A. The noise level from the entry of air, or from the blower, where appropriate, shall not exceed 80 dB(A), except for short duration units, e.g. escape units, which shall not exceed 90 dB(A). Noise-emitting alarms are exempt from this requirement.

For this test, the head covering shall be positioned on the head of a test subject selected.

2.1.7 Protection against explosion

Where the device is claimed to be suitable for use in atmospheres where there is the danger of fire or explosion caused by means of a spark or excessive temperature, the 'intrinsic safety' and 'flameproof' properties of equipment shall comply with and be certified to the requirements of AS/NZS 60079.1 and AS/NZS 60079.11 and as appropriate, the anti-static requirements of AS/NZS 1020.

NOTES:

- 1 'Intrinsic safety 'i' is defined in AS/NZS 60079.11 in the following terms: 'type of protection based on the restriction of electrical energy within apparatus and of interconnecting wiring exposed to the potentially explosive atmosphere to a level below that which can cause ignition by either sparking or heating effects.'
- 2 'Flameproof enclosure 'd' is defined in AS/NZS 60079.1 as an 'enclosure in which the parts which can ignite an explosive gas atmosphere are placed and which can withstand the pressure developed during an internal explosion of an explosive mixture, and which prevents the transmission of the explosion to the explosive gas atmosphere surrounding the enclosure'.
- 3 'Antistatic' is defined in AS/NZS 1020 as being 'used to indicate that a material is, by virtue of its low resistivity, incapable of retaining a significant static charge when in contact with earth.'
- 4 Attention is drawn to the availability of a scheme for certification of explosion-protected electrical equipment. Equipment so certified conforms to one of the explosion-protected electrical equipment Standards listed in publication MP 87.1.

2.1.8 Avoidance of frictional sparks

Where applicable, respirators shall not have exposed metal components manufactured from magnesium, titanium, aluminium or of alloys containing such proportions of these metals which on impact with rusted iron or steel are likely to produce sparks capable of igniting flammable gas/air mixtures.

2.1.9 Protection from flame impingement

Where the respirator is claimed to be suitable for use in environments requiring some protection from flame impingement, facepieces, head covering and attachments shall be tested. Suitable tests are provided in Appendix C. When tested in accordance with Appendix C, the device shall not grossly deform, decompose or continue to burn.

Alternatively, where a full facepiece is intended for use in extreme environments, e.g. by fire and emergency services, it shall meet the requirements of EN 136 for a class 3 full face mask.

2.2 FACIAL FIT

2.2.1 General

Facial fit of complete respirators shall be tested by determining the total inward leakage of the respirator by a test aerosol of sodium chloride according to the method described in Appendix D.

Personnel shall be selected in accordance with Appendix B. Where the fit of a respirator to a particular physiognomy, whether it be characterized by size or specific facial features, is to be assessed, the testing laboratory, may select test personnel who conform to that physiognomy. Where testing has been carried out in this manner, the manufacturer shall label the respirator accordingly. See Clause 12.1.2.2.

When carrying out the test procedure, none of the wearers shall experience any undue discomfort on account of the fit, air delivery, or any other feature of the respirator.

Alternative methods of determining total inward leakage, e.g. using sulfur hexafluoride, may be accepted by the test authority where a correlation with these methods and test criteria has been shown.

2.2.2 Assessment

Total inward leakage (TIL) of assembled respirators when tested in accordance with Appendix D shall be assessed for compliance with Table 2.1. Half facepiece respirators shall be tested with the highest efficiency filters.

Full facepiece respirators of the non-powered type shall be tested with either P3 filter or a simulated filter blank.

If any test subject records a mean inward leakage for any one test in excess of that specified in Column 2 of Table 2.1, or if the mean of the results of an individual test subject exceeds that specified in Column 1 of Table 2.1, the respirator shall be deemed not to comply with its intended class, or have failed.

Where the respirator is supplied in more than one size, the test subject shall be supplied with the appropriate size. Any test subject whose maximum inward leakage exceeded that specified in Table 2.1 may participate in a further test using an alternative size of the same respirator.

TABLE 2.1
MAXIMUM TOTAL INWARD LEAKAGE (TIL)
PER TEST SUBJECT

Respirator	Percent total inward leakage	
	Mean result of test subject not to exceed	No individual exercise result to exceed
Non-powered		
– Half face piece		
Class P1 filters(s)	22.0	22.0
Class P2 filters(s)	8.0	8.0
– Full facepiece		
Class P3	0.05	0.05
Powered		
Class PAPR P1 filters(s)	5.0	5.0
Class PAPR P2 filters(s)	1.0	1.0
Class PAPR P3 filters(s)	0.05	0.05
Air-supplied		
Continuous flow	0.02	0.05
Positive pressure demand	0.02	0.05

2.3 BREATHING AND CONNECTING TUBE

The breathing tube or connecting tube between the facepiece and the respirator attached to the body harness or waist belt, through which air is conveyed—

- (a) shall be flexible such that it permits free head movement without interference to the facial seal of the respirator;
- (b) shall not unduly restrict or close off the air supply by chin, arm movement or pressure; and
- (c) shall be capable of withstanding temperatures as claimed by the manufacturer.

2.4 DEMAND VALVE

2.4.1 Design

The design of the demand valve of supplied-air respirators shall be such that it is adequately protected against damage and its efficiency is not impaired by any conditions likely to be encountered in normal use. Where the device includes an adjustable reducing valve it shall incorporate a suitable locking device to prevent the adjustment from being altered accidentally.

The assembly shall be protected by a pressure-reducing safety valve or mechanism if the demand valve and associated fittings cannot withstand the full cylinder pressure. Breathing shall be possible at the maximum operating pressure of the pressure safety valve or safety mechanism.

2.4.2 Mode of operation

It shall not be possible to connect a negative pressure demand valve to a positive pressure facepiece or vice versa.

SECTION 3 FACEPIECES HEAD COVERINGS AND HARNESSSES

3.1 DESIGN REQUIREMENTS

3.1.1 General

Each facepiece or head covering shall comply with the following:

- (a) Be designed to fit a wide range of facial contours and head sizes of the workplace population.
NOTE: More than one size of any individual design of facepiece may be manufactured to fit a larger proportion of the population.
- (b) Be supported on the head or shoulders by suitable means so that the device remains in position during normal work practices, especially when the wearer bends forward from the waist.
- (c) Permit the component parts likely to require service to be readily detached for maintenance and cleaning, but be secure against accidental disconnection.
- (d) Where the head covering has been designated by the manufacturer as being suitable for abrasive blasting, the construction shall provide physical protection to the wearer's head, shoulders and upper part of the chest against rebounding abrasives. Helmets fitted with a visor which is supported in a hinged frame shall have a means for securely fastening the frame in its closed position so that it cannot be opened inadvertently.
- (e) Where an inner bib is provided as part of the head covering, it shall be of a material which will prevent or restrict the flow of air through it. The bib may have a drawstring or elasticized neck band or cuff to draw the bib closely around the wearer's neck. The hood or bib shall be readily removable for cleaning or replacement.

The design of the facepiece or head covering should cause the least possible interference with speech and vision.

The full facepiece should be designed to minimize misting of the face mask, e.g. by provision of orinasaal inserts or nose cups. It should also permit the use of special spectacles designed for use without temple pieces, so that air tightness is not affected.

Full facepieces should incorporate facilities for speech transmission. The components of any electrically operated speech transmission device shall be 'intrinsically safe' or 'flameproof' (see Clause 2.1.7) if they are to be used in flammable atmospheres.

Where the use of the apparatus is intended solely for escape, a mouthpiece and nose clip may be incorporated in place of a facepiece.

3.1.2 Exhalation valve assembly

Where exhalation valves are incorporated into the facepiece they shall be of the self-closing type, i.e. they shall not remain open after outward airflow has ceased. The exhalation valve assembly shall be protected from mechanical damage.

3.1.3 Mouthpiece and nose clip

3.1.3.1 General

Where the respirator incorporates a mouthpiece, a nose clip shall also be supplied.

3.1.3.2 Mouthpiece

The mouthpiece shall—

- (a) prevent saliva from draining into the filter;
- (b) provide an air tight seal when held firmly and without undue discomfort in the wearer's mouth;
- (c) include a means for the support of the mouthpiece between the teeth and lips, and lugs to keep the teeth apart;
- (d) prevent closure of the mouthpiece by mouth pressure; and
- (e) be secured in position by suitable means to ensure that the mouthpiece will not fall out when the wearer's mouth is relaxed.

3.1.4 Nose clip

The nose clip shall be designed so as to effect the maximum possible security against displacement or slipping, for example, if the wearer receives a chance blow, or stumbles, or their nose becomes wet with perspiration. Suitable means shall be provided for attaching the nose clip to the mouthpiece. The nose clip shall be so positioned that, when inserting the mouthpiece, the user is made aware of the need to apply the nose clip.

3.1.5 Facepiece connector

The connection between the facepiece and the demand valve shall be achieved by permanent or special type connection.

It shall not be possible to connect a negative pressure demand valve to a positive pressure facepiece and vice versa.

3.2 PERFORMANCE REQUIREMENTS

3.2.1 Facial fit

In combination with other components, e.g. filters and air supply, the assembled respirator shall provide adequate protection either by means of a facial seal or by the provision of positive pressure in the space enclosed by the respirator, or by both, to minimize the entry of ambient atmosphere.

Facial fit of complete respirators shall be tested by determining the total inward leakage in accordance with Clause 2.2.

3.2.2 Accumulated carbon dioxide

Full facepieces and head coverings except those for chemical oxygen self-contained self-rescuers shall be tested for the accumulation of carbon dioxide in the breathing zone. When tested in accordance with Paragraph E5.3 of Appendix E, the carbon dioxide content of inhaled air (including the deadspace effects of the test equipment) shall not exceed 1% by volume, except that for smoke masks it shall not exceed 2% by volume. For breathing apparatus of the escape type refer to the values shown in Figure 9.1.

NOTES:

- 1 This test will continue until a constant carbon dioxide content in the air inhaled is achieved.
- 2 For constant-flow apparatus, the testing authority should select the pressure and flow rate of the air-supply system to be within the manufacturer's range of pressure and airflows.

3.2.3 Positive pressure screening test

This test applies to continuous flow respirators, i.e. air-line, or constant flow PAPR. No fewer than two respirators shall be submitted for test and those shall pass the test requirements.

When tested in accordance with Paragraph E5.5 of Appendix E, during the respiratory cycle of the test, a positive pressure of at least 2.5 Pa (0.25 mm H₂O) shall be maintained in the space enclosed by the facepiece or head covering, except in the immediate vicinity of the inhalation point. The apparatus shall be tested with any regulating device adjusted to both its highest and lowest flow rates.

The testing of air-line respirators shall be carried out at the manufacturer's recommended range of supply pressures.

This test is not required if total inward leakage results exist. In cases of dispute, the results of total inward leakage testing shall, however, take precedence.

3.2.4 Exhalation valve

3.2.4.1 General

This Clause shall apply to the exhalation valve assembly including the housing.

Where the assembly consists of two or more components in parallel, the performance requirements shall apply to the combination and not to each component separately.

3.2.4.2 Exhalation valve leakage

The exhalation valve or fitting surface of the facepiece shall be sealed to a former and, where appropriate, the inlet air opening of the facepiece sealed.

When tested with air at a constant suction head of 250 Pa, the leakage into the facepiece from the valve or valves and any leakage as appropriate from around the eyepiece or visor shall not exceed 30 mL/min. During the test, both valve(s) and seating shall be free of moisture.

A typical test arrangement is given in Appendix F.

3.2.5 Exhalation resistance—Air filtering respirators

This Clause shall apply to the complete respirator.

Where there are two or more components in parallel, the performance requirements shall apply to the combination and not to each component separately.

When tested in accordance with Appendix G at a continuous flow rate of 85 ± 2 L/min, the exhalation resistance of the entire assembly, measured relative to the static pressure in the facepiece, shall be less than or equal to—

- (a) For all full facepieces 200 Pa.
- (b) For all half facepieces 120 Pa.

NOTES:

- 1 In the case of negative pressure assemblies, the static pressure in the facepiece will be equal to zero.
- 2 In the case of a powered respirator, the exhalation resistance is measured with the power source switched on.
- 3 In the case of a breath responsive powered respirator, test can be done on a breathing pump set to give a peak flow of 65 L/min (typically 18 times 1.5 L/min).

3.2.6 Security of attachments

Fittings directly attached to the head covering or facepiece including filter receptacles, exhalation valve housing, speech diaphragms and demand valves but excluding straps and buckles shall be tested accordingly for security of attachment as applicable when assembled in accordance with the manufacturer's instructions.

Each such attachment shall withstand an axial tensile force of 50 N for 10 s.

Each strap, buckle and its attachment to a full facepiece shall withstand an axial tensile force of 150 N shall be applied for 10 s in the direction of pulling when the facepiece is fitted.

Each strap, buckle and its attachment to a half facepiece shall withstand an axial tensile force of 10 N applied for 10 s in the direction of pulling when the facepiece is fitted.

Exhalation valve covers and straps not forming part of the securing harness are excluded from this requirement.

Additionally, each attachment or component of a head covering shall remain intact and in place for the duration of both the simulated work test when it is carried out (Clause 8.4.9 or Clause 9.15.4) and the facial fit test (Clause 2.2.1).

SECTION 4 PARTICULATE FILTER RESPIRATORS

4.1 DESIGN AND CONSTRUCTION

The design and construction of a particulate filter shall be such that, when combined or incorporated with the appropriate facepiece or head covering it shall provide protection against particulates in accordance with its class.

The respirator shall be designed so all the inhaled air passes through the filter or filters.

Particulate filter respirators shall comply with Sections 2, 3 and 12, as appropriate. A filter shall comply with Clause 4.3.

4.2 CLASSIFICATION AND COMPONENTS

4.2.1 Classes

Three classes of particulate filter are differentiated according to filtering efficiency:

- (a) Class P1—intended for use against mechanically generated particulates of sizes most commonly encountered in industry.
- (b) Class P2—intended for use against both mechanically and thermally generated particulates.
- (c) Class P3—intended for use against all particulates including highly toxic materials.

4.2.2 Components

The respirator shall include a particulate filter complying with Clause 4.3.

It may incorporate—

- (a) a full or half facepiece, a head covering, or a mouthpiece held securely in position by a head harness;
- (b) an exhalation valve or exhalation valve assembly;
- (c) an inhalation valve or inhalation valve assembly;
- (d) one or more filter holders;
- (e) one or more flexible breathing tubes;
- (f) a belt or harness to attach the filter or filters to the wearer's body; and
- (g) a gas and vapour filter complying with Clause 5.4.

4.3 PERFORMANCE REQUIREMENTS

4.3.1 General

The performance requirements specified in Clause 4.3 shall apply to the whole filter and inlet valve assembly, where applicable, including all the parts through which the inhaled air passes. The tests shall be carried out in the sequence Clause 4.3.2, 4.3.3, 4.3.4 and 4.3.5.

4.3.2 Simulated rough usage

Before testing for TIL, inhalation resistance and filtering efficiency, all filters enclosed in separate rigid containers shall be subjected to simulated rough usage in accordance with Appendix H.

At the conclusion of the test, the filters shall show no visible deterioration and, when tested for inhalation resistance and filter efficiency, shall comply with the relevant requirements.

4.3.3 Simulated wear treatment

Respirators except PAPR which have no exhalation valve, or where a substantial proportion of the exhaled air passes back through the filter, shall be subject to exhaled air humidity pre-conditioning in accordance with Paragraph E5.6 of Appendix E.

If filters are not tested directly upon completion of such pre-conditioning, they should be stored in a manner so as to retain their humidity prior to testing for filtering efficiency.

4.3.4 Inhalation resistance

When tested in accordance with Appendix G with a continuous stream of air passing through the assembly at a defined rate, the resistance imposed by the assembly shall not exceed the values given in Table 4.1.

When each filter of a twin filter respirator is tested separately, the airflow specified for a test shall be halved. If, however, it is possible that the single filter may be used alone, then the full airflow shall be used. Where a particulate filter is combined with a gas filter, the inhalation maximum resistance specified for the gas filter in Clause 5.4.4 shall apply.

NOTE: This test is not applicable to filters used in powered air-purifying respirators.

TABLE 4.1
INHALATION RESISTANCE

Filter class	Filter assembly only maximum resistance, Pa*		Assembled respirator maximum resistance, Pa*	
	At 30 ±1 L/min	At 95 ±2 L/min	At 30 ±1 L/min	At 95 ±2 L/min
P1	60	210	110	340
P2	70	240	120	370
P3	120	420	170	570

* 1 mbar = 100 Pa = 100 mm H₂O

4.3.5 Test of filtering efficiency

When sealed to a suitable former, and tested in accordance with Appendix I, non-powered respirator filters shall not show penetration in excess of the following:

- (a) Class P1..... not more than 20%.
- (b) Class P2..... not more than 6%.
- (c) Class P3.....not more than 0.05%.

The test shall be performed at the flow rate required for the inhalation resistance test for the particular class of filter (see Clauses 4.3.4 and 5.4.4).

When a single filter of a twin filter respirator is tested separately, the air flow specified for this test shall be halved. If it is possible that the single filter may be used in a single filter respirator, then the full airflow shall be used.

NOTE: Having established compliance with the Standard by the above method, manufacturers may use an alternative test method for production control purposes. Either the method described in BS 2577 or an oil mist test may be used provided that the penetration equivalence to the sodium chloride aerosol of the chosen method has been demonstrated for the same type of filter.

4.3.6 Filters used in series

Where a separate particulate filter is used in series with any other filter, the particulate penetration shall be tested in the combined configuration in accordance with Clause 4.3.5.

SECTION 5 GAS AND VAPOUR FILTER RESPIRATORS

5.1 DESIGN AND CONSTRUCTION

The design and construction of a gas filter shall be such that, when combined with the designated facepiece, head covering or filter holder, the complete respirator shall provide protection in accordance with one or more of the types and classes of filters given in this Section. The respirator shall be designed so that all the inhaled air passes through one or more filters.

Gas filter respirators shall comply with Sections 2, 3 and 12 as appropriate. The filter shall comply with Clause 5.4.

5.2 TYPES OF FILTER

Each filter type shall be designated by a letter or chemical abbreviation indicative of the substance or group of substances against which protection is intended. A class number indicates the level of absorption capacity. If a filter is a combination of types, it shall meet the requirements of each type separately.

The designation of filter type shall comply with one or a combination of the following:

Type A	— for use against certain organic gases and vapours as specified by the manufacturer.
Type B	— for use against certain inorganic gases and vapours as specified by the manufacturer (excluding carbon monoxide).
Type E	— for use against sulfur dioxide and other acid gases and vapours as specified by the manufacturer.
Type G	— for use against certain organic compounds with vapour pressures less than 1.3 Pa (0.01 mm Hg) at 25°C as specified by the manufacturer. These filters shall have an integral particulate filter with an efficiency at least equivalent to that of a P1 filter.
Type K	— for use against ammonia and organic ammonia derivatives as specified by the manufacturer.
Type AX	— for use against low boiling point organic compounds as specified by the manufacturer (boiling point less than 65°C).
Type NO	— for use against oxides of nitrogen.
Type Hg	— for use against metallic mercury.
Type MB	— for use against methyl bromide.
Specific Chemical Type	— for use against one or more specific chemicals not falling into any of the above type descriptions. The filter is identified by the name of that chemical. Additional particulate filtration may be provided.

5.3 CLASSIFICATION AND COMPONENT PARTS

5.3.1 Classes of filter

Filters shall be classified in one of the following:

Class AUS—low absorption capacity filters.

Class 1—low to medium absorption capacity filters.

Class 2—medium absorption capacity filters.

Class 3—high absorption capacity filters.

5.3.2 Component parts

The respirator shall include a gas filter complying with the appropriate requirements of Clause 5.4.

It may also incorporate—

- (a) a full or half facepiece, or a head covering or mouthpiece held securely in position by a head harness;
- (b) an exhalation valve or exhalation valve assembly;
- (c) an inhalation valve or inhalation valve assembly;
- (d) one or more filter holders;
- (e) one or more flexible breathing tubes;
- (f) belt or harness to attach the filter (or filters) to the wearer's body; and
- (g) a particulate filter complying with Clause 4.3.

Where the use of the apparatus is intended solely for escape, either a hood or a mouthpiece and nose clip may be incorporated in place of a facepiece (see Section 7).

5.4 PERFORMANCE REQUIREMENTS

5.4.1 General

Performance requirements shall apply to the whole filter(s) and inhalation valve assembly, where applicable, including all the parts through which the inhaled air passes. Tests shall be carried out in the sequence of Clauses 5.4.3, 5.4.4 and 5.4.5.

5.4.2 Particulate filtration efficiency

If a gas filter is combined with a particulate filter, the combined filter shall meet the penetration requirement for the particulate filter (see Clause 4.3.5) in addition to the requirements of Clauses 5.4.4 and 5.4.5.

Type G filters and HgAUSP1 shall meet the requirements of Type P1 filters. HgP3 filters shall meet the requirements of Type P3 filters.

Type NO filters shall meet the requirements of Type P3 filters.

5.4.3 Simulated rough usage

Before testing TIL, inhalation resistance and filtering capacity, all filters enclosed in separate rigid containers shall be subjected to simulated rough usage in accordance with Appendix H.

At the conclusion of the test, filters shall show no visible deterioration and, when tested for inhalation resistance and filtering capacity, shall comply with relevant requirements.

Filters and filter elements not supplied in rigid containers shall be subjected to the rough usage test in the packaging in which they are offered for sale.

5.4.4 Inhalation resistance—Gas and vapour filter respirators

Filter resistance criteria requirements are as follows:

- (a) Class AUS and Type G filters.

When tested in accordance with Appendix G, at a continuous airflow rate of 85 ± 2 L/min, the resistance imposed by the respirator filter assembly shall not exceed 500 Pa (50 mm H₂O).

- (b) Classes 1, 2 and 3 filters.

When tested in accordance with Appendix G, at continuous airflow rates of 30 ± 1 L/min and 95 ± 2 L/min, the resistance imposed by the respirator assembly shall not exceed the values in Table 5.1.

TABLE 5.1
MAXIMUM INHALATION RESISTANCE

Filter class types A, B, E and K	Filter assembly only maximum resistance, Pa*		Assembled respirator maximum resistance, Pa*	
	At 30 ± 1 L/min	At 95 ± 2 L/min	At 30 ± 1 L/min	At 95 ± 2 L/min
1-	100	400	150	530
1-P1	160	610	210	740
1-P2	170	640	220	770
1-P3	220	820	270	950
2-	140	560	190	690
2-P1	200	770	250	900
2-P2	210	800	260	930
2-P3	260	980	310	1130
3-	160	640	210	790
3-P1	220	850	270	1000
3-P2	230	880	280	1030
3-P3	280	1060	330	1210
Special types				
NO-P3	260	980	310	1130
HG-P3	260	980	310	1130
AX	140	560	190	690
AX-P1	200	770	250	900
AX-P2	210	800	260	930
AX-P3	260	980	310	1130

* 1 mbar = 100 Pa = 10 mm H₂O

Where a combination of particulate and gas/vapour filters are in use, the total inhalation resistance shall not exceed that specified above for the appropriate class of filter.

When a single filter of a twin filter respirator is tested separately, the airflow specified for a test shall be halved. If, however, it is possible that the single filter may be used alone, the full airflow shall be used. Where a particulate filter is combined with a gas filter, the inhalation resistance of the gas filter shall apply.

NOTE: This test is not applicable to filters used in powered air-purifying respirators.

5.4.5 Filter capacity

When tested for filter capacity, filters shall comply with the appropriate breakthrough conditions given in Tables 5.2 or 5.3. Assessment of each filter type shall require the testing of not less than three filters. The performance requirements shall apply to the filter or filters and inhalation valve assembly where applicable and include all components through which the air passes.

When a single filter of a twin filter respirator is tested separately, the airflow specified for a test shall be halved. If, however, it is possible that a single filter may be used alone, then the full airflow shall be used.

The conditions of test shall comply with the following:

- (a) The tolerance on test gas concentration shall be $\pm 10\%$ at atmospheric pressure.
- (b) The test gas shall be passed through the filter at a continuous flow of 30 ± 1 L/min.
- (c) The relative humidity (RH) shall be $70 \pm 5\%$.
- (d) The test temperature shall be $23 \pm 3^\circ\text{C}$.
- (e) For each test gas, a new corresponding filter shall be used. Type B1, Type B2 and Type B3 filters shall be tested with the three nominated gases.

Methods of test for breakthrough times shall be chosen so that the accuracy of detection is within 20% of the allowable breakthrough concentration. The method used may be infrared absorption spectroscopy, gas chromatography, colorimetry or some other method as stipulated by the approving authority. If colorimetric methods are used, they shall be calibrated with reference to the allowable breakthrough concentration.

Where the average test gas concentration used is not that specified in Table 5.2, the recorded breakthrough time shall be adjusted by simple proportion.

TABLE 5.2
NON-POWERED RESPIRATORS—GAS AND VAPOUR
FILTER CAPACITY

Type	Class	Test gas or vapour	Test gas concentration p.p.m. by volume	Breakthrough conditions	
				Breakthrough concentration p.p.m. by volume	Minimum life min
A	AUS	Cyclohexane (C ₆ H ₁₂)	1000	5	20
A	1	Cyclohexane (C ₆ H ₁₂)	1000	10	70
A	2	Cyclohexane (C ₆ H ₁₂)	5000	10	35
A	3	Cyclohexane (C ₆ H ₁₂)	8000	10	65
B	AUS	Chlorine (Cl ₂)	1000	0.5	20
B	1	Chlorine (Cl ₂)	1000	0.5	20
		Hydrogen sulfide (H ₂ S)	1000	10	40
		Hydrogen cyanide (HCN)	1000	10	25
B	2	Chlorine (Cl ₂)	5000	0.5	20
		Hydrogen sulfide (H ₂ S)	5000	10	40
		Hydrogen cyanide (HCN)	5000	10	25
B	3	Chlorine (Cl ₂)	10 000	0.5	30
		Hydrogen sulfide (H ₂ S)	10 000	10	60
		Hydrogen cyanide (HCN)	10 000	10	35
E	1	Sulfur dioxide (SO ₂)	1000	5	20
E	2	Sulfur dioxide (SO ₂)	5000	5	20
E	3	Sulfur dioxide (SO ₂)	10 000	5	30
G	—	Cyclohexane (C ₆ H ₁₂)	50	5	15
K	1	Ammonia (NH ₃)	1000	25	50
K	2	Ammonia (NH ₃)	5000	25	40
K	3	Ammonia (NH ₃)	10 000	25	60
AX	—	Dimethyl ether (CH ₃ OCH ₃)	500	2	50
		Isobutane (i-C ₄ H ₁₀)	2500	5	50
NO	—	Nitric oxide (NO)	2500	5	20
		Nitrogen dioxide (NO ₂)	2500	5	20
MB	2	Methylbromide (CH ₃ Br)	5000	5	30
	3	Methylbromide (CH ₃ Br)	10 000	5	30

NOTE: See Clause 1.7 for conversion of gas concentrations from p.p.m. to mg/m³.

5.4.6 Additional requirements for filters

As well as the requirements of Table 5.2 or Table 5.3, the following shall apply:

- For Type NO filters, the total concentration of NO + NO₂ shall not exceed 5 p.p.m. (by volume) at breakthrough.
NOTE: Both NO and NO₂ may be present in the effluent air.
- Where hydrogen cyanide is the test gas, the total air concentration of C₂N₂ plus HCN shall not exceed 10 p.p.m. (by volume) at breakthrough.
- Cyanogen, C₂N₂ may also be present in the effluent air.

TABLE 5.3
NON-POWERED RESPIRATORS—VAPOUR FILTER CAPACITY

Type	Particulate filter class	Test vapour	Test vapour concentration mg/m ³	Breakthrough conditions	
				Breakthrough concentration mg/m ³	Minimum life mg/m ³
Hg	AUSP1	Hg	1.0	0.05	500
Hg	P3	Hg	13.0	0.1	6000

5.4.7 Desorption

Type AX filters and specific chemical type filters where the organic compound has a boiling point of less than 65°C shall be tested for desorption.

NOTE: The purpose of this test is to ensure that the test medium does not release adsorbed gases with respect to time.

Where the filter is marked 'SINGLE USE ONLY', compliance with this test is not required.

The test procedure shall be as follows:

- Each of three fresh filters shall be loaded with the appropriate test gas for a period equal to half the minimum life given in Table 5.2. The test conditions given in Clause 5.4.5 shall apply.
- Seal and store the loaded filters at approximately 20°C for a period of 3 ±1 days.
- Pass clean air at a rate of 30 ±1 L/m, and at 70 ±5% RH and 23 ±3°C, through the filter for a period of 2 h.
- During this period, the test gas in the effluent air shall not exceed the breakthrough concentrations given in Table 5.2.

SECTION 6 POWERED AIR - PURIFYING RESPIRATORS

6.1 DESIGN AND CONSTRUCTION

The design and construction of the respirator shall be such that the complete assembly will provide protection in accordance with its type and filter capacity against airborne contaminants, either particulate or gaseous or both.

Powered air-purifying respirators shall comply with Sections 2, 3, 4, 5 and 12 as appropriate, in addition to the provisions of this Section.

The respirator shall—

- (a) provide the wearer with filtered air for not less than the defined period;
- (b) provide a positive air pressure in the wearer's breathing zone so as to minimize the entry of unfiltered air;
- (c) when fitted with a half facepiece or full facepiece, provide an adequate seal which will minimize entry of the ambient atmosphere; and
- (d) permit the component parts likely to require service to be readily detached for maintenance and cleaning but be secure against accidental disconnection.

Where the respirator incorporates an integral power supply, it should be easily portable on the wearer's person, including a separate battery pack, where appropriate. If not incorporating an integral power supply, the respirator should be provided with facilities which—

- (i) permit easy connection/disconnection to an external power supply of less than 30 V; and
- (ii) where polarity of supply is important, prevent reversal of power supply connections.

6.2 COMPONENTS

6.2.1 Facepiece type

The apparatus normally consists of—

- (a) a full facepiece or a half facepiece held securely in position by a head harness;
- (b) an exhalation valve or valves;
- (c) where required, a flexible breathing tube;
- (d) where required, a powered filtering unit comprising—
 - (i) a filter or filters;
 - (ii) where required, a filter holder or holders;
 - (iii) a blower unit;
 - (iv) a battery pack, or a means of connection to an external power supply, as appropriate; and
- (e) where required, a waist belt or body harness.

6.2.2 Hood or helmet type

The apparatus normally consists of—

- (a) a head covering;
- (b) a means of diffusing the air entering the hood or helmet;
- (c) a powered filtering unit comprising—
 - (i) a filter or filters;
 - (ii) where required, a filter holder or holders;
 - (iii) a blower unit;
 - (iv) a battery pack, or a means of connection to an external power supply, as appropriate;
- (d) where required, a shoulder cape or jacket with or without sleeves, which may extend to the waist;
- (e) where required, a flexible breathing tube;
- (f) where required, an inner bib; and
- (g) where required, a waist belt or body harness.

6.3 PERFORMANCE REQUIREMENTS

6.3.1 Battery

Where the respirator incorporates an integral power supply, the battery shall be of the non-spillable type and, unless of a sealed type, shall incorporate a safe venting device. Operational battery life shall be sufficient for respirators to comply with Clause 3.2.3.

All powered air-purifying respirators incorporating a battery pack shall be tested in accordance with Appendix Q, to determine both their initial flow rate and the flow rate provided without replacement of the battery for manufacturer's stated design duration which shall not be less than 4 h. At the completion of the test, the PAPR shall continue to meet requirement for positive pressure in accordance with Clause 3.2.3.

Means shall be provided to enable the wearer of the hood or helmet to confirm the receipt of an airflow sufficient to maintain a positive pressure inside the helmet.

NOTE: Care should be taken to ensure that the method of measurement does not substantially alter the flow through powered units.

6.3.2 Particulate filters

Particulate filters used with a PAPR when tested in accordance with Appendix I shall not show penetrations in excess of those given below. Each filter shall be tested at the flow rate of the respirator when fitted with a fully charged battery (measure after 30 minutes running time). When a PAPR has more than one filter connected in parallel, each filter shall be tested at the calculated average flow rate passing through it.

- (a) Class PAPR-P1 not more than 5%.
- (b) Class PAPR-P2 not more than 1%.
- (c) Class PAPR-P3 not more than 0.05%.

6.3.3 Gas filters

Gas filters used with a PAPR shall comply with either Class 1, 2 or 3 as given in Table 5.2 when tested at the average flow rate measured through the filter in the PAPR unit when it is operating at the flow rate of the respirator as measured in Appendix Q.

NOTE: The high airflow through the filter of the PAPR requires that the filter has greater capacity to achieve adequate time of protection.

Alternatively, the following equation may be used to convert the breakthrough time achieved under other test conditions to an equivalent breakthrough time which would be achieved if the filter were tested at the average flow rate measured when attached to a PAPR operating at full capacity:

$$\alpha = \frac{\Omega \times \beta \times \delta}{\gamma}$$

where

α = absorption time (min) used to calculate equivalence to class in Table 5.2

Ω = test flow rate, in L/min

β = experimental minimum absorption time, in minutes

δ = number of filters used in the system

γ = average total airflow of PAPR, in L/min (see Clause 6.3.1 and Appendix Q)

Example:

β = 50 min when tested at A2 filter conditions

γ = 150 L/min

δ = 3

Ω = 30 L/min

$\alpha = \frac{30 \times 50 \times 3}{150} = 30 \text{ min}$

Therefore the value obtained may be used to show that an A2 (non-PAPR) filter giving a breakthrough time of 50 min under standard flow-rate conditions, when used in a PAPR incorporating three A2 filters, would provide a breakthrough time of 30 min. Therefore, this system would have a lower capacity than a single A2 filter used in a non-powered air-purifying respirator, and the filter system must be classed as PAPR-A1.

With demand type flow-control powered air-purifying respirators, the calculation of minimum life may be determined by using the average flow rate through the filter system when measured using a breathing machine as specified in Paragraph E4(a) of Appendix E.

6.3.4 Combined filters

Gas filters with either an integral or detachable particulate filter shall comply with both the requirements of Clauses 6.3.2 and 6.3.3. Coarse dust pre-filters intended to prolong filter life are exempt from this requirement.

SECTION 7 ESCAPE RESPIRATORS — FILTRATION TYPE

7.1 DESIGN AND CONSTRUCTION

The design and construction of an escape respirator of the filtration type shall be such that when the filter is combined or incorporated with the appropriate facepiece or head covering it shall provide protection in an emergency against a specific hazard.

This Section does not refer to routine work and rescue respirators which are covered in Sections 5, 6, 9 and 10.

The unit shall be designed so that all inhaled air passes through the filter.

Filtration type escape respirators shall comply with Sections 2, 3, 4, 5 and 12, as appropriate, in addition to this Section.

7.2 CLASSIFICATION

Filtration type escape respirators are classified as follows:

- (a) *Filter self-rescuer (mines)* For self-rescue from carbon monoxide and combustion products released in an explosion or underground fire.
- (b) *Smoke mask* For self-rescue from combustion products in other than underground mine fires.
- (c) *Filter self-rescuer (industrial)* For self-rescue from specified gases accidentally released in an industrial or laboratory situation.

7.3 FILTER SELF-RESCUER (MINES)

7.3.1 Components

The apparatus normally consists of the following components:

- (a) An airtight case with carrying attachment.
- (b) A mouthpiece and nose clip.
- (c) A suitable head harness.
- (d) An active element.
- (e) A chin guard.
- (f) An exhalation valve or exhalation valve assembly.
- (g) A heat exchanger.

It may also incorporate—

- (i) a saliva trap; and
- (ii) an inlet valve or inlet valve assembly.

Metals for exposed parts shall be chosen in accordance with the requirements of Clause 2.1.8.

7.3.2 Carrying case

7.3.2.1 General

The carrying case shall be compact, lightweight and of airtight construction and shall be fitted with a carrying attachment.

The case and a carrying attachment shall be adequately protected against corrosion and damage in underground atmospheres and working conditions.

7.3.2.2 Fit with active element

The case shall be designed to be a close fit around the active element to prevent movement within the case. The design shall be such as to enable the active element to be easily withdrawn from the case and donned in difficult conditions, such as in darkness and restricted space. The active element shall be packed so that if damage to the case prevents complete withdrawal, it shall still be possible to use the respirator.

7.3.2.3 Seal

The device which provides the airtight seal shall be constructed so that the seal can be rapidly broken without the use of special tools, but be secure against accidental opening. Where the seal has been broken, this shall be obvious by visual inspection.

7.3.3 Mouthpiece and nose clip

The mouthpiece and nose clip shall be designed in accordance with Clause 3.1.3.

7.3.4 Head harness

The head harness shall, by its design, achieve the intent of Clause 3.1.1(b).

7.3.5 Active element

The filter shall normally consist of—

- (a) an external detachable coarse particulate filter;
- (b) a particulate filter on the inlet and outlet sides of the element;
- (c) an absorbent to remove atmospheric contaminants including moisture, other than carbon monoxide, which may have an adverse effect on the catalyst;
- (d) a catalyst or some other means for converting carbon monoxide in dry air to carbon dioxide; and
- (e) a metal housing.

7.3.6 Chin guard

A chin guard shall normally be provided to protect the wearer's chin from heat generated by the equipment.

7.3.7 Exhalation valve

The design of the exhalation valve shall comply with Clause 3.1.2.

7.3.8 Heat exchanger

The heat exchanger shall be fitted between the active element and the mouthpiece. It shall be so constructed that when in use, it absorbs heat from the inhaled mixture and releases heat to the exhaled mixture.

7.3.9 Mass

The mass of the complete apparatus should not exceed 1200 g.

7.3.10 Performance requirements

7.3.10.1 *Water immersion*

Before testing for breathing resistance and filter efficiency, the self-rescuer shall be subject to water immersion as described in Paragraph H6.3, of Appendix H.

At the conclusion of the test, the self-rescuer shall not increase more than 5 g in mass.

7.3.10.2 *Breathing resistance*

During the simulated breathing tests described in Paragraph E5.1 of Appendix E—

- (a) the inhalation resistance shall not exceed 900 Pa; and
- (b) the exhalation resistance shall not exceed 200 Pa.

7.3.10.3 *Carbon monoxide filtering efficiency*

During the simulated breathing test described in Paragraph E5.1 of Appendix E in an atmosphere of 0.25% by volume of carbon monoxide—

- (a) the total volume of carbon monoxide passing through the active element during the period of test shall not exceed 400 mL; and
- (b) at no time during the test shall the concentration of carbon monoxide exceed 400 p.p.m. (by volume).

7.3.10.4 *Temperature of purified air*

During the simulated breathing test described in Paragraph E5.2 of Appendix E in an atmosphere of 1.5% by volume of carbon monoxide, the temperature of the air at or in the mouthpiece shall not exceed 90°C.

7.3.10.5 *Powdered chemicals*

After testing to Paragraphs H6.1 and H6.2 of Appendix H, a complete apparatus shall be dismantled, examined and the migration of any powdered chemical shall be noted.

7.3.10.6 *Assembled respirator test*

The apparatus shall be tested and assessed in accordance with Appendix J.

While carrying out the test procedure, none of the wearers shall experience any undue discomfort or impairment of efficiency on account of fit, the functioning of the filter, or any other feature of the apparatus.

7.4 SMOKE MASK

7.4.1 Components

The respirator normally consists of the following component parts:

- (a) A head covering which may incorporate a half facepiece.
- (b) A filter or filters.

It may also incorporate inhalation or exhalation valves or both.

7.4.2 Performance requirements

7.4.2.1 *Water immersion*

After being subjected to simulated rough usage in accordance with Paragraphs H6.1, H6.2 and H6.3 of Appendix H, the mass of the respirator shall not have increased by more than 1%.

This test shall be carried out on the smallest container that is intended to be hermetically sealed.

7.4.2.2 Inhalation resistance

After being assessed for resistance to water immersion as described in Clause 7.4.2.1, the breathing resistance shall be determined in accordance with Appendix G, with a continuous stream of air at 85 ± 1.0 L/min. The inhalation resistance shall not exceed 800 Pa and the exhalation resistance 300 Pa.

7.4.2.3 Temperature of purified air

After being assessed for resistance to water immersion as in Clause 7.4.2.1, the respirator shall be tested in accordance with Paragraph E5.2 of Appendix E. The inhaled air temperature, wet bulb, shall not exceed 50°C and, if the air is dry (i.e. less than 5% RH), the inhaled air temperature (dry bulb) shall not exceed 90°C. The carbon dioxide content of the inhaled air shall not exceed 3% by volume.

7.4.2.4 Gas filter efficiency

After being assessed for inhalation resistance in accordance with Clause 7.4.2.2, the filter efficiency shall be tested using a test gas flow rate of 30 ± 1.0 L/min and this shall comply with the appropriate conditions in Table 7.1. A separate filter shall be used for each test gas.

Where HCN is the test gas, C_2N_2 may also be present in the effluent air. The total air concentration of C_2N_2 plus HCN shall not exceed 10 p.p.m. (by volume) at breakthrough.

TABLE 7.1
SMOKE MASK GAS FILTRATION

Test gas	Chemical symbol	Test gas concentration p.p.m.	Breakthrough concentration p.p.m.	Minimum life min
Carbon monoxide	CO	2500	250	15
Hydrogen chloride	HCl	1000	5	15
Hydrogen cyanide	HCN	400	10	15
Acrylaldehyde (2-propenal)	CH ₂ CHCHO	100	0.5	15

7.4.2.5 Particulate filter penetration

After being assessed for resistance in accordance with Clause 7.4.2.2, the filter penetration shall not exceed 6% when tested in accordance with Appendix I.

7.4.2.6 Total inward leakage test

When tested in accordance with Appendix D, the hood shall meet the requirements of Table 2.1 (Class P2).

7.4.2.7 Flammability

When tested in accordance with Appendix C, the materials used in the escape respirator shall maintain their structural integrity and shall not continue to burn.

7.5 FILTER SELF-RESCUER (INDUSTRIAL)

The components of the respirator shall normally include—

- a head covering or facepiece covering eyes, nose and mouth, or a mouthpiece and nose clip; and
- a gas filter or filters complying with Clause 5.4 and Table 5.1 for Class 1, 2 or 3 capacity filters.

Where the filter is claimed to comply with more than one filter type each filter shall be of the same class.

The respirator may also incorporate—

- (i) an exhalation valve or exhalation valve assembly;
- (ii) an inhalation valve or inhalation valve assembly;
- (iii) one or more filter holders;
- (iv) one or more flexible breathing tubes;
- (v) a belt or harness to attach the filter or filters to the wearer's body; and
- (vi) a particulate filter or filters complying with Clause 4.3.5.

The filter self-rescuer (industrial) may be suitable for use in atmospheres containing certain gases, when specified by the manufacturer.

SECTION 8 AIR - HOSE AND AIR - LINE RESPIRATORS

8.1 DESIGN AND CONSTRUCTION

8.1.1 General

Air-hose and air-line respirators shall provide the wearer with air when connected to a clean air supply (air-hose) or attached to a compressed air supply (air-line).

In addition to this Section, air-hose and air-line respirators shall also comply with the appropriate requirements of Sections 2, 3 and 12.

8.1.2 Types

8.1.2.1 General

The main types of air-hose and air-line respirators are classified according to the pressure of the air supplied as follows:

- (a) Air-hose respirator systems which transport air at near atmospheric pressure.
- (b) Air-line respirator systems which transport pressurized air and have demand valves or regulators in proximity to the facepiece so that air breathed is at near atmospheric pressure.

NOTE: Volumetric flow rates given in this Section are measured at atmospheric pressure unless otherwise noted.

8.1.2.2 Air-hose respirator types

There are two types of air-hose respirator which are distinguished by the method of air supply, as follows:

- (a) Natural breathing type—these are known as hose masks; they may have a manually-operated blower.
- (b) Electrically-operated air blower type.

Different types of facepiece may be utilized with air-hose respirators. These are as follows:

- (i) Natural breathing type—full facepiece only.
- (ii) Electrically-operated air blower type with—
 - (A) full facepiece;
 - (B) half facepiece; or
 - (C) head covering.

8.1.2.3 Air-line respirator types

There are two types of air-line respirator which are distinguished by the mode of air supply, as follows:

- (a) Continuous flow type, where a positive pressure is provided by a continuous supply of air into the wearer's breathing zone.
- (b) Demand flow type, with either a negative or positive pressure demand valve. There is a negative pressure during inhalation or a reduced positive pressure at the commencement of inhalation which serves to operate the demand valve and admit air at positive pressure.

Continuous flow type air-line respirators may be used with a half facepiece, full facepiece, or head covering. Demand flow types may also be used with a half or full facepiece. Demand flow types shall not be used with a head covering.

8.1.2.4 *Air-line respirators combined with SCBA*

Where a SCBA is used with an air-line respirator (for example to provide 'come home' facilities) the requirements of Section 9 shall apply to the system. In addition the system including the air-line respirator, SCBA and air-line shall be configured so that the operation of the SCBA is not affected should the air-line be cut or become disconnected from the supply or air-line respirator.

8.1.3 Components

8.1.3.1 *General*

Where respirator parts are required by this Clause, each part shall meet the requirements for that part noted below or elsewhere in this Standard.

All respirators covered by this Section shall normally consist of the following parts:

- (a) A flexible breathing tube connecting the facepiece to the air-hose or air-line.
- (b) A waist belt or body harness.
- (c) An air-hose or air-line.

8.1.3.2 *Specific components for air-hose respirators—Natural breathing type*

In addition to the requirements of Clause 8.1.3.1 the respirator shall normally include the following:

- (a) A full facepiece.
- (b) An exhalation valve.
- (c) An inlet valve.
- (d) A strainer and hose anchoring attachment where a blower is not fitted.

NOTE: The respirator may also incorporate a manually-operated blower.

8.1.3.3 *Specific components for air-hose respirators—Electrically operated blower type*

In addition to the requirements of Clause 8.1.3.1, the respirator normally includes the following components:

- (a) A full facepiece, half facepiece or head covering.
- (b) An exhalation valve for full facepiece and half facepiece types.
- (c) An electrically-operated blower.
- (d) A hose assembly.

A respirator fitted with a head covering may also incorporate a shoulder cape, protective suit or jacket or inner bib.

Where a respirator fitted with a headcovering is employed in the course of sand or abrasive blasting it shall be fitted with a cape covering the shoulders and upper part of the chest.

8.1.3.4 *Specific components for air-line respirators*

In addition to the requirements of Clause 8.1.3.1, the respirator normally includes the following components:

- (a) A full facepiece, half facepiece or head covering.
- (b) An exhalation valve for full facepiece and half facepiece types.
- (c) A means of diffusing the air entering the head covering.