AS/NZS 1716:2012

Australian/New Zealand Standard™

Respiratory protective devices

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee SF-010, Occupational Respiratory Protection. It was approved on behalf of the Council of Standards Australia on 23 January 2012 and on behalf of the Council of Standards New Zealand on 24 January 2012.
This Standard was published on 13 February 2012.

The following are represented on Committee SF-010:

Accident Compensation Corporation, New Zealand
Association of Accredited Certification Bodies
Australasian Fire and Emergency Service Authorities Council
Australian Aluminium Council
Australian Chamber of Commerce and Industry
Australian Council of Trade Unions
Australian Industry Group
Australian Institute of Occupational Hygienists
Australian Institute of Petroleum
Australian Mines and Metals Association
Business New Zealand
Composites Australia
Department of Defence, Australia
Department of Labour New Zealand
Department of Primary Industries, NSW
Energy Networks Association, Australia
Hyperbaric Engineering Industry Forum
Independent Chairperson
NSW Department of Primary Industries
NSW Mines Rescue
Queensland Mines Rescue Brigade
Safety Institute of Australia
Sydney Water Corporation
TestSafe Australia
The University of New South Wales
United Firefighters Union of Australia
WorkCover New South Wales
WorkSafe Victoria

Keeping Standards up-to-date

Standards are living documents which reflect progress in science, technology and systems. To maintain their currency, all Standards are periodically reviewed, and new editions are published. Between editions, amendments may be issued. Standards may also be withdrawn. It is important that readers assure themselves they are using a current Standard, which should include any amendments which may have been published since the Standard was purchased.

Detailed information about joint Australian/New Zealand Standards can be found by visiting the Standards Web Shop at www.saiglobal.com.au or Standards New Zealand web site at www.standards.co.nz and looking up the relevant Standard in the on-line catalogue.

For more frequent listings or notification of revisions, amendments and withdrawals, Standards Australia and Standards New Zealand offer a number of update options. For information about these services, users should contact their respective national Standards organization.

We also welcome suggestions for improvement in our Standards, and especially encourage readers to notify us immediately of any apparent inaccuracies or ambiguities. Please address your comments to the Chief Executive of either Standards Australia or Standards New Zealand at the address shown on the back cover.

This Standard was issued in draft form for comment as DR AS/NZS 1716.

Australian/New Zealand Standard™

Respiratory protective devices

Originated in Australia as AS Z18—1963.
Originated in New Zealand as part of NZS 1568:1961.
Previous edition AS/NZS 1716:2003.
Seventh edition 2012.

Jointly published by SAI Global Limited under licence from Standards Australia Limited, GPO Box 476, Sydney, NSW 2001 and by Standards New Zealand, Private Bag 2439, Wellington 6140.

ISBN 978 1 74342 024 9

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.

CONTENTS

Page

Page

Page

APPENDICES

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard
Respiratory protective devices

S E C T I O N 1 S C O P E A N D G E N E R A L

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 (KO_2) 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 ±5%.

Unless otherwise specified, temperature limits in this Standard shall be subject to a tolerance of ±1°C.

Unless otherwise specified, the ambient temperature for testing shall be 23 ±3°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:

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

where

24.45 = molar volume in litres at 25°C and 101.3 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 warming 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 HARNESSES

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 orinasal 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 H_2O) shall be maintained in the space enclosed by the facepiece or head covering, except inn 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 negatives 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 H_2O

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 filer 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 H_20).

(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 H_2O

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 ±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 ±5%.

(d) The test temperature shall be 23 ±3°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	Breakthrough conditions	
				Breakthrough concentration	Minimum life
			p.p.m. by volume	p.p.m. by volume	min
A	AUS	Cyclohexane (C_6H_{12})	1000	5	20
A	1	Cyclohexane (C_6H_{12})	1000	10	70
A	2	Cyclohexane (C_6H_{12})	5000	10	35
A	3	Cyclohexane (C_6H_{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_2S)	1000	10	40
		Hydrogen cyanide (HCN)	1000	10	25
B	2	Chlorine (Cl_2)	5000	0.5	20
		Hydrogen sulfide (H_2S)	5000	10	40
		Hydrogen cyanide (HCN)	5000	10	25
B	3	Chlorine (Cl_2)	10 000	0.5	30
		Hydrogen sulfide (H_2S)	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_6H_{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_3OCH_3)	500	2	50
		Isobutane (i-C_4H_{10})	2500	5	50
NO	—	Nitric oxide (NO)	2500	5	20
		Nitrogen dioxide (NO_2)	2500	5	20
MB	2	Methylbromide (CH_3Br)	5000	5	30
	3	Methylbromide (CH_3Br)	10 000	5	30

NOTE: See Clause 1.7 for conversion of gas concentrations from p.p.m. to mg/m^3.

5.4.6 Additional requirements for filters

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

(a) For Type NO filters, the total concentration of NO + NO_2 shall not exceed 5 p.p.m. (by volume) at breakthrough.

NOTE: Both NO and NO_2 may be present in the effluent air.

(b) Where hydrogen cyanide is the test gas, the total air concentration of C_2N_2 plus HCN shall not exceed 10 p.p.m. (by volume) at breakthrough.

(c) Cyanogen, C_2N_2 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	Breakthrough conditions	
				Breakthrough concentration	Minimum life
			mg/m^3	mg/m^3	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:

(a) 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.

(b) Seal and store the loaded filters at approximately 20°C for a period of 3 ±1 days.

(c) 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.

(d) 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_2CHCHO	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) a head covering or facepiece covering eyes, nose and mouth, or a mouthpiece and nose clip; and

(b) 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.

(d) A regulating device or demand valve. For head covering types, a regulating device only.

(e) An air-line assembly with couplings.

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 head covering is employed in the course of abrasive blasting, it shall be fitted with a cape covering the shoulders and upper part of the chest.

8.1.4 Air-line respirator auxiliary air supply

Where provision is made for air-line respirators to be provided with a self-contained air-supply, the device shall be provided with means to automatically maintain integrity of the air supply to the user. An ancillary device such as a waist belt and a junction block may be used in the system.

8.2 WAIST BELT OR BODY HARNESS

The waist belt or body harness shall be designed so that it causes no undue discomfort or limitation of movement to the wearer. The drag of the trailing air-hose or air-line shall be borne solely by the waist belt or body harness and there shall be no drag on the breathing tube, facepiece or head covering.

The attachment or clip connecting the air-hose or air-line to the waist belt or body harness shall be so designed and constructed that, whatever the direction of pull, the hose or air-line is not damaged nor is the air supply reduced. The waist belt or body harness with couplings and continuous flow valve (if present) is secured to a dummy torso in an upright position. The air supply tube shall be capable of withstanding a steady pull to air supply hose in the direction of its axis.

(a) The air supply hose, couplings and continuous flow valve (if present) shall not separate from the couplings when so tested.

(b) When an air-line is supplying air at the manufacturer’s maximum recommended working pressure it shall not show any sign of mechanical failure or leakage.

8.3 AIR-HOSE AND AIR-LINE

8.3.1 General

The air-hose or air-line shall be flexible and resistant to kinking.

8.3.2 Strainer

For natural breathing type air-hose respirators, the air-hose shall be fitted with a strainer at the inlet end. It should be capable of excluding debris and be designed so that complete blockage of the strainer cannot occur. Provision shall be made for securely anchoring the inlet end of the air-hose and strainer outside the contaminated atmosphere.

8.3.3 Air-line

The air-line shall be rated at not less than twice the maximum working pressure of the air supply.

8.3.4 Connectors and couplings

All connectors and couplings on air-line respirator systems should be designed so that it is not possible to connect a low pressure (near atmospheric) breathing tube directly to a higher pressure part of the circuit, without passing through a regulator. All air-line connectors shall be of ‘safety type’, i.e. requiring at least two deliberate actions to separate the connector or coupling.

8.4 PERFORMANCE REQUIREMENTS

8.4.1 Application of tests

Not less than two of each type of respirator shall be submitted for test and shall comply with the requirements specified in this Clause.

8.4.2 Demand valve

The design and mode of operation of demand valves shall comply with Clause 2.4.

NOTE: Hazards can arise from incorrect combinations of facepieces and demand valves, e.g. negative pressure demand valves with positive pressure facepieces. Accordingly, precautions should be taken to prevent this possibility, e.g. non-interchangeability of different designs of demand valve.

8.4.3 Air supply

8.4.3.1 *Air-hose respirators*

For manually-operated blower type air-hose respirators, the blower shall be capable of delivering air to the space enclosed by the facepiece at a flow rate of at least 85 L/min. For electrically-operated blower type air-hose respirators, the blower shall be capable of delivering air to the space enclosed by the respirators so that the requirement of Clause 3.2.3 are met with the regulating device adjusted to both its maximum and minimum flow rates.

8.4.3.2 *Air-line respirators*

The minimum air supply to continuous flow air-line respirators shall be capable of delivering air to the space enclosed by the respirators in accordance with Clause 3.2.3 at the manufacturer's recommended minimum supply pressure. The pressure shall be measured at the end of the maximum length of air-line recommended by the manufacturer, i.e. at the end connecting to the respirator. If a flow valve is provided, the above requirement shall be met with the valve fully closed. See also Clause 11.2.2(f).

8.4.3.3 *Air-line respirators—Negative demand flow types*

Negative demand valves shall not be used in air-line respirators.

8.4.4 Breathing resistance

8.4.4.1 *Air-hose respirators—Natural breathing type*

Coil half the air-hose around a drum of 500 mm diameter. When subjected to a continuous stream of air at a flow rate of 86 ±2 L/min in accordance with Appendix G, the dynamic inhalation resistance of the assembly shall not exceed—

(a) 750 Pa for natural breathing devices; and

(b) 1500 Pa for natural breathing, blower-assisted devices (blower not operating).

The performance requirements for natural breathing and blower assisted types shall apply to the whole inlet assembly, including all the parts through which the inhaled air passes, i.e. the respirator and air hose.

8.4.4.2 *Air-line respirators—Continuous flow type*

The exhalation resistance of continuous flow air-line respirators fitted with a facepiece shall not exceed 1 kPa at a continuous flow of 300 ±5 L/min.

8.4.4.3 *Air-line respirators—Negative pressure demand type*

Negative pressure valves shall not be used in air-line respirators.

8.4.4.4 *Air-line respirators—Positive pressure demand type*

The exhalation resistance, measured relative to atmospheric pressure, shall not exceed 600 Pa at opening, and when measured in accordance with Appendix E or G the resistance shall not exceed the following:

(a) 700 Pa, at a continuous flow rate of 160 ±5 L/min, or the test conditions specified in Paragraphs E4(e) and E5.4 of Appendix E.

(b) 1 kPa, at a continuous flow rate of 300 ±5 L/min, or the test conditions specified in Paragraphs E4(d) and E5.4 of Appendix E.

The static pressure inside the facepiece shall not exceed 500 Pa. At no time other than the exhalation cycle shall the facepiece cavity pressure exceed to opening pressure of the exhalation valve.

8.4.4.5 *Air-line respirators—Auxiliary filter*

Where an air-line respirator is fitted with an auxiliary filter type of protection system, the system shall comply with the relevant clauses of Sections 2, 3, 4 and 5 except a higher breathing resistance may be incorporated to operate when the normal air supply is not functioning, to alert the wearer. This resistance shall not exceed 1500 Pa at a flow rates of 85 ±2 L/min in accordance with Appendix G. The auxiliary filter is not intended to be used as the primary means of providing respirable air.

8.4.5 Positive pressure under peak flow

During inhalation, the pressure in the outer cavity of positive pressure demand type respirators, when tested in accordance with Appendix E or Appendix G, as appropriate, shall—

(a) remain positive for either continuous flow rates up to 200 ±5 L/min, when tested in accordance with Appendix G or the test conditions specified in E4(f) and E5.4 of Appendix E;

(b) not exceed a negative pressure of 100 Pa at either continuous flow rates between 200 and 300 ±5 L/min when tested in accordance with Appendix G or the test conditions specified in Paragraphs E4(d) and E5.4 of Appendix E; and

(c) for a respirator consisting of a primary mask and having provision for a rescue mask, the primary mask shall conform to the provisions in Item (a) and, in addition, both systems will be tested in parallel at a combined flow rate of 450 ±5 L/min in accordance with Appendix G.

Air-line respirators shall be tested at the manufacturer's minimum recommended supply pressure.

8.4.6 Test of the air-hose, air-line and couplings

8.4.6.1 *Strength of air-line and couplings*

The strength of the air-line and couplings shall be such that, when tested with a steady pull of 1 kN in any direction applied for 1 min, at the manufacturer's recommended supply pressure, there shall be no separation of the couplings or failure of the air-line or failure of the connection.

8.4.6.2 *Resistance to collapse of air-hose*

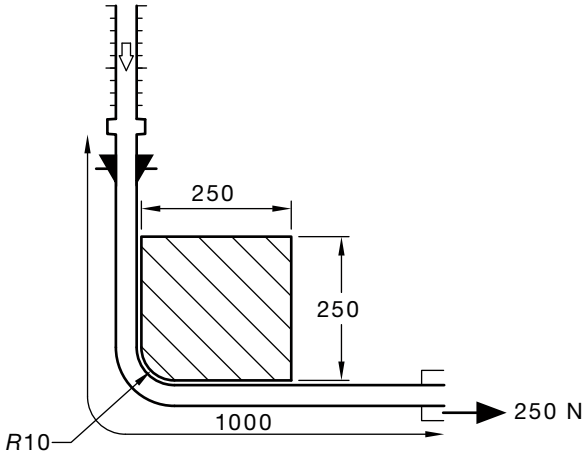
The resistance to collapse of the air-hose supplying a hose-mask respirator shall be determined in the following manner.

(a) A length of air-hose shall be subjected to a force of 850 N applied between two 75 mm^2 plane surfaces, and on the opposite sides of the hose and at right angles to its length, while air is flowing through it at a rate of 85 ±2 L/min.

(b) Any portion of the hose may be so tested. The flow of air through the hose shall not be reduced to such an extent that the resistance requirement of Clause 8.4.3 cannot be complied with, and there shall be no appreciable residual distortion of the hose when the pressure has been released.

8.4.6.3 *Resistance to kinking of air-line*

The air-line shall be resistant to kinking to the extent that airflow is maintained to at least 90% of the original flow rate at the recommended minimum working pressure when bent through a right angle with a corner radius of 5 mm as shown in Figure 8.1. The air-line shall be statically loaded to 250 N for 1 min prior to testing. This loading shall be maintained during testing.



DIMENSIONS IN MILLIMETRES

FIGURE 8.1 ARRANGEMENT FOR TESTING RESISTANCE TO KINKING

8.4.6.4 *Air tightness*

When immersed in water and subjected to a minimum internal air pressure outlined below there shall be no substantial loss of air from any air-hose, air-line, couplings and regulator (where fitted). This test shall be applied after the hose or line and couplings have been submitted to the test described in Clause 8.4.6.1. The couplings shall not be interfered with between tests.

NOTE: A leakage is not considered to be substantial unless it causes the device to fail the requirements of Clause 3.2.3.

Minimum internal air pressure for each type of respirator shall be as follows:

(a) Air-hose and breathing tubes—15 kPa.

(b) Air-line—twice the maximum supply pressure recommended by the manufacturer.

The breathing tube connected to the helmet, head covering, hood or facepiece shall be subjected to this test for air tightness, but shall not be subjected to the tests described in Clauses 8.4.6.1 and 8.4.6.2.

8.4.6.5 *Heat resistance*

If the air-hose or air-line is required to be resistant to damage from contact with hot surfaces, no sign of damage or indication of failure, nor deterioration in quality or air passing through it shall be evident after the following procedure are carried out.

Set the apparatus under test to its minimum recommended air flow, and test in accordance with Paragraph E4(e) of Appendix E, for both of the following conditions:

(a) 15 min contact of the hose with a hot plate maintained at 130 ±15°C; and

(b) immersion in boiling water for 15 min.

These two tests will be carried out on two separate lengths of hose or air-line as applicable.

8.4.7 Condition of the inhaled air (carbon dioxide content)

When the assembly is tested in accordance with Paragraph E5.3 of Appendix E (see Note), the carbon dioxide content of the inhaled air (including dead space effects(shall not exceed 1% by volume over the inhalation cycle. This test shall continue until a constant carbon dioxide content in the air inhaled is achieved.

NOTE: 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 pressures and airflows.

8.4.8 Durability of abrasive blast helmets/protectors

When the hood is intended for use when abrasive blasting, the respiratory performance shall be sufficient to meet the requirements of Clause 3.2.3 and the eye protection shall not be penetrated during the test, when tested in accordance with the requirements of Table 8.1.

The device is fitted to a test torso and blasted using an abrasive blasting device with the following characteristics:

(a) Nozzle diameter—10 mm.

(b) Abrasive material—iron grit, grain size 0.6 to 1 mm.

(c) Line pressure—500 kPa.

(d) Nozzle pressure—1000 kPa.

TABLE 8.1

RESISTANCE TO ABRASIVE MATERIALS

Test	Distance between nozzle exit and protective device metres	Time seconds
Resistance to rebound	3	120
Resistance to short period of blasting	1	2

8.4.9 Simulated work test

The respirator shall be tested and the results assessed in accordance with Appendix J. When carrying out the test procedure, none of the wearers shall experience any undue discomfort when assessed by the features listed in Paragraph J5 of Appendix J.

SECTION 9 COMPRESSED AIR SELF-CONTAINED BREATHING APPARATUS

9.1 DESIGN AND CONSTRUCTION

9.1.1 Design functions

The design and construction of self-contained breathing apparatus (SCBA) of the compressed air, open-circuit type shall—

(a) provide air from a source carried by the wearer;

(b) permit it to be worn without undue discomfort and in such a manner that it is practicable for the wearer to perform work or rescue duties, and not unduly impede the wearer when walking in a crouching attitude, crawling, or manoeuvring in confined areas; and

(c) give trouble-free operation over the temperature range of −10°C to 60°C.

Metals for exposed parts shall be chosen in accordance with the requirements of Clause 2.1.8. Compressed air, open circuit, self-contained breathing apparatus shall comply also with the appropriate requirements of Sections 2, 3, 8 and 12.

9.1.2 Types

Compressed air SCBAs are classified, according to intended function, as either work-set type or escape-set type.

Work-set compressed air SCBAs have a nominal effective life (NEL) exceeding 15 min, when tested in accordance with Clause 9.2. They operate on the principle of lung-governed positive pressure demand air supply

NOTE: The Committee agreed that a tolerance of +30% is permitted on the upper limit of NEL of escape-set compressed air SCBA provided that the requirements of Figure 9.1 are not exceeded at any cylinder pressure above 1 MPa.

Escape-set compressed air SCBAs have a nominal effective life equal to or less than 15 min when tested in accordance with Clause 9.2. They operate either on the principle of lung-governed demand air supply or constant-flow air supply. The latter may be used in conjunction with a head covering. Demand type escape-sets may be used with a full facepiece, a half facepiece, or head covering.

9.1.3 Requirements

9.1.3.1 *General*

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

9.1.3.2 *Components*

Respirators included in this Section normally consist of the following parts:

(a) An exhalation valve assembly.

(b) A breathing tube and pressure hose or pipe.

(c) One or more cylinders of compressed air.

(d) One or more cylinder valves.

(e) A body harness or some other means of securing the apparatus to the wearer.

9.1.3.3 *Specific components for compressed air SCBA—Work-set type*

In addition to the requirements of Clause 9.1.3.2, the respirator normally includes the following components:

(a) A full facepiece or head covering

(b) A positive pressure demand valve.

(c) A warning device.

(d) A pressure gauge, or other pressure-measuring device.

9.1.3.4 *Specific components for compressed air SCBA—Escape demand type*

In addition to the requirements of Clause 9.1.3.2, the respirator normally includes the following components:

(a) A full facepiece or head covering

(b) A positive pressure demand valve.

(c) A pressure gauge or other pressure-measuring device or pressure indicator.

9.1.3.5 *Specific components for compressed air SCBA—Escape continuous flow type*

In addition to the requirements of Clause 9.1.3.2, the respirator normally includes the following components:

(a) A full facepiece, half facepiece or head covering.

(b) A pressure gauge or pressure indicator.

(c) A continuous flow device.

9.2 NOMINAL EFFECTIVE LIFE

When tested in accordance with Paragraph E4(c) of Appendix E, the nominal effective life of the apparatus, with the cylinder or cylinders fully charged, shall be the time taken for the pressure in the cylinder or cylinders to fall to 1 MPa.

For continuous flow escape type SCBAs, the nominal effective life shall be the lesser of the time taken for the pressure in the cylinder or cylinders to fall to 1 MPa and the time taken for the concentration of carbon dioxide in the inhaled air to exceed the allowable concentration given in Figure 9.1.

Where escape sets may be upgraded to work sets, the full requirements of work sets shall be complied with.

9.3 PRESSURE TUBES AND HOSES

Metallic tubes and non-metallic hoses shall be capable of withstanding the test pressures as follows:

(a) Twice the cylinder filling pressure for non-metallic hoses working at full cylinder pressure.

(b) Twice the maximum working pressure for non-metallic hoses working at reduced pressure.

(c) 1.5 times the cylinder filling pressure for metallic tubes working at full cylinder pressure.

(d) 1.5 times the maximum working pressure for metallic tubes working at reduced pressure.

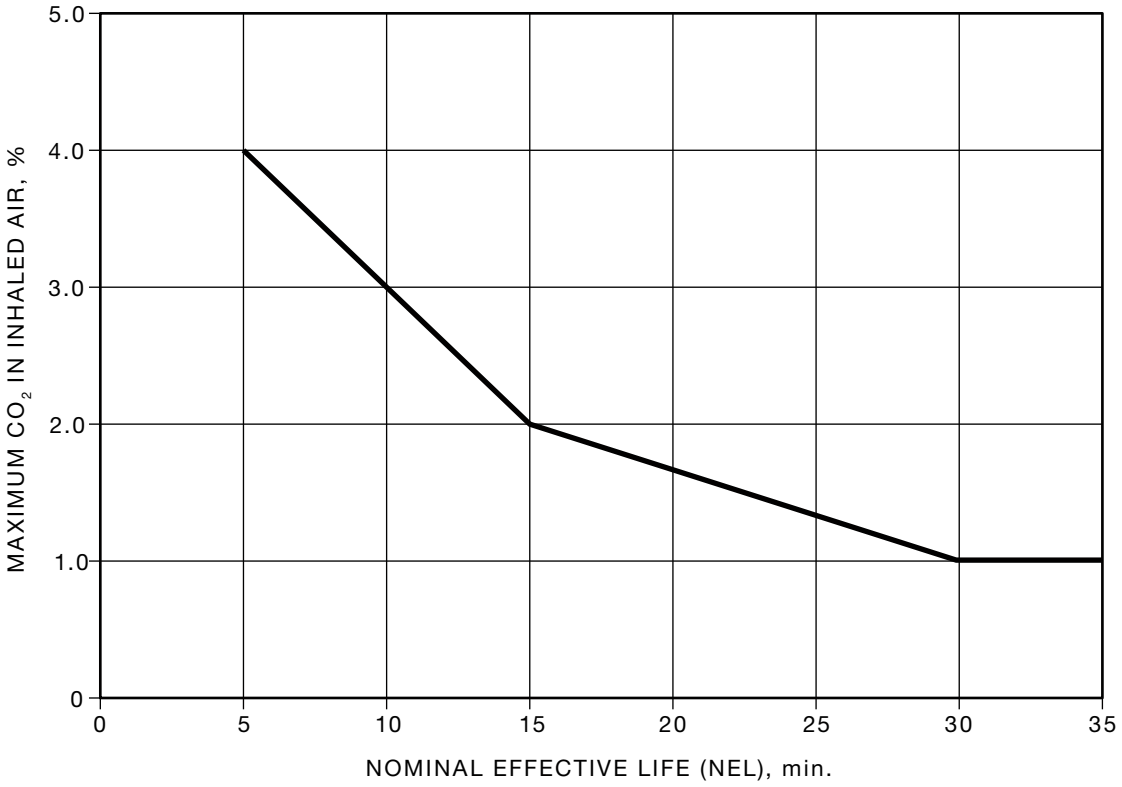


FIGURE 9.1 RELATIONSHIP BETWEEN NOMINAL EFFECTIVE LIFE (NEL) AND MAXIMUM CARBON DIOXIDE CONTENT OF INHALED AIR

9.4 COMPRESSED AIR SCBA—DEMAND FLOW TYPES

9.4.1 Functioning of assemblies without positive pressure

Such equipment is not covered by this Standard.

9.4.2 Functioning of assemblies with positive pressure

9.4.2.1 *Demand valve*

The demand valve shall comply with Clause 2.4.

9.4.2.2 *Resistance to breathing*

The exhalation resistance measured relative to atmospheric pressure shall not exceed 600 Pa at opening and when measured in accordance with Appendix E or G, as appropriate, the resistance shall not exceed the following:

(a) 700 Pa, at a continuous flow rate of 160 ±2 L/min, or the test conditions specified in Paragraphs E4(e) and E5.4 of Appendix E.

(b) 1 kPa, at a continuous flow rate of 300 ±5 L/min, or the test conditions specified in Paragraphs E4(d) and E5.4 of Appendix E.

The static pressure inside the facepiece shall not exceed 500 Pa. At no time other than the exhalation cycle shall the facepiece cavity pressure exceed the opening pressure of the exhalation valve.

9.4.2.3 *Positive pressure under peak flow*

During inhalation, the pressure in the outer cavity of positive pressure demand type respirators, when tested in accordance with Appendix E or Appendix G, as appropriate, shall—

(a) remain positive for either continuous flow rates up to 200 ±5 L/min, when tested in accordance with Appendix G or the test conditions specified in Paragraphs E4(f) and E5.4 of Appendix E;

(b) not exceed a negative pressure of 100 Pa at either continuous flow rates between 200 and 300 ±5 L/min when tested in accordance with Appendix G or the test conditions specified in Paragraphs E4(d) and E5.4 of Appendix E; and

(c) for a respirator consisting of a primary mask and having provisions for a rescue mask, the primary mask shall conform to the provisions in Item(a) and, in addition, both systems will be tested in parallel at a combined flow rate of 450 ±5 L/min in accordance with Appendix G.

The respirator shall meet the requirements of this Clause (9.4.2.3) at all cylinder pressures above 2 MPa.

9.5 CONTINUOUS-FLOW—ESCAPE TYPES

9.5.1 Design

The constant-flow escape device shall be preset by the manufacturer and designed so that the air delivery rate cannot be manipulated by the wearer. The flow of air shall commence with the opening of the cylinder valve or air supply device.

9.5.2 Noise level

Respirators incorporating a head covering shall comply with Clause 2.1.6.

9.6 AUXILIARY AIR SUPPLY

Where provision is made for the apparatus to be supplied by an auxiliary source of compressed air, the apparatus shall be provided with a suitable leak-proof, non-return auxiliary coupling. The apparatus and the auxiliary air supply shall, as a system, comply relevant parts of this Section and Section 8 of this Standard.

NOTE: An ancillary device such as a waist belt and a junction block may be used in this system.

9.7 CYLINDERS

Only cylinders of equal maximum filling pressure shall be connected to an apparatus with more than one cylinder.

The AS 2030 series provides requirements and guidance on gas cylinders.

9.8 CYLINDER VALVE

The AS 2030 series provides requirements and guidance on gas cylinders.

9.9 PRESSURE MEASURING DEVICES

9.9.1 General

Where fitted, a pressure gauge shall be of a type that will meet the requirements of AS 1349. Other pressure measuring devices shall be of equivalent accuracy.

9.9.2 Design

The pressure measuring device shall not be affected by dust and water. It shall withstand immersion in water to the depth of one metre for not less than 24 h. After the test, no water shall be visible in the device.

The size and position of the pressure measuring device shall be such that it can be easily read by the wearer when the apparatus is being worn. The design of the read-out should be such that it can be easily read in low-light conditions.

9.9.3 Accuracy and markings

The pressure gauge shall be clearly marked and the graduations where present, evenly spaced. The accuracy of the gauge shall be within 10% of the nominal pressure. Graduations shall be from zero up to a value of 500 kPa above the filling pressure of the cylinder. The design of the gauge shall allow the reading of the indicated pressure to within 1000 kPa.

9.10 PRESSURE INDICATOR

Where fitted, a pressure indicator shall indicate whether the pressure in the cylinder is less than that indicated in the fully charged condition. The accuracy of the indicators shall be within 10% of the nominal pressure.

9.11 RESTRICTION OF AIR LOSS

An isolating valve or slow leak orifice shall be provided in the high pressure indicating circuit to minimize the loss of air in the event of a failure to any components such as flexible tube or gauge in the high pressure circuit. Air loss shall be limited to 25 L/min at 20 MPa.

9.12 ACTIVE WARNING DEVICE

All works sets shall be fitted with an active warning device. The device shall operate to warn the wearer when the cylinder pressure drops to a predetermined level. The actuation of this device shall be automatic upon opening the cylinder valve.

The warning device shall respond after two third of the total breathing air volume is used and before the volume has been reduced to 200 L, provided that in no case shall the remaining effective life after warning exceed 15 min + 30%.

If an aural warning device is used, the sound pressure level shall be a minimum of 90 dB(A) measured in a free field at the wearer’s ear nearer the device as a continuous or intermittent warning. The frequency range shall be between 2 and 4 kHz.

If operated by the air supply, the air loss shall not exceed an average of 5 L/min from response of the signal to a pressure of 1000 kPa or not more than 50 L for those warning devices not operating continuously. The duration of the warning at 90 dB(A) shall be at least 15 s for a continuous signal and 60 s for an intermittent signal.

A pressure measuring device or indicator is not deemed to be an active warning device.

9.13 BODY HARNESS AND SECURING HARNESS

The harness shall be so designed to be adjustable and enable the wearer to don and remove the apparatus quickly and easily without assistance. All adjusting devices shall be constructed so that once adjusted they will not slip inadvertently.

9.14 MASS

The weight of the apparatus when fully charged and ready for use shall not exceed 18 kg.

9.15 TESTING

9.15.1 Application of tests

No fewer than two of each type of breathing apparatus shall be submitted for test and shall comply with the requirements specified in this Clause 9.15.

9.15.2 Warning device

When tested under the conditions specified in Paragraph E4(b) of Appendix E, the warning device shall function as specified in Clause 9.12.

9.15.3 Resistance to temperature

9.15.3.1 *High temperature*

When tested in accordance with the procedure given below the breathing apparatus shall—

(a) not exceed an inhalation resistance of 700 Pa for negative pressure demand type respirators;

(b) achieve a positive pressure greater than 10 Pa in the outer cavity of the mask at all times during the breathing cycle of positive pressure demand SCBA;

(c) not exceed an exhalation resistance of 300 Pa for an apparatus without positive pressure; and

(d) not exceed an exhalation resistance of 700 Pa for an apparatus with positive pressure.

The test procedure shall be as follows:

(i) Fill the apparatus, including the compressed air cylinders, to half capacity.

(ii) Store the apparatus in a chamber at a temperature of 60 ±3°C, and a relative humidity of not more than 50% for not less than 4 h.

(iii) Test the apparatus under the conditions specified in Paragraph E4(e) of Appendix E, at all cylinder pressures down to 2 MPa. Testing shall commence within 2 min of the apparatus being removed from the conditioning chamber.

NOTE: Testing may be terminated after 10 min.

For positive pressure breathing apparatus, the positive pressure shall be maintained in the cavity of the mask adjacent to the facial seal.

9.15.3.2 *Low temperature*

Where resistance to low temperature is required the breathing apparatus when tested in accordance with the procedure given below the breathing apparatus shall—

(a) not exceed an inhalation of 1 kPa; and

(b) not exceed an exhalation resistance of 1 kPa, for both positive and negative pressure breathing apparatus.

The test procedure shall be as follows:

(i) Store the apparatus, including the facepiece and fully charged compressed air cylinders, in a chamber at a temperature of –9°C to –10°C for a period of not less than 4 h.

(ii) Test the apparatus under the conditions specified in Paragraph E4(c) of Appendix E, at all cylinder pressures down to 2 MPa.

(iii) Testing shall commence within 2 min of the apparatus being removed from the conditioning chamber and may be terminated after 10 min.

For positive pressure breathing apparatus, the positive pressure shall be maintained in the cavity of the mask adjacent to the facial seal.

9.15.4 Simulated work test for compressed air SCBA

When tested in accordance with Appendix J none of the test personnel shall experience any undue impairment of efficiency or discomfort on account of fit, functioning, or any other feature of the respirator apparatus.

9.16 REQUIREMENTS FOR AIR QUALITY (CYLINDERS) FOR SUPPLIED-AIR RESPIRATORS

Requirements for air quality are provided in AS/NZS 1715.

SECTION 10 COMPRESSED OXYGEN SELF-CONTAINED BREATHING APPARATUS

10.1 DESIGN AND CONSTRUCTION

The design and construction of compressed oxygen self-contained breathing apparatus (SCBA) shall—

(a) provide compressed oxygen carried by the wearer and minimize entry of the external atmosphere;

(b) permit it to be worn without undue discomfort and in such a manner that it is practicable for the wearer to perform work and rescue duties and not unduly impede the wearer when walking in a crouching attitude, crawling, or manoeuvring in confined areas;

(c) give trouble-free operation over the temperature range of −10°C to 60°C;

(d) prevent leakage from the circuit to atmosphere except through a relief valve;

(e) allow the apparatus to be effectively sealed from atmospheric air during storage; and

(f) where applicable, use component materials that are fire-resistant and antistatic.

NOTE: Oxygen SCBAs are not designed for prolonged use under water; however, the apparatus should continue to function satisfactorily while briefly submerged in water in the normal working position at a maximum depth of 1 m and after withdrawal until the oxygen supply is exhausted.

Metals for exposed components shall be chosen in accordance with Clause 2.1.8.

Oxygen SCBAs shall also comply with the appropriate requirements of Section 2, 3 and 12.

10.2 COMPONENTS

10.2.1 General

When respirators parts are required by this Clause (10.2), each component shall meet the requirements for that component noted below and elsewhere in this Standard.

10.2.2 Components

All respirator included in this Section shall normally consist of the following components:

(a) A full facepiece or a mouthpiece and nose clip.

(b) A breathing hose or pressure hose or pipe.

(c) A body harness or some other means to secure the apparatus to the wearer.

(d) A breathing bag, or equivalent.

(e) An oxygen cylinder.

10.2.3 Specific components for compressed oxygen SCBA—work set type

In addition to the components listed in Clause 10.2.2, the respirator shall normally include the following components:

(a) A demand valve.

(b) One or more cylinder valves.

(c) A pressure gauge or pressure indicator.

(d) An isolating valve, or other means of preventing a rapid loss of oxygen in the event of a gauge line severing, where applicable.

(e) A relief valve (optional on demand-only types).

(f) A constant-flow valve or other means of ensuring oxygen flow.

(g) A constant-flow reducing valve (for demand-only types).

(h) Carbon dioxide absorbent.

10.2.4 Specific components for compressed oxygen SCBA—escape-set type

In addition to the components listed in Clause 10.2.2, the respirator shall normally include the following components:

(a) A demand valve (for demand flow types only).

(b) A cylinder valve.

(c) A pressure gauge or pressure indicator.

(d) A relief valve.

(e) Carbon dioxide absorbent.

(f) A constant-flow valve or other means of ensuring oxygen flow.

(g) A constant-flow reducing valve (for continuous flow types only).

10.3 NOMINAL EFFECTIVE LIFE

When tested in accordance with Paragraph R4(c) of Appendix R, the nominal effective life of the apparatus, with the oxygen supply fully charged, shall be the lesser of the following:

(a) The time taken for the concentration of carbon dioxide in the inhaled oxygen to exceed the allowable concentration of 1.5% by volume.

(b) In the case of compressed oxygen closed-circuit self-contained breathing apparatus, the time taken for the pressure in the cylinder to fall to 1000 kPa.

10.4 INHALATION TEMPERATURE

When tested in accordance with Clause 10.3, the wet bulb temperature of the inhaled gas shall be less than 40°C at any time during the test. When testing escape type respirators, the temperature of the inhaled gas shall not exceed 50°C.

10.5 RESISTANCE TO BREATHING

When tested in accordance with Paragraph E5.3 of Appendix E, the resistance to breathing on both the inhalation and exhalation sides of the breathing circuit shall not exceed 500 Pa before the nominal effective life is reached.

10.6 SIMULATED ROUGH USAGE

Before testing for the nominal effective life and resistance to breathing, the ‘carbon dioxide absorption unit’ of work sets shall be subjected to simulated rough usage in accordance with the requirements of Appendix H.

At the conclusion of this procedure the unit shall show no visible deterioration and, when tested for the nominal effective life and the resistance to breathing, shall comply to within 10% of the relevant requirements.

10.7 SIMULATED WORK TEST

The apparatus shall be tested and assessed in accordance with Appendix J, Paragraph J4.4 simulated work test. When carrying out the test procedure, none of the wearers shall experience any undue discomfort when assessed with the features listed in Paragraph J5.

10.8 DEMAND VALVE

Where a lung-governed oxygen supply valve is provided, it shall be so designed and adjusted that the operating pressure is kept to the minimum and that it operates only when the wearer requires more oxygen than is provided by the system capacity or continuous flow device.

Operation of the lung demand valve shall not be influenced by any external pressures that could hold the demand valve open and deplete the oxygen supply.

10.9 CONTINUOUS FLOW VALVE

For apparatus without a supplementary lung-governed oxygen supply, the flow shall be sufficient to satisfy the requirement of nominal effective life as specified in Clause 10.3.

Adjustment of the continuous flow valve shall not be possible while the apparatus is being worn.

10.10 RELIEF VALVE

The relief valve shall operate automatically and be designed so that inward leakage of the external atmosphere is prevented.

10.11 CARBON DIOXIDE ABSORBENT

The quantity of carbon dioxide absorbent material shall be more than sufficient to absorb the amount of carbon dioxide equivalent to the oxygen used by the wearer during the nominal effective life. The design of the apparatus containing the absorbent material shall be such that fine particles of the absorbent are prevented from being entrapped in the breathing circuit.

10.12 BREATHING BAG

10.12.1 General

The breathing bag or equivalent shall be gastight and protected against damage by external forces.

10.12.2 Breathing bag capacity

The breathing bag capacity, when correctly fitted and ready for use, shall be not less than 5 L when measured as follows:

(a) For continuous flow types, the capacity measured between the opening pressure of the relief valve and a negative pressure of 200 Pa, relative to atmospheric pressure.

(b) For demand valve types, the capacity measured between the opening pressure of the relief valve and the opening pressure of the demand valve.

10.13 PRESSURE TUBES AND HOSES

Metallic tubes and non-metal hoses shall comply with Clause 9.3.

10.14 PRESSURE GAUGE

The pressure gauge shall comply with Clause 9.9. The gauge shall be plainly marked ‘OXYGEN—USE NO OIL’. The markings shall include measurements in ‘bar’.

10.15 PRESSURE GAUGE ISOLATING VALVE

The pressure gauge isolating valve shall comply with Clause 9.11. Other means of preventing a rapid loss of oxygen in the event of gauge or gauge line failure in the high pressure circuit may be used but this shall also comply with Clause 9.11. The impact of the isolating valve or other arrangement on the duration of the apparatus shall be evaluated by testing.

10.16 BODY HARNESS AND SECURING HARNESS

The body harness and securing harness shall comply with Clause 9.13.

10.17 MASS

The weight of the apparatus when fully charged and ready for use shall normally not exceed 18 kg.

10.18 CYLINDERS

Cylinders shall comply with AS 2030.1 and be colour coded in accordance with AS 4484. Only cylinders of equal maximum filling pressure shall be connected to an apparatus with more than one cylinder.

10.19 CYLINDER VALVE

The cylinder valve shall comply with Appendix K.

10.20 COMPRESSED OXYGEN (DRY BREATHING)

Compressed oxygen of the dry-breathing type shall be odourless and contain not less than 99.5% by volume of oxygen.

10.21 LEAK TIGHTNESS

The respirator shall be subject to a positive and a negative pressure of 750 Pa. With the relief valve blanked off, the pressure change shall not exceed 30 Pa within 1 min. With the relief valve unblanked and at a negative pressure of 750 Pa, the pressure change shall not exceed 60 Pa within 1 min.

SECTION 11 CHEMICAL OXYGEN (KO_2) SELF-CONTAINED SELF-RESCUERS

11.1 DESIGN AND CONSTRUCTION

The design and construction shall—

(a) provide oxygen generated from a chemical source carried by the wearer;

(b) permit the apparatus to be worn without undue discomfort and in such a manner that it is practicable for the wearer to escape and not unduly impede the wearer when walking or in a crouching position, crawling or manoeuvring in confined areas;

(c) give trouble free operation over the range of –5°C and 60°C;

NOTE: Storage of the apparatus should not exceed temperatures specified by the manufacturer.

(d) prevent leakage from the circuit to atmosphere except through a relief valve; and

(e) allow the apparatus to be effectively sealed from atmospheric air during storage.

Chemical oxygen self-contained self-rescuers shall also comply with the appropriate requirements of Sections 2, 3 and 12.

11.2 COMPONENTS

11.2.1 General

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

11.2.2 Components

All respirators included in this Section shall normally consist of the following components:

(a) A full facepiece or a mouthpiece and nose clip.

(b) A breathing hose or pressure hose or pipe.

(c) A body harness or some other means to secure the apparatus to the wearer.

(d) A breathing bag.

(e) An oxygen cartridge.

(f) A relief valve.

11.3 PERFORMANCE REQUIREMENTS

11.3.1 Breathing simulator tests

Prior to subjecting an apparatus to a breathing simulator test for the purpose of determining the rated duration, the apparatus shall pass a case seal test in accordance with Clause 11.3.13.

11.3.2 Nominal and rated duration

When tested in accordance with Paragraph R4(a) of Appendix R, the rated duration of the apparatus shall be classified in increments of 5 minutes and will be the lowest value obtained from at least 2 tests. The rated duration is the period of time the apparatus complies with the following criteria:

(a) The oxygen content of the inhaled atmosphere shall not fall below 21% (by volume).

NOTE: A short-term deviation to a level of not less than 19% (by volume) for a period of not more than 2 minutes at the beginning of the test is permissible.

(b) The average carbon dioxide concentration of the inhaled atmosphere shall not exceed 1.5% (by volume). At no time shall the instantaneous carbon dioxide concentration exceed 3% (by volume).

(c) The average temperature of the inhaled atmosphere irrespective of humidity shall not exceed 55°C, when testing at 35 L/min for the rated duration.

(d) For apparatus with a rated duration of less than 30 minutes at no time shall the instantaneous temperature exceed 70°C.

NOTE: This criteria only applies where a breathing simulator is fitted with a fast response 0.05 mm diameter thermocouple.

(e) When the apparatus (including the relief valve) under test is enclosed in a sealed test chamber containing a test gas of 2% carbon monoxide in air saturated with water vapour, at 37°C, the inward leakage of carbon monoxide shall not exceed 30 p.p.m. in the inhaled atmosphere.

(f) The nominal duration specified in the manufacturer's documentation shall not exceed the rated duration by more than 5 minutes when tested at 35 L/min.

NOTE: It should be recognized that in use, the actual duration may vary according to the work rate, size, fitness and age of the wearer.

11.3.3 Extended usage period

The performance of the apparatus during breathing simulator tests carried out to Clause 11.3.2 shall be monitored for a further period of five minutes until the apparatus no longer produces oxygen or the breathing bag collapses. This may be greater than the rated duration of the apparatus.

Additionally, the performance of the apparatus during the extended usage period shall meet the following requirements:

(a) Inhaled carbon dioxide content not to exceed 5%.

(b) Inhalation/exhalation resistance not to exceed 15 mbar.

Until the above conditions(s) is achieved, the apparatus shall perform in a manner so as to continue to afford protection without any inherent risk to the wearer's safety.

11.3.4 Carbon monoxide leakage of the apparatus (including relief valve)

The apparatus shall be test enclosed in a sealed test chamber containing a test gas of 2% carbon monoxide in air and tested in accordance with Paragraph R4(a). The inward leakage of carbon monoxide shall not exceed 30 p.p.m. in the inhaled atmosphere for a period of not less than the rated duration.

11.3.5 Breathing resistance at 35 L/min

When tested in accordance with Paragraph R4(a)—

(a) For apparatus with a rated duration of up to and including 30 min, the sum of the inhalation and exhalation resistance shall not exceed 1.6 kPa and the maximum individual breathing resistance for inhalation or exhalation shall not exceed 1.0 kPa.

(b) For apparatus with a rated duration of more than 30 min, the sum of the inhalation and exhalation resistance shall not exceed 1.3 kPa and the maximum individual breathing resistance for inhalation or exhalation shall not exceed 0.75 kPa.

11.3.6 High volume tests

11.3.6.1 *General*

When tested in accordance with Paragraph R5 of Appendix R, the apparatus shall comply with the performance criteria of Clause 11.3.2(a), (b) and (c) for 5 minutes at 70 L/min or for 30 percent of the manufacturer's claimed duration at 70 L/min, whichever is the lesser period.

11.3.6.2 *Breathing resistance*

When tested in accordance with Paragraph R5 of Appendix R, the inhalation or exhalation resistance shall not exceed 2.0 kPa. During this test the apparatus shall remain functional.

11.3.7 Rough usage—Water immersion

After testing in accordance with Paragraph H6.1 and H6.2 of Appendix H, the apparatus, including the carrying case shall be tested for water leakage in accordance with Paragraph H6.3 of Appendix H.

At the completion of the test, the mass of the assembled apparatus including the carrying case, shall not increase by more than 5 g.

11.3.8 Rough usage—Examination for powdering of chemicals

After testing, in accordance with Paragraph H6.1 and H6.2, a complete apparatus shall be dismantled and examined. No migration of any powdered chemical shall be possible.

The apparatus tested in Clause 11.3.7 shall not be subject to such examinations.

11.3.9 Component assessment

11.3.9.1 *Use of light metals and alloy*

Exposed parts of the apparatus shall not be made of magnesium, titanium, aluminium or of alloys containing such proportions of these metals as will, on impact, give rise to frictional sparks capable of igniting flammable gas mixtures (see also Clause 2.1.8).

11.3.9.2 *Surface resistivity*

When tested to Paragraph N2.2 of Appendix N, the insulation resistance shall not exceed 10^9 Ω. Metallic containers may be considered to pass this requirement.

Where the apparatus is required to be antistatic during escape, materials used including the breathing bag shall either—

(a) be tested to Paragraph N2.2 of Appendix N and the insulation resistance be found not to exceed 10^9 Ω; or

(b) have a surface area of the element not exceeding 100 cm^2.

11.3.10 Goggles

If the apparatus is supplied with goggles, the lenses of the goggles shall be manufactured from a durable material and shall be protected against fogging. The head straps of the goggles shall be flexible and easily adjustable or self-adjusting. The goggles shall not interfere with the donning of the apparatus.

Goggles shall be evaluated in the simulated work test, Appendix J.

11.3.11 Relief valve

When tested in accordance with Paragraph N4 of Appendix N, the relief valve shall open at a positive pressure of not less than 0.1 kPa.

11.3.12 Breathing bag

The effective volume of the breathing bag shall be at least 6 L. One method of testing this is given in Paragraph N5 of Appendix N.

11.3.13 Case seal

The assembled apparatus shall be subjected to a pressure test. This test is to assess the adequacy of the case seal. When tested in accordance with Paragraph N3 of Appendix N the pressure in the test container shall not decrease by more than 0.3 kPa within 60 s.

11.3.14 Simulated work tests

Following satisfactory performance in the prescribed simulated breathing machine tests, the apparatus shall undergo simulated work tests, in accordance with Paragraph J4.5 of 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 breathing bag, or any other feature of the apparatus.

SECTION 12 MARKING AND INSTRUCTIONS

12.1 MARKING

12.1.1 General

Manufacturers making a statement of compliance with this Australian/New Zealand Standard on a product, packaging or promotional material related to that product should ensure that such compliance is capable of being verified.

12.1.2 Marking of face pieces and head coverings

12.1.2.1 *Marking of equipment*

Each facepiece and head covering shall be clearly and indelibly marked with the following, as appropriate:

(a) The manufacturer's name, trade name or mark.

(b) Where more than one size of facepiece is manufactured, the size of the facepiece. Half facepiece respirators shall not be marked as high efficiency respirators.

12.1.2.2 *Additional marking*

The packaging or label shall be clearly marked with the following, as appropriate:

(a) The year of manufacture, date code or other means of traceability.

(b) Where a respirator is designed to cater for a particular physical characteristic.

(c) The operational temperature range.

12.1.3 Particulate filters

12.1.3.1 *Marking of equipment*

Each filter shall be clearly marked with the following, as appropriate:

(a) Manufacturer's name, trade name or mark.

(b) Filter classification and white colour code. If the marking is not directly on the filter body, it shall be on a label of the appropriate colour code affixed to the filter body. In this case, the colour of the body shall not be considered to be the colour code.

(c) Where the filter is designed to be used with a powered air-purifying respirator, the abbreviation PAPR as a prefix to the classification, e.g. PAPR-P2.

12.1.3.2 *Additional marking*

Any additional marking shall accompany each filter so that it is available to the end user. The particulate filter packaging or label shall be clearly marked with the following, as appropriate:

(a) The year of manufacture, date code or other means of traceability.

(b) A warning if the efficiency of the filter deteriorates in the presence of substances, such as oil mists, commonly encountered in the workplace.

(c) Compatible respirator where appropriate.

(d) With Class P3 filters the words 'Provides P3 protection only with full facepiece respirator'.

(e) P3 filters which fit half facepieces use the words 'Provides P2 protection with half facepiece respirator'.

12.1.4 Gas and vapour filters

12.1.4.1 *Marking of equipment*

Each filter shall be clearly and indelibly marked with the following, as appropriate:

(a) Manufacturer's name, trade name or mark.

(b) The year of manufacture, date code or other means of traceability.

(c) Type and classification. Multiple gas type filters shall be listed in alphabetical order, e.g. A, B, E, K.

For specific chemical filters, the type designation shall be an abbreviation of the specific gas for which the filter is approved.

For combined gas and particulate type filters the marking shall indicate the gas type and classification first followed by the particulate classification, e.g. A1P1.

(i) For Type NO filters the warning:

'SINGLE USE ONLY'.

(ii) For Type Hg filters the warning, as appropriate:

Class 1: 'MAXIMUM USE TIME 8 HOURS'.

Class 2: 'MAXIMUM USE TIME 50 HOURS'.

(iii) For Type AX filters, the warning, where applicable:

'SINGLE USE ONLY'.

(d) Where colour coding is used, the appropriate colour code on accordance with Table 12.1. Where a filter meets the requirements of more than one class it shall be marked with a combination of colours, e.g. AB2 brown-grey.

(e) If the marking is not directly on the filter body, it shall be on a label of the appropriate colour code affixed to the filter body. In this case, the colour of the body shall not be considered to be the colour code.

(f) Where the filter is designed to be used with a powered air-purifying respirator, the abbreviation PAPR as a prefix to the type and classification, e.g. PAPR-A1P1.

TABLE 12.1

COLOUR CODES FOR DIFFERENT TYPES OF FILTERS

Type	Colour code
A	Brown
B	Grey
E	Yellow
K	Green
P	White
NO	Blue
Hg	Red
AX	Brown

12.1.4.2 *Marking of packaging*

Any additional marking shall accompany the filter(s) so that it is available to the end user. The packaging or a label shall be clearly marked with the following information, as appropriate:

(a) The year of manufacture, date code or other means of traceability.

(b) Unopened expiry date.

(c) A warning, as follows:

'DO NOT USE WHERE THERE MAY BE A DEFICIENCY OF OXYGEN'.

(d) An indication of the gas or gases against which the filter will give protection.

(e) For Class AUS and Class 1 filters, a warning as follows:

'DO NOT USE IN HIGHLY TOXIC ATMOSPHERES. REFER TO AS/NZS 1715'.

(f) For Class 3 filters when used alone or in combination with P3 particulate filters, the wording:

'USE ONLY WITH FULL FACEPIECES WHEN A HIGH PROTECTION FACTOR IS REQUIRED'.

(g) A warning for Type G air purifying filters as follows:

'SUITABLE ONLY FOR AIRBORNE CONTAMINANTS WITH VAPOUR PRESSURE LESS THAN 0.01 MILLIMETRES OF MERCURY AT 25°C'.

(h) Compatible respirator, where applicable.

(i) Maximum concentration limitations, i.e. assigned (or minimum) protection factor as described in AS/NZS 1715.

(j) Recommended storage requirements.

12.1.5 Air-line and air-hose respirators

12.1.5.1 *Marking of equipment*

Each respirator shall be clearly and indelibly marked with the following, as appropriate:

(a) The manufacturer's name, trade name or mark.

(b) For air-line respirators, the minimum supply pressure specified by the manufacturer.

(c) Where a blower is supplied with the hose-mask respirator and operates only in one direction, the direction of rotation.

(d) Air-lines and air-hoses shall be marked 'respirable air' or 'breathing air' or similar wording.

12.1.5.2 *Marking of packaging*

The packaging or a label shall be clearly marked with the following information, as appropriate:

(a) Where resistance to temperature extremes is claimed for the air-line or air-hose, the maximum and minimum temperatures of the air-line or air-hose.

(b) For air-line and air-hose respirators, the maximum lengths of hose or line permitted for the particular assembly.

12.1.6 Compressed air self-contained breathing apparatus

Each assembly shall be clearly and indelibly marked with—

(a) the maximum working pressure (specified by the manufacturer) for compressed air cylinders;

(b) the manufacturer's name, trade name or mark; and

(c) the word 'ESCAPE', where applicable.

12.1.7 Filter self-rescuer (Mines)

Each respirator shall be clearly marked with the following information:

(a) Manufacturer's name, trade name or mark.

(b) The model number.

(c) Month and year of manufacture.

(d) The total weight of the apparatus.

(e) A unique serial number.

(f) Traceable identification of the catalyst batch used.

(g) A refill date if applicable.

12.1.8 Compressed oxygen self-contained breathing apparatus

Each assembly shall be clearly and indelibly marked with the following, as appropriate:

(a) The manufacturer's name, trade name or mark.

(b) If the respirator is factory charged and sealed, the maximum storage life under specified conditions.

(c) If fitted with a refillable absorbent, the type and mass of absorbent used.

(d) If fitted with a replaceable filter, the month and year of manufacturer of the filter, and the type of apparatus for which the filter is to be used. In addition, if it is possible to connect the filter to the apparatus incorrectly, an indicator shall be given which clearly signifies the correct method of connection.

12.1.9 Chemical oxygen self-contained self-rescuers

Each respirator shall be clearly marked with the following information:

(a) The manufacturer, supplier identified by name, trade mark or other means of identification.

(b) Model number and type.

(c) Rated duration in accordance with this Standard.

(d) A unique serial number.

(e) Month and year of manufacture.

(f) An easy to understand picture or pictogram on the carrying container showing the donning procedure.

(g) The total weight of the apparatus.

If contained in a sealed carrying container, the marking shall be on the container.

Training Units shall be clearly marked and coloured, in such a way that they cannot inadvertently be mistaken as functional escape devices.

12.2 INSTRUCTIONS FOR USE

12.2.1 General

Each respirator shall be supplied with clear instructions for use, printed in English.

Where appropriate, instructions referring to the—

(a) limited storage life of unopened filters; and

(b) limited service life of installed filters.

12.2.2 Instructions for use, maintenance and storage

On delivery, instructions shall accompany each respirator in the smallest package unit.

(a) The instructions shall include the following:

(b) Limitations on the use, e.g. application of half-facepiece units with limitations for toxic gases; impact of slow leak orifice on duration of compressed oxygen sets.

(c) Compatible filter or filters, where appropriate.

(d) Correct assembly of respirators, e.g. correct fitting of filters to the facepiece for which they are designed, non-mixing of filters.

(e) Instructions for fitting, including testing for correct facial fit.

(f) Instructions for decontamination, washing, maintenance, storage, and periodic testing, as appropriate.

(g) Air pressure required to maintain airflow for the range of air-lines supplied.

(h) Any additional or optional performance characteristics that are claimed by the manufacturer and that are verifiable by testing e.g. flame or fire resistance of masks.

For self-contained breathing apparatus (work-set and escape types), where the changeover to positive pressure is of manual operation, a warning shall be included that the set shall only be operated in the positive mode.

12.2.3 Additional requirements for powered air-purifying respirators

Each powered air-purifying respirator shall be supplied with the following:

(a) Where appropriate, a procedure for charging the battery of powered blower units.

(b) A procedure for checking adequacy of airflow rate.

(c) A procedure for changing of filters.

(d) The ranges of temperature and relative humidity under which the equipment was tested.

(e) The operating temperature and relative humidity ranges to be included in instructions.

12.2.4 Instructions for use of the chemical oxygen (KO_2) self-contained self-rescuers

On delivery, instructions for use shall accompany every apparatus. The instructions shall:

(a) Be in English.

(b) Contain all information necessary for trained and qualified persons on—

  (i) application limitation;

  (ii) maximum surface temperature during use;

  (iii) checks prior to use;

  (iv) donning and fitting;

  (v) maintenance (preferably separately printed instructions);

(vi) inspection intervals;

(vii) storage;

(viii) shelf-life; and

(ix) instructions for disposal after use.

(c) Be unambiguous.

Illustrations, part numbers, marking, etc. may be added for this.

The instructions for use should be complemented by an easy to understand picture (pictogram) on the carrying container showing the donning procedure.

Warning shall be given in the instructions against possible problems likely to be encountered, for example—

(i) integrity of the apparatus during carriage or transport;

(ii) procedure for donning respirator; and

(iii) danger of ignition if chemicals come into contact with combustible substances or water.

Any other information the supplier may wish to provide to ensure that the apparatus is appropriate for use in underground coal mines, may be included in the instructions.

12.3 ADDITIONAL MARKING

Where rigid or semi-rigid construction of head coverings could imply protective helmet protection and it does not comply with AS/NZS 1801 the device shall be marked with the following:

WARNING: THIS HEAD COVERING DOES NOT MEET THE REQUIREMENTS OF AS/NZS 1801. IF HEAD PROTECTION IS REQUIRED CONSULT YOUR SAFETY OFFICER.

APPENDIX A

NOISE LEVEL TEST

(Normative)

A1 SCOPE

This Appendix sets out the method of testing head coverings equipped with powered and air-supplied respirators for noise level from the entry of air or from the blower, where appropriate.

A2 PRINCIPLE

The respirator is worn by a test subject and the noise level (in dB(A)) is measured at the subject's ears inside the head covering.

A3 APPARATUS

The apparatus shall consist of the following:

(a) Microphones with diameter not exceeding 12 mm, capable of being fitted inside the head covering, adjacent to the wearer's ears.

(b) Sound level meter of Type 1 or 2 as specified in AS IEC 61672.1.

A4 PROCEDURE

The procedure shall be as follows:

(a) Calibrate the sound level meter in accordance with the manufacturer's instructions.

(b) Fix the microphones to the test subject centrally at the entry to each external ear and level with the tragia.

(c) Have the test subject don the head covering.

(d) Supply the head covering with air through the shortest length of air-line supplied with the respirator and at the manufacturer's maximum specified airflow and measure, in succession, the sound pressure level at each ear with the sound level meter set to indicate frequency weighting characteristics (A).

Where a battery-powered PAPR is tested, the batteries shall be fully charged at commencement of the test.

(e) Take the highest level readings from both ears on an energy equivalent basis.

(f) Check that the background noise level in the test area is at least 10 dB(A) lower than that measured for the device and, if necessary, adjust the background level to meet this condition.

(g) If the condition in Step (f) is satisfied repeat Steps (b) to (f) for other specified airflows. If not, after adjusting the background level, repeat Steps (b) to (f).

A5 REPORTING THE RESULTS

The following shall be reported:

(a) Identification of the test sample.

(b) Any sample preparation or conditioning.

(c) The name of the test laboratory or authority responsible for performing the test.

(d) The dates of the test.

(e) The number of replicate results from which the test result has been derived, e.g. ‘single test result’ or ‘the mean of duplicates’

(f) The identity of any reference material used to assist in the validation of the test result.

(g) Any observation, in relation to either the test sample or the performance of the test, which may assist in the correct interpretation of the test results.

(h) The results from each level of airflow as the noise generated by the respirator.

(i) The number of this test method, i.e. Appendix A of AS/NZS 1716.

APPENDIX B

METHOD OF SELECTING PERSONNEL FOR ASSEMBLED RESPIRATORS TESTS

(Normative)

B1 METHOD OF SELECTION

To obtain as adequate a coverage of facial size and contour as possible, eliminating the unusual or abnormal faces, the testing authority shall select persons aged between 18 years and 65 years who are randomly distributed over the appropriate racial types. The facial dimensions of the persons chosen are measured in accordance with Figure B1 and should fit into the groups set out in Figure B1.

B2 SPECIFIC SELECTION CRITERIA

The testing authority should be guided also by the following principles in selecting the test panel:

(a) The panel should exclude persons with scars or other skin blemishes in the area contacted by the facepiece, as such blemishes are likely to interfere with the result of the fitting test.

(b) Male panel members are required to be freshly shaven at the time of the test.

(c) The panel should exclude persons whose facial contours are distorted owing to the loss of teeth and who are not fitted with dentures.

(d) The panel should exclude persons with misshapen noses or abnormal facial contours.

(e) The panel should exclude persons who are psychologically unsuitable.

(f) The panel should be distributed as evenly as possible by visual inspection between thin, medium and well-fleshed persons, but excessively thin, excessively fat or heavily-jowled persons should be avoided.

(g) When testing supplied-air self-contained breathing apparatus, the panel should comprise persons used to wearing respirators and whose medical and physical conditions are known to be satisfactory.

B3 SELECTION OF TEST PANEL

For each facepiece or visor type, a test panel shall be chosen in accordance with Figure B1. A test panel of 10 persons shall comprise 2 each from Groups A and C and 6 from Group B.

Where a facepiece is manufactured in more than one size, the test panel may be offered each of the available sizes. The most comfortable size shall then be worn by the subject during the course of the total inward leakage or qualitative facial fit tests. For blouse or hood type respirators, a test panel of at least 10 persons shall be chosen, with no regard to their facial dimensions.

When a manufacturer has at least one facepiece tested by this panel and it is found to comply with Clause 2.2.2, any additional facepieces need only be tested on individuals belonging to part of this panel. The respirator shall then be labelled to reflect the specific group of the population for which it is intended, e.g. small female faces.

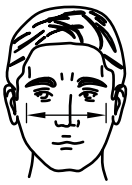
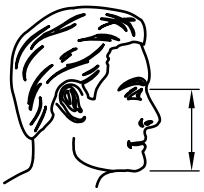
Facial dimensions, (mm)				
Group	Number of persons in group			
	10	15	Bizygomatic diameter	Menton-nasal root depression length
A	2	3	128 to 136	100 to 111
B	6	9	136 to 146	112 to 123
C	2	3	147 to 154	124 to 133

FIGURE B1 FACIAL DIMENSIONS OF TEST PANEL

APPENDIX C

RESISTANCE TO FLAME TEST

(Normative)

C1 SCOPE

This Appendix sets out the method for determining the flammability of respirator facepieces and head coverings of equipment to be used in close proximity to flames.

C2 PRINCIPLE

The device, mounted on a dummy head, is passed through a flame and the effects of the flame on the device observed.

C3 APPARATUS

The apparatus shall consist of the following:

(a) A propane gas cylinder complete with regulator, flow control valve and fine pressure gauge.

(b) A flashback arrester.

(c) A propane burner capable of producing a flame 40 mm to 45 mm in height with a temperature of 800 ±50°C (with the vent closed) at a point 20 mm above the burner top. The burner should be adjustable in height.

(d) A dummy head mounted on a support which can be rotated in a circle at a speed of 60 mm/s (see Figure C1).

(e) A stopwatch.

(f) Thermocouple and suitable temperature measuring instruments.

C4 PROCEDURE

The procedure shall be as follows:

(a) Fit the device to the dummy head and ensure that a speed of 60 mm/s can be obtained.

(b) Position the head and device so that it is over the burner.

(c) Adjust the position of the burner so that the distance between the top of the burner and the lowest part of the device which is to pass through the flame is 20 mm. Move the head away from the burner.

(d) Ignite the gas at the burner. Ensure that the burner air vent is fully closed and adjust the flow control valve to give a flame height of 40 mm to 45 mm above the burner top.

(e) Air vent settings should be adjusted to give a flame temperature of 800 ±50°C at a point 20 mm above the burner top.

(f) Pass the device mounted on the dummy head once through the flame at the set speed of 60 mm/s.

(g) Using two further samples, repeat the test to enable an assessment to be made of all materials on the exterior of the device. Any one sample shall be passed through the flame once only.

C5 ASSESSMENT

After completing the flame test, examine the device and report whether it has grossly deformed or decomposed and whether it continues to burn after passing through the flame.

C6 REPORTING OF RESULTS

The following shall be reported:

(a) Identification of the test sample.

(b) Any sample preparation or conditioning.

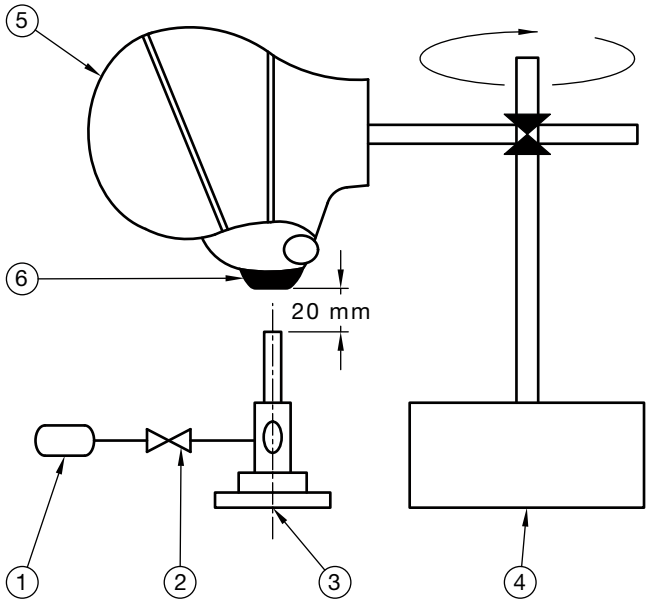
(c) The name of the test laboratory or authority responsible for performing the test.

(d) The dates of the test.

(e) Any observation, in relation to either the test sample or the performance of the test, which may assist in the correct interpretation of the test results.

(f) The results of each test.

(g) The number of this test method, i.e. Appendix C of AS/NZS 1716.



LEGEND:

1 = Regulated propane supply
2 = Control valve
3 = Propane burner
4 = Rotation and speed controller
5 = Dummy head
6 = Face piece

FIGURE C1 SCHEMATIC DIAGRAM OF TYPICAL APPARATUS FOR ASSESSMENT OF FLAMMABILITY

APPENDIX D

TOTAL INWARD LEAKAGE OF ASSEMBLED RESPIRATORS— QUANTITATIVE SODIUM CHLORIDE TEST

(Normative)

D1 SCOPE

This Appendix sets out the method of quantitatively assessing total inward leakage through the filter and around the facepiece, using a sodium chloride aerosol method and a panel of people.

The sodium chloride aerosol particles used in this test are much smaller than particles typically found in the workplace. This test does not indicate the performance of the respirator in actual use. It is used as an assessment of the ability of a respirator to achieve adequate fit over a variety of facial dimensions.

The method aims to test the efficiency of the whole unit and neither the facial seal nor filter efficiency alone.

D2 PRINCIPLE

The respirator is worn in a controlled atmosphere consisting of a suspension of sodium chloride (NaCl) aerosol in air. The air inside the respirator is sampled and analyzed by means of a detector, e.g. a flame photometer, for the sodium chloride content. Comparison is made with the aerosol concentration at the air intake of the respirator.

D3 APPARATUS

The apparatus to be used is described in Appendix L.

D4 PROCEDURE

D4.1 Subject preparation

A test panel of 10 subjects shall be selected according to Appendix B. Where there is more than one size of facepiece, the test subjects shall be supplied with the appropriate size.

Prior to commencement of testing, the respirator and filter shall be examined to ensure that they are in good working order and can be used without hazard.

Full facepiece respirators of the non-powered type may be tested with a simulated blank (see Paragraph L4.8).

The subjects shall be familiar with the use of the specific respirator under test or with similar equipment.

The test subjects shall be asked to read the manufacturer's fitting instructions and, if necessary, be shown how to fit the probe-equipped respirator correctly by the test supervisor, in accordance with the fitting instructions. The respirator shall be worn for at least 10 min before proceeding with the facial fit test. The sample probe shall rest just touching the subject's lips with the plane through the holes being vertical.

NOTE: A suitable probe is described in Appendix L; however, alternative probes of equal performance may be used.

The test subjects shall be informed that if they wish to adjust the respirator during the test they may do so. However, if this is done, the relevant section of the test shall be repeated after allowing the system to re-settle.

The test subject shall not be advised of the results as the test proceeds.

D4.2 Test—Non-powered filtering respirators—Sampled on inhalation only

After first ensuring that the test atmosphere is OFF, proceed as follows:

(a) Place the test subject in the enclosure. Connect the sampling probe as described in Appendix L. Have the test subject use an exercise machine at 25 watts, e.g. a treadmill at 6.5 km/h, for 2 min. Measure the test aerosol concentration inside the facepiece to establish the background level.

(b) When a stable reading is obtained, turn the test atmosphere on.

(c) Have the subject continue to use exercise machine for a further 2 min or until the test atmosphere has stabilized.

(d) While still using the exercise machine, the subject shall perform the following exercises:

(i) Keep head still, i.e. without moving or talking, for 2 min.

(ii) Turn head from side to side (approximately 15 times), as if inspecting the walls of a tunnel for 2 min.

(iii) Move the head up and down (approximately 15 times), as if inspecting the roof and floor for 2 min.

(iv) Read the following passage (or an effective alternative) being certain to read aloud and slowly:

‘When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colours. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond reach, his friends say he is looking for the pot of gold at the end of the rainbow.’

The passage should be re-read until a period of 2 min has elapsed.

(v) Walk, without head movement or talking, for 2 min.

(e) Record the following:

(i) Chamber (i.e. challenge) concentration.

(ii) Mean leakage integrated over each of the exercises set out in Step (d).

The leakage is calculated from measurements made over the last 100 s of each of the exercise periods to avoid carry-over of results from one exercise to the other—

$$P(\%) = \frac{C_2}{C_1} \times \left[\frac{t_{IN} + t_{EX}}{t_{IN}} \right] \times 100$$

where

C_1 = challenge concentration

C_2 = measured mean concentration (taken via an integration recorder)

t_{IN} = total duration of inhalation

t_{EX} = total duration of exhalation

(f) Turn off the test atmosphere and when the test aerosol has cleared from the chamber, the subject may leave.

Repeat Steps (a) to (f) for each test subject. After each test the filter shall be replaced. The facepiece shall either be replaced by a new sample or cleaned, disinfected and dried before being used again.

D4.3 Test—Powered filtering or supplied-air respirator

After first ensuring that the test atmosphere is OFF, provide each subject with a respirator having any one of the following—

(a) a fully-charged battery

(b) an equivalent power supply; or

(c) a supply of air, set at the minimum pressure to meet Clause 8.4, as appropriate.

Supplied-air respirators are to be tested with the maximum air-line/air-hose length and minimum recommended pressure.

Ensuring the respirator is turned ON comply with the following:

(i) Place the test subject in the enclosure. Connect the sampling probe as described in Appendix L. Have the test subject use an exercise machine at 25 watts (e.g. treadmill at 6.5 km/h) for 2 min. Measure the test aerosol concentration inside the facepiece to establish the background level.

(ii) When a stable reading is obtained, turn on the test atmosphere.

(iii) Have the subject continue to use the exercise machine for a further 2 min or until the test atmosphere has stabilized.

(iv) While still using the exercise machine, the subject shall perform the following exercises:

(A) Keep head still, i.e. without moving or talking, for 2 min.

(B) Turn head from side to side (approximately 15 times), as if inspecting the walls of a tunnel for 2 min.

(C) Move the head up and down (approximately 15 times), as if inspecting the roof and floor for 2 min.

(D) Read the following passage (or effective alternative) being certain to read aloud and slowly:

‘When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colours. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond reach, his friends say he is looking for the pot of gold at the end of the rainbow.’

The passage should be re-read until a period of 2 min has elapsed.

(E) Walk, without head movement or talking, for 2 min.

(v) Record the following:

(A) Chamber concentration.

(B) Mean leakage integrated over each of the exercises set out in Step (iv).

The leakage is calculated from measurements made over the last 100 s of each of the exercise periods to avoid carry-over of results from one exercise to the other—

$$P(\%) = \frac{C_2}{C_1} \times 100$$

where

C_1 = challenge concentration

C_2 = measured mean concentration

(vi) Turn off the test atmosphere and when the test aerosol has cleared from the chamber in order that the subject may leave.

Repeat Steps (i) to (vi) for each test subject. After each test the filter shall be replaced. The facepiece shall either be replaced by a new sample or cleaned, disinfected and dried before being used again.

D5 REPORTING OF RESULTS

The following shall be reported:

(a) Identification of the respirator.

(b) The name of the test laboratory or authority responsible for performing the test.

(c) The date(s) of the test(s).

(d) Information identifying the facial dimensions of the test panel.

(e) For non-powered filtering respirators, the integrated total inward leakage for each exercise for each individual.

(f) For other respirators, the mean total inward leakage for each exercise for each individual.

(g) Mean inward leakage of all exercises for the total panel.

(h) The number of this test method, i.e. Appendix D of AS/NZS 1716.

APPENDIX E

BREATHING SIMULATOR TESTS—OPEN CIRCUIT

(Normative)

E1 SCOPE

This Appendix sets out the following test open-circuit procedures which employ machine simulation of breathing:

(a) Breathing resistance and carbon monoxide filtering efficiency in filter self-rescuers (mines).

(b) Temperature rise in filter self-rescuers (mines).

(c) Breathing resistance and carbon dioxide accumulation.

(d) Positive pressure in facepieces and head coverings.

(e) Exhaled air humidity pre-conditioning.

Closed circuit tests which only apply to chemical oxygen (KO_2) self-contained self-rescuers are described in Appendix R.

E2 PRINCIPLE

The respirator to be tested is operated on a breathing machine which simulates natural breathing in one of a number of environmental and test conditions.

E3 APPARATUS

The apparatus shall consist of the following:

(a) A breathing simulator, designed to provide sinusoidal airflow. The simulator shall exhale and inhale through the facepiece, hood or mouthpiece of the apparatus under test. A diagram for a typical test rig is shown in Figure E1.

(b) Except where the respirator is fitted with a mouthpiece, a manikin of size and type suitable for testing the respirator.

NOTE: For full and half facepieces, a ‘Sheffield head’ (see Figure E2) is considered suitable for the purposes of this test. This is obtainable from:

Inspec International Ltd
56 Leslie Hough Way
Salford
Greater Manchester M6 6AJ
UNITED KINGDOM

OR

Phoenix Medical Ltd
Unit 3
Lancashire Enterprise Business Park
Leyland
PR26 6TZ
UNITED KINGDOM

(c) Where measurements of positive pressure (i.e. for hoods and head coverings) are required, a manometer capable of measuring pressurized air to an accuracy of 0.5 Pa (0.05 mm water gauge) over the range ±100 Pa (±10 mm water gauge) under the test conditions.

(d) Where measurements of breathing resistance are required, a manometer capable of measuring pressurized air to an accuracy of 5 Pa (0.5 mm water gauge) over the range ±1.2 kPa (±120 mm water gauge) under the test conditions.

(e) Where required, a means of measuring the temperatures of the inhaled and exhaled breath. (Where a single thermocouple is used to measure both temperatures, the thermocouple wires shall not be greater than 0.05 mm in diameter.)

(f) Where required, a means of measuring the concentration of carbon dioxide in air up to at least 5% by volume.

(g) Where carbon monoxide is being used in a test, a means of measuring the concentration of carbon monoxide in air up to at least 0.05% by volume. Some method of periodically checking supplied concentrations of carbon monoxide up to 1.5% by volume will also be necessary.

E4 PROCEDURE

Fit the facepiece, hood or head covering of the respirator onto a manikin. Adjust the head straps, support harness inner bib, and other components as necessary. Connect the manikin to the breathing simulator.

Operate the breathing simulator so that the respirator under test is subjected to the following:

(a) A tidal volume of 1.5 L with 20 respirations per minute (total air inhalation rate of 30 L/min).

(b) A tidal volume of 1.75 L with 20 respirations per minute (total air inhalation rate of 35 L/min).

(c) A tidal volume of 2.0 L with 20 respirations per minute (total air inhalation rate of 40 L/min).

(d) A tidal volume of 2.5 L with 38 respirations per minute (total air inhalation rate of 95 L/min).

(e) A tidal volume of 2.0 L with 25 respirations per minute (total air inhalation rate of 50 L/min).

(f) A tidal volume of 2.0 L with 32 respirations per minute (total air inhalation rate of 64 L/min).

(g) A tidal volume of 2.5 L with 40 respirations per minute (total air inhalation rate of 100 L/min).

E5 TESTS AND ENVIRONMENTAL CONDITIONS

E5.1 Breathing resistance and carbon monoxide filtering efficiency in filter self-rescuers (mines)

The breathing simulator shall be set to exhale air at a temperature of 37°C with a water vapour content of not less than 41.8 mg/L.

One active element shall be subjected to a continuous test run for at least 60 min in an atmosphere of 0.25% by volume of carbon monoxide in air at 24 ±1°C containing not less than 20.7 mg/L water vapour, under conditions specified in Paragraph E4(b).

The carbon monoxide content of the inhaled air shall be monitored during the test. The inhalation and exhalation resistance shall be measured at the beginning and end of the test.

E5.2 Temperature rise in filter self-rescuers (mines)

The breathing simulator shall be set to exhale air at a temperature of 37°C with a water vapour content of not less than 41.8 mg/L.

The active element shall be subjected to a continuous test run for at least 60 min in an atmosphere of 1.5% by volume of carbon monoxide in air at 23 ±1°C containing not less than 20.7 mg/L of water vapour, under conditions specified in Paragraph E4(b).

The temperature of the inhaled air shall be monitored during the test. The inhalation and exhalation resistance shall be measured at the beginning and end of the test.

E5.3 Carbon dioxide accumulation

The respirator shall be subjected to a test run as in Paragraph E4(c) and Figure E2. The breathing simulator shall be set to exhale a 5% by volume carbon dioxide/air mixture at 37°C with a water vapour content of not less than 41.8 mg/L.

The carbon dioxide content of the inhaled air shall be monitored.

The ambient temperature shall be within the range 25 ±5°C, provided that the temperature is held to within ±1° for the duration of the test. Relative humidity shall be within the range 30% to 60%, provided that it is held within ±5% for the duration of the test.

Where required, the duration of the test run shall be recorded.

Where a pressure gauge is fitted to the apparatus under test, the cylinder pressure shall be noted at the start and completion of the test.

E5.4 Resistance to breathing

The respirator shall be subjected to a test run as in Paragraph E4(d), (e) or (f) as required. The range of pressures within the cavity of the mask adjacent to the facial seal shall be measured during the respiratory cycle of the machine. The pressure recordings shall not be measured in the immediate vicinity of the inhalation point.

The maximum resistances shown on the manometer shall be noted.

E5.5 Positive pressure in facepieces and head coverings

The respirator shall be subjected to a test run, as described in Paragraph E4(a).

For battery-powered respirators, activate the blower unit and operate for not less than 4 h.

For air-supplied respirators with hoods or head coverings, operate the air supply in accordance with the manufacturer's specified minimum supply pressure or range of pressures.

The range of pressure within the breathing zone, except in the immediate vicinity of the inhalation point, shall be measured during the respiratory cycle of the machine.

The maximum pressures shown on the manometer shall be noted.

E5.6 Exhaled air humidity pre-conditioning

The breathing simulator shall be set to exhale air in accordance with Paragraph E4(a), at a temperature of 37°C with a water vapour content not less than 41.8 mg/L.

The test shall be conducted for 2 h and 45 min in total. During this time, at intervals of approximately 20 min, the respirator shall be completely removed from the dummy head and refitted so that during the test period the respirator is fitted eight times to the dummy head.

To prevent excess water spilling out of the dummy's mouth and contaminating the respirator, the head shall be inclined so that the water runs away from the mouth and is collected in a trap.

If during the test a strap breaks, the test shall be started again with a new respirator. The strap breakage shall be reported.

E6 REPORTING OF RESULTS

The following shall be reported:

(a) Identification of the test sample.

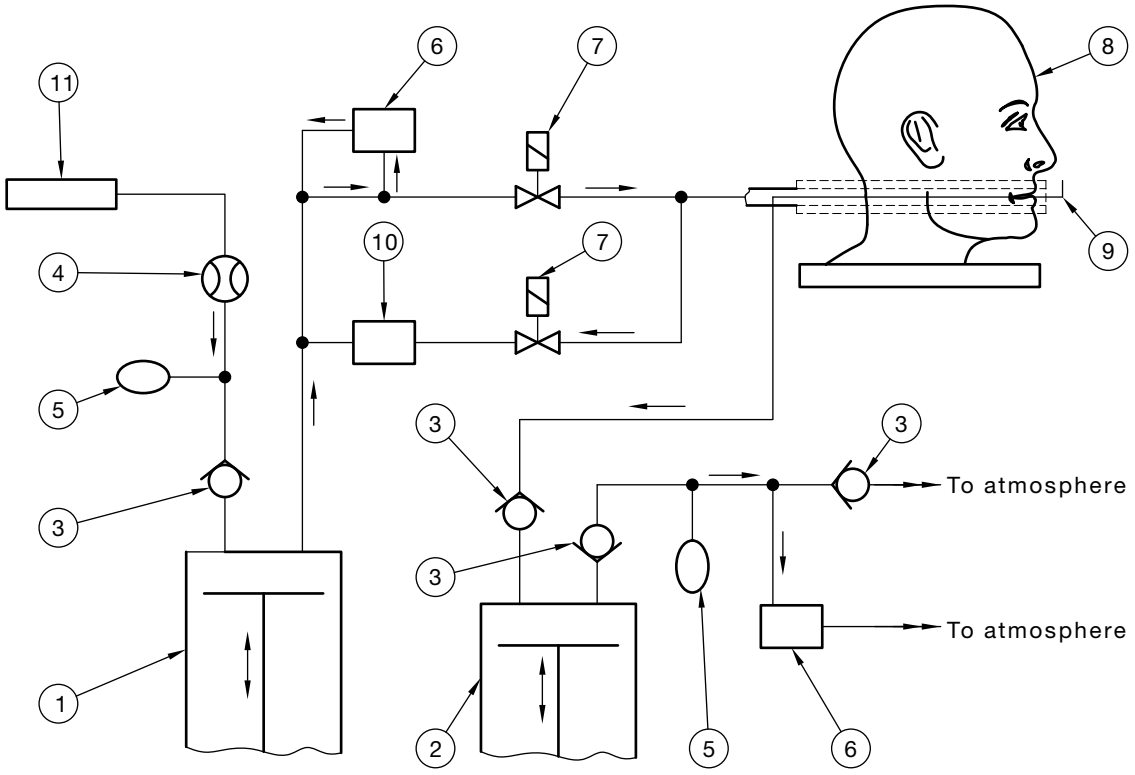
(b) Any sample preparation or conditioning.

(c) The name of the test laboratory or authority responsible for performing the test.

(d) The date(s) of the test(s).

(e) Any observation, in relation to either the test sample or the performance of the test, which may assist in the correct interpretation of the test results.

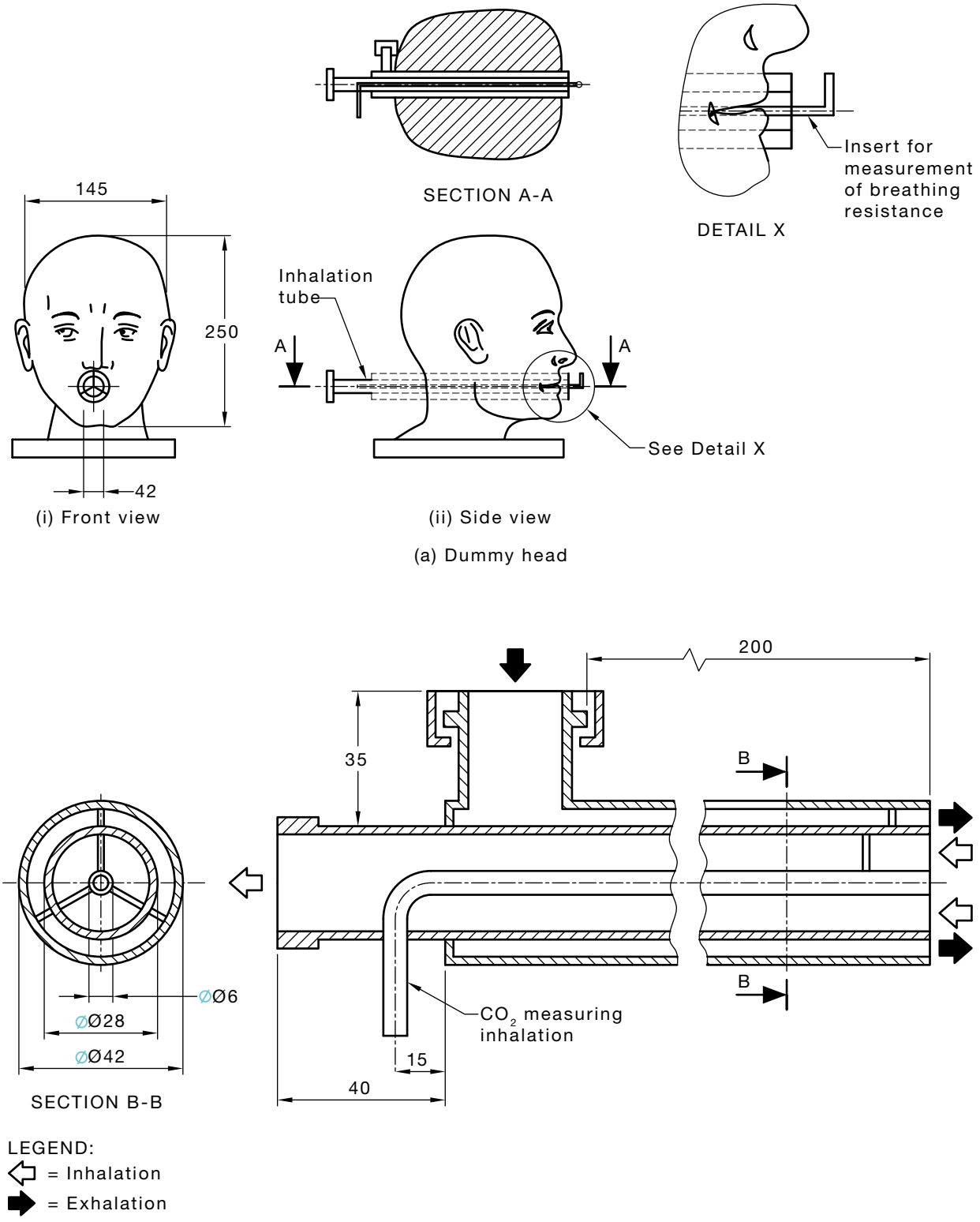
(f) The test procedure used in detail, e.g. procedure E4(c) Appendix E of AS/NZS 1716.



LEGEND:

1 = Breathing simulator
2 = Auxiliary breathing simulator
3 = Non-return valve
4 = Flowmeter
5 = Compensator
6 = Carbon dioxide analyser
7 = Solenoid valves
8 = Dummy head
9 = Sampling tube for inhalation air
10 = Carbon dioxide absorber
11 = Carbon dioxide supply

FIGURE E1 EXAMPLE OF A SUITABLE TEST RIG FOR DETERMINATION OF CARBON DIOXIDE CONTENT OF INHALATION OF AIR



DIMENSIONS IN MILLIMETRES

FIGURE E2 DUMMY HEAD (SHEFFIELD HEAD) FOR CARBON DIOXIDE CONTENT TEST OF THE INHALATION AIR (DEAD SPACE) FOR A FULL FACE MASK

APPENDIX F

EXHALATION VALVE LEAKAGE TEST

(Normative)

F1 SCOPE

This Appendix sets out a typical method for testing the leakage rate of the respirator exhalation valve.

F2 PRINCIPLE

The exhalation valve of a respirator is connected to leakage meter apparatus, exposed to a specified suction head, and the leakage rate from the exhalation valve noted.

NOTE: Valve assemblies can be connected to the leakage meter by simple jigs which may be fashioned from laboratory type rubber stoppers.

F3 APPARATUS

The apparatus shall consist of the following:

(a) A typical unit is shown in Figure F1. It consists of a cylindrical vessel 125 mm diameter, approximately 250 mm high, the open end of which is closed by a metal plate and a rubber gasket.

(b) A connection ‘A’ connects the apparatus to a vacuum line and a valve controls the rate of flow.

(c) Tube ‘B’ is open to air and the depth of insertion within the glass vessel can be varied by a simple gland.

(d) The component under test is attached to tube ‘C’ which has a gland to allow axial movement at a constant depth.

(e) The end of tube ‘C’ is bent so that it can be positioned centrally under the 30 mL glass measuring vessel, which is attached to the air release tap ‘D’ by a rubber sleeve.

F4 PREPARATION

To prepare the leakage meter for use—

(a) fill the 30 mL measuring vessel to the zero mark with water;

(b) close tube ‘C’ and apply suction to the meter through tube ‘A’;

(c) adjust the flow rate, by means of the valve in the suction line, until the rate of bubbles rising from the bottom of tube ‘B’ is approximately 60 to 80 bubbles per minute; and

(d) attach the manometer to tube ‘C’ and adjust the depth of tube ‘B’ until the pressure in tube ‘C’ is 245 Pa (25 mm of water).

F5 PROCEDURE

The procedure shall be as follows:

(a) Attach the component under test to tube ‘C’ by a suitable jig or connection and move tube ‘C’ from under the measuring vessel.

(b) Open the air release tap to allow air to escape from the measuring vessel and then close the tap.

(c) When conditions are steady, relocate the end of tube ‘C’ under the measuring vessel. Record the time and the amount of leakage into the measuring vessel.

(d) Calculate the leakage rate, in mL/min.

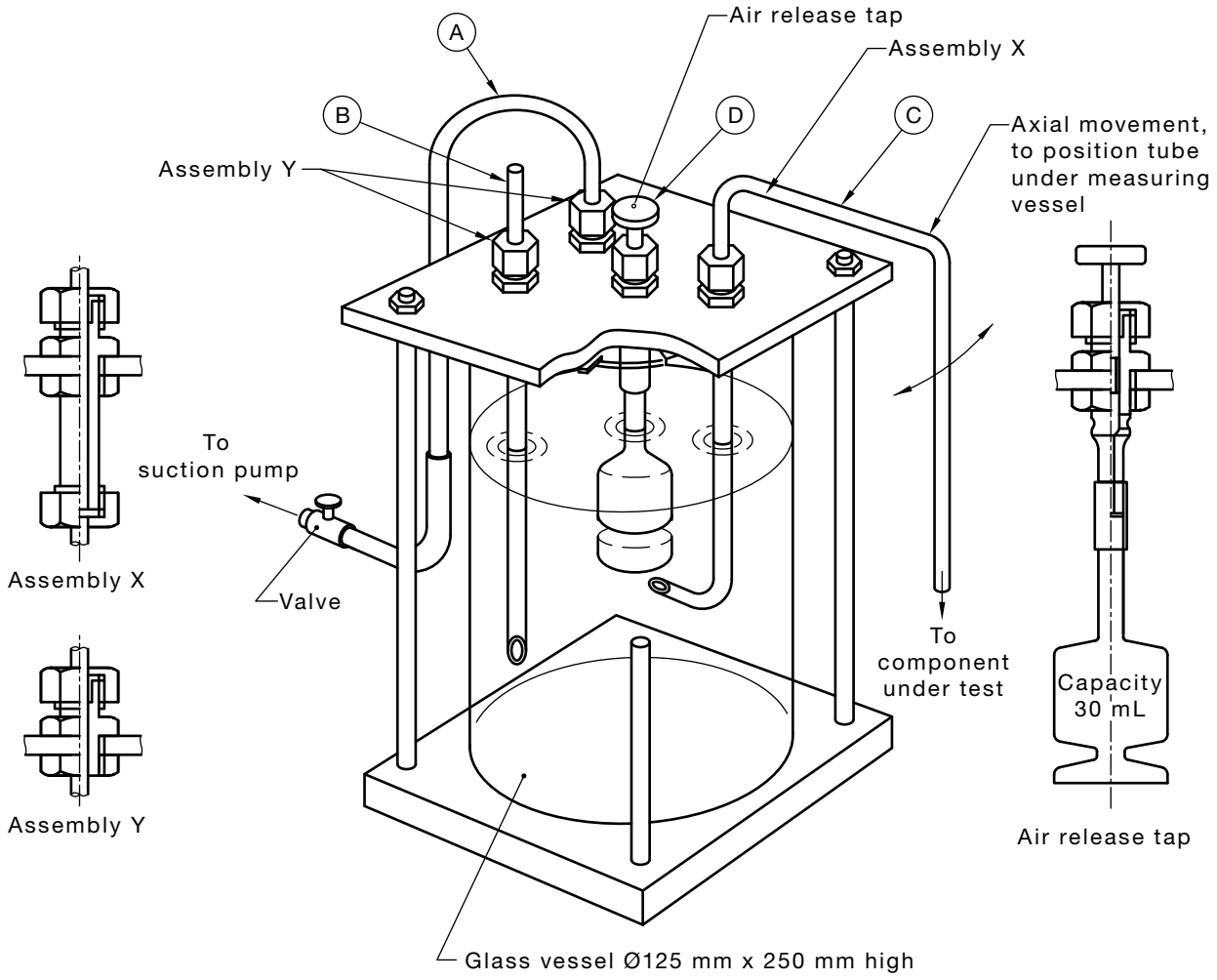


FIGURE F1 TYPICAL LEAKAGE METER

F6 REPORTING OF RESULTS

The following shall be reported:

(a) Information identifying the respirator.

(b) The name of the test laboratory or authority responsible for performing the test.

(c) The date(s) of the test(s).

(d) The leakage rate per minute from each exhalation valve.

(e) The number of this test method, i.e. Appendix F of AS/NZS 1716.

APPENDIX G

BREATHING RESISTANCE TEST

(Normative)

G1 SCOPE

This Appendix sets out the method of testing the resistance of respirators (and associated filters where appropriate) under continuous-flow conditions.

G2 PRINCIPLE

Breathing resistance of the respirator is measured under continuous-flow conditions at specified flow rates at a temperature of 23 ±3°C.

G3 APPARATUS

Typical arrangements for a resistance meter for measuring both negative and positive pressure, as shown in Figure G1, consist of a control valve, a flowmeter and a manometer.

The measuring tube to which the component under test is connected should have an internal diameter of not less than 22 mm and the manometer tapping should be arranged so that the true static pressure within the tube is indicated by the manometer. Some form of simple jig may be necessary to facilitate the connection of the component to the resistance meter.

G4 PROCEDURE

The procedure shall be as follows:

(a) Attach the jig, if used, to the resistance meter.

(b) Set the airflow at the required rate by means of the control valve and adjust the manometer to the zero position.

(c) Fit the component to be tested to the jig and note the pressure reading on the manometer.

G5 REPORTING OF RESULTS

The following shall be reported:

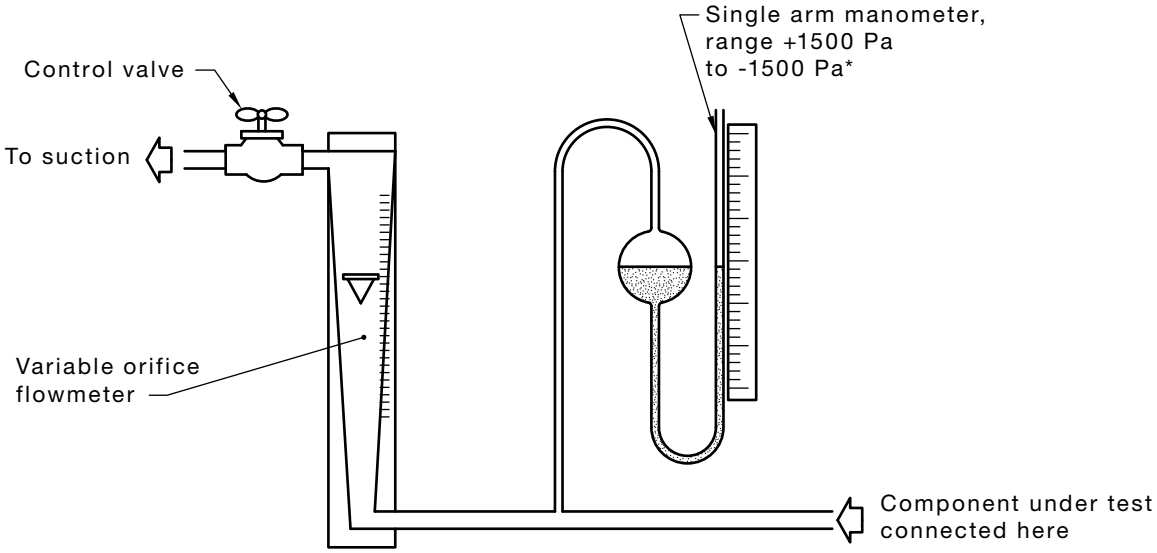
(a) Information identifying the respirator.

(b) The name of the test laboratory or authority responsible for performing the test.

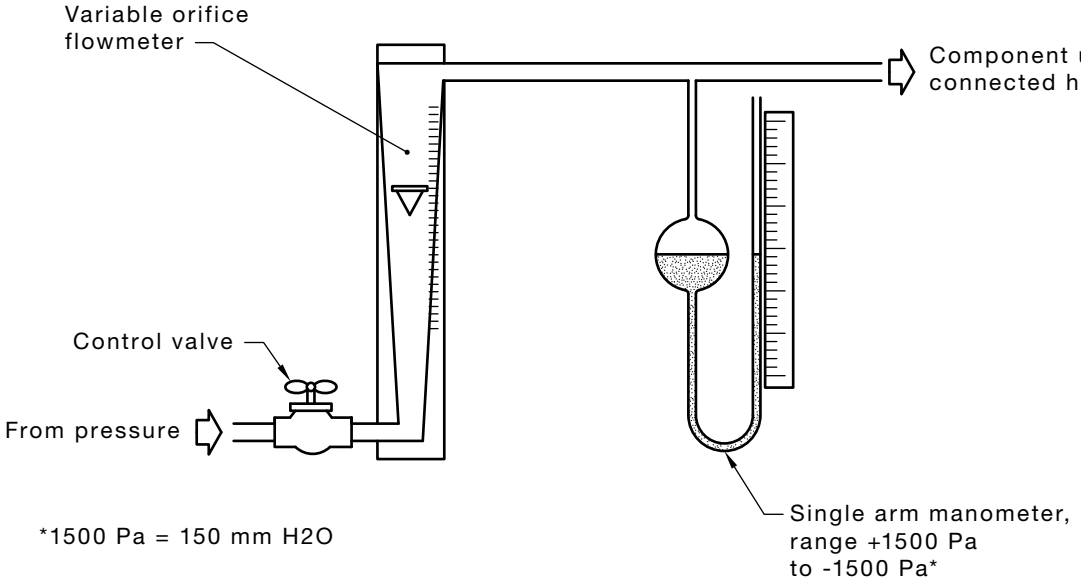
(c) The date(s) of the test(s).

(d) The maximum exhalation or inhalation resistance, as appropriate.

(e) The number of this test method, i.e. Appendix G of AS/NZS 1716.



(a) Suction



(b) Pressure

FIGURE G1 TYPICAL RESISTANCE METER

APPENDIX H

SIMULATED ROUGH USAGE TESTS

(Normative)

H1 SCOPE AND APPLICATION

H1.1 Scope

This Appendix sets out methods for testing particulate and gas filters, the carbon dioxide absorption units of compressed oxygen work sets and chemical oxygen self-rescuers to ensure that they will remain stable under conditions of rough usage or handling.

H1.2 Application

All particulate and gas filters shall be tested as described in Paragraph H3. Paragraph H4 describes an alternative method that may be used. In case of dispute, the results of testing performed on filters subject to the method described in Paragraph H3 shall be considered correct.

Chemical oxygen self-contained self-rescuers and carbon dioxide absorption units of compressed oxygen work sets shall be tested as described in Paragraph H6. Half of the chemical self-contained self-rescuer samples are then subject to water leakage tests and the others to internal examination.

H2 PRINCIPLE

All respirator filters enclosed in separate rigid containers and intended to comply with Section 4, 5 or 6 are subjected to shaking to ensure that they remain stable under conditions of rough usage.

All chemical oxygen self-contained self-rescuers and carbon dioxide absorption units of compressed oxygen work sets are subjected to impact and vibration.

H3 TEST APPARATUS AND PROCEDURE FOR RESPIRATOR FILTERS

The filters shall be tested in the ‘as received’ conditions. They shall be removed from their packaging, placed in the tray and arranged as shown in Figure H1, so that each filter has a movement of 6 ±1 mm. The tray shall then be subjected to a horizontal reciprocating movement at a rate of between 180–200 cycles per minute with a peak to peak stroke of 85 ±2 mm for the times shown in Table H1.

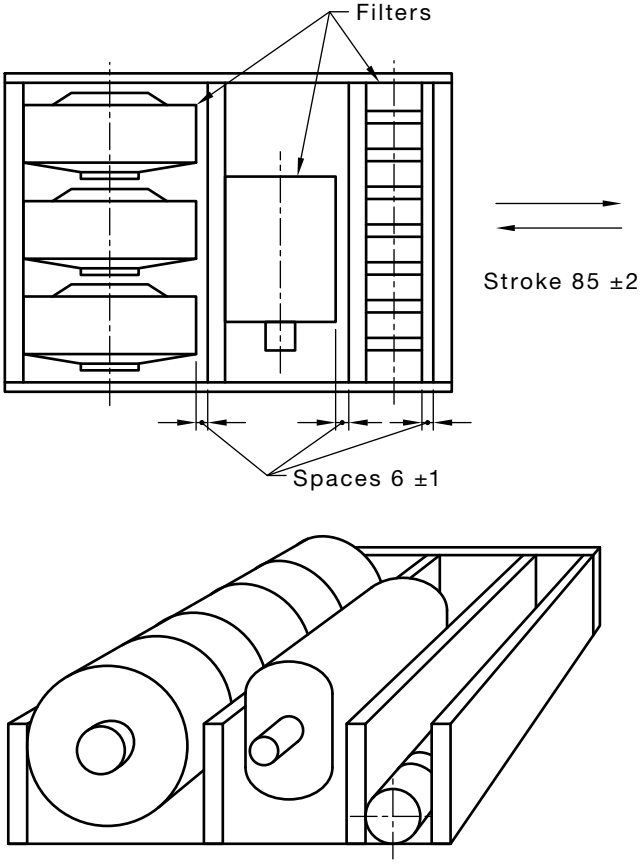
H4 ALTERNATIVE TEST APPARATUS AND PROCEDURE FOR RESPIRATOR FILTERS

The filters shall be tested in the ‘as received’ conditions. They shall be removed from their packaging, placed on their sides in the case and arranged so that they do not touch one another during the test, using the apparatus shown schematically in Figure H2. The apparatus consists of a steel case which is fixed on a vertically moving piston, capable of being lifted up 20 mm by a rotating cam and dropping down onto a steel plate under its own mass as the cam rotates. The mass of the steel case shall be greater than 10 kg.

The test rig is operated at the rate of approximately 100 cycles per minute for approximately 20 min and a total of 2000 cycles.

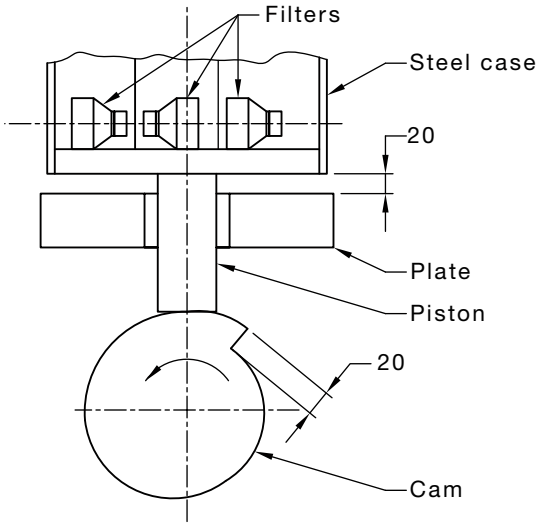
TABLE H1
RESPIRATOR FILTER TEST TIMES

Filter type	Time, min
Particulate filters	10
Gas and vapour filters Class AUS and Class 1 (including combined gas and particulate filters)	10
Gas and vapour filters Classes 2 and 3 (including combined gas and particulate filters)	30
Other filters	30



DIMENSIONS IN MILLIMETRES

FIGURE H1 TYPICAL ARRANGEMENT OF FILTERS DURING ROUGH USAGE TEST



DIMENSIONS IN MILLIMETRES

FIGURE H2 ALTERNATIVE TEST EQUIPMENT FOR ROUGH USAGE TEST

H5 TEST APPARATUS FOR VIBRATION RESISTANCE

The test apparatus shall consist of a flat platform of suitable size and suitable mass carrying capacity coupled to two shaft-driven eccentrics which are mounted on a base framework. The eccentrics shall produce a maximum peak-to-peak vertical displacement of the upper surface in the region between the drive shafts of 25.5 ±0.5 mm. The movement of the platform shall be such that it describes a circle with a diameter of 25.5 ±0.5 mm in the vertical plane.

The acceleration of the platform in the plane of rotation shall be between 1.1 g and 1.2 g. This can be attained by a mean shaft speed of 285 ±3 r/min.

Barriers shall be positioned so that the horizontal motion of a test apparatus when placed at the centre of the platform in its normal position shall have a free movement in any horizontal direction of nominal 6 mm.

For the purpose of this test, the chemical oxygen self-rescuer or carbon dioxide absorption unit of a compressed oxygen work set is not fastened nor otherwise fixed to the machine.

The acceleration is controlled by the shaft speed. The acceleration of the test sample need not be measured.

H6 TEST PROCEDURE FOR CHEMICAL OXYGEN SELF-RESCUERS

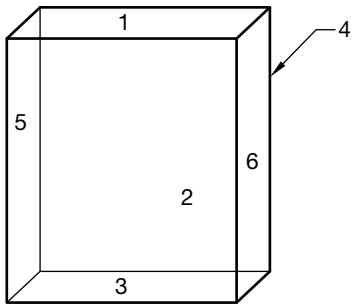
H6.1 Impact

Prior to testing to Paragraph H6.2, all chemical oxygen-rescuers and carbon dioxide absorption units of compressed oxygen work sets shall be tested for resistance to impact. Each sample shall be dropped three times from a height of 1.5 m onto a concrete floor. The test shall be conducted so that a different face is subject to impact on the concrete surface.

H6.2 Vibration resistance

Using the equipment described in Paragraph H5, each chemical oxygen self-rescuer and carbon dioxide absorption unit of a compressed oxygen work set is vibrated for 1 hour while it is standing on face ‘3’ (see Figure H3), 1 hour while it is standing on face ‘1’ and 1 hour while it is lying on face ‘6’.

Samples not tested for water leakage shall be dismantled and the breathing circuit examined for migration of any powdered chemical.



NOTE: Face 4 makes contact with the body of the wearer.

FIGURE H3 IDENTIFICATION OF FACES
OF RECTANGULAR APPARATUS

H6.3 Water leakage

The complete chemical oxygen self-contained self-rescuer including the carrying case shall be weighed and its mass recorded. This shall be subjected to the following tests, one after the other:

(a) Submerge the assembled apparatus in a water bath at 80 ±3°C for 8 h.

(b) Submerge the assembled apparatus in a water bath at 23 ±3°C for 16 h.

NOTE: Any material that is not an essential part of the carrying case or apparatus may be removed prior to the water leakage test.

The outside surface shall be wiped to remove any moisture. The assembled apparatus including the carrying container shall be weighed and the mass recorded.

H7 REPORTING OF RESULTS

The following shall be reported:

(a) Identification of the test sample.

(b) Any sample preparation or conditioning.

(c) The name of the test laboratory or authority responsible for performing the test.

(d) The dates of the test(s).

(e) Any observation, in relation to either the test sample or the performance of the test, which may assist in the correct interpretation of the test results.

(f) Details of any visible damage sustained by the filter, carbon dioxide absorption unit or self-rescuer.

(g) The number of this test method, i.e. Paragraph H3, H4 or H6 of Appendix H of AS/NZS 1716.

APPENDIX I

PARTICULATE FILTERS—TEST FOR FILTERING EFFICIENCY

(Normative)

I1 SCOPE

This Appendix sets out the method for determining the filter efficiency of particulate respirators. It is a test of initial filter penetration using an aerosol of sodium chloride.

I2 PRINCIPLE

An aerosol of sodium chloride particles is generated by atomizing an aqueous solution of the salt and evaporating the water. The concentration of this aerosol is measured by appropriate means, e.g. hydrogen flame photometry, before and after the filter is tested. Accurate determinations are possible in the range <0.001% to 100% filter penetration.

I3 APPARATUS

The apparatus used is described in Appendix L.

I4 PROCEDURE

The test aerosol is fed into the test chamber, where the filter is fixed. The specified flow rate is passed through the filter and the aerosol concentration is measured immediately before and after the filter by a flame photometer, or other suitable method.

I5 CALCULATION OF THE PENETRATION

Penetration shall be calculated using the following equation:

$$P = \frac{C_2}{C_1} \times 100\%$$

where

P = penetration

C_1 = NaCl concentration before the filter

C_2 = NaCl concentration after the filter

I6 REPORTING OF RESULTS

The following shall be reported:

(a) Information identifying the filter/respirator.

(b) Any sample preparation or conditioning.

(c) The name of the test laboratory or authority responsible for performing the tests.

(d) The date(s) of the test(s).

(e) Any observation, in relation to either the test samples or the performance of the tests, which may assist in the correct interpretation of the test results.

(f) The number of samples tested.

(g) The flow rate of the test.

(h) The filter penetration as a percentage for each sample.

(i) Information identifying the test method.

(j) The number of this test method, i.e. Appendix I of AS/NZS 1716.

APPENDIX J

SIMULATED WORK TESTS

(Normative)

J1 SCOPE

This Appendix describes the tests designed to assess the suitability of self-rescue and supplied-air respirators for use in a variety of work situations.

J2 APPLICATION

Five test procedures are described to assess compressed air SCBA respirators, compressed oxygen SCBA respirators, air-line respirators and air-hose respirators, filter self-rescuers and chemical oxygen self-rescuers.

J3 TEST SUBJECTS

The respirators shall be tested on test subjects who practise regularly with respirators and whose medical and physical conditions are known to be satisfactory.

J4 TEST PROCEDURE

J4.1 General

A number of subjects, as decided by the test authority, shall be fitted with the respirator submitted for test. After the respirator has been correctly adjusted, wearers shall perform one of the simulated work tests described below.

J4.2 Simulated work tests for air-line or compressed-air SCBA respirators—Work or rescue type

J4.2.1 *General*

The tests shall be performed using either one of the procedures set out in Paragraphs J4.2.2 and J4.2.3.

J4.2.2 *Work test*

The following test shall be continuous without removal of the respirator and shall be performed for a period equal to the nominal effective life of the charged cylinder or 15 min for an air-line or air-hose respirator:

(a) Remove 1 kg rectangular section blocks (100 mm × 75 mm) from a shelf approximately 300 mm above head height and stack the blocks on the floor at least two paces (2 m to 3 m) from the shelf. When all blocks have been removed and stacked, they shall be replaced on the shelf. Each block shall be moved separately and at the rate of 6 to 8 blocks per minute. This task shall be continued for one-third of the period.

(b) One-third of the period ascending and descending two steps, each having a 220 mm rise, at a rate of 12 times per minute.

(c) One-third of the period walking on level ground at a rate of 6.5 km/h.

J4.2.3 *Alternative test*

The test shall be continuous without removal of the respirator and shall be completed within a total working time of 30 min.

The sequence of activities is at the discretion of the testing authority but shall generally comply with the following:

(a) 30 pulls on a work machine, each pull being vertical from 1.8 m towards the ground on a mass of 25 kg.

(b) Walking on the level with full headroom along a total distance of 125 m.

(c) Walking on the level with headroom of 1.1 m to 1.5 m along a total distance of 200 m.

(d) Crawling on the level with headroom of less than 0.75 m along a total distance of 100 m.

(e) Climbing up and down a ladder and passing once, in both directions, through a 460 mm square opening. Total vertical distance 20 m.

(f) Carrying approximately 22 sandbags (15 kg each) individually over a distance of at least 9 m and placing them on a wall 1.4 m high.

J4.3 Simulated work test for compressed-air SCBA—Escape type

The test shall be continuous without removal of the respirator and shall be performed for a period equal to the nominal effective life of the charged cylinder as follows:

(a) Remove 1 kg rectangular section blocks (100 mm × 75 mm) from a shelf approximately 300 mm above head height and stack the blocks on the floor at least three paces (2 m to 3 m) from the shelf. When all blocks have been removed and stacked, they shall be replaced on the shelf. Each block shall be moved separately and at the rate of 6 to 8 blocks per minute. This task shall be continued for one-half of the period.

(b) One-half of the period walking at a rate of 6.5 km/h on level ground.

J4.4 Simulated work test for compressed oxygen SCBAs

The following tasks shall be performed at the test subject's own pace and after the completion of each task there shall be a rest period not exceeding 5 min:

(a) Fifteen minutes carrying 15 kg sandbags over a distance of at least 9 m and placing them on a wall 1.4 m high.

(b) Ten minutes negotiating a circuit of a gallery which comprises a ramp and a series of beams of constant length of 9 m and varying heights of 1.8, 1.35, 1.2, 0.9 and 0.6 m.

(c) Ten minutes carrying, pushing or pulling a dummy body with a mass of 68 kg and strapped to a stretcher, around the same circuit of the gallery.

(d) Twenty minutes passing 15 kg sandbags through a steel tube 3.7 m long by 0.7 m in diameter.

(e) Five minutes repeatedly raising and lowering a weight of 25.4 kg mass from a height of 1.8 m by means of a rope and pulley in a climatic chamber with a temperature of 38 ±2°C and relative humidity of 75% to 95%.

(f) Fifteen minutes climbing over three 1.2 m high hurdles.

(g) Ten minutes climbing up and down a vertical ladder of 5.5 m.

(h) Five minutes carrying and building chock pieces in a climatic chamber with a temperature of 38 ±2°C and relative humidity of 75% to 95%.

J4.5 Simulated work test for escape respirators—Filtration type

After removing the apparatus from the sealed container, a number of persons, selected by the testing authority, shall don the apparatus and enter a gas chamber containing air at a temperature of 23 ±3°C and an RH of 50% to 70%.

The following 60 min work cycle shall be performed while wearing the apparatus:

(a) Twelve minutes ascending and descending two steps, each having a rise of 220 mm, at a rate of 12 times per minute.

(b) Four minutes rest.

(c) Twelve minutes working at a rate of 6.5 km/h on level ground.

(d) Four minutes rest.

(e) Repeat Steps (a), (b), (c) and (d).

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.

J4.6 Simulated work test for escape respirators—Chemical oxygen self-rescuer type

Simulated escape tests shall be performed with at least two apparatus and two test subjects.

The execution of further tests is at the discretion of the testing authority.

At the start of the tests the wearer shall follow the manufacturer's instructions for activating and donning the apparatus.

After removing the apparatus from the sealed container, a wearer shall don the apparatus and enter a test chamber containing air at a temperature of 23 ±3°C and a RH of 50% to 70%.

The following work cycle shall be performed while wearing the apparatus:

(a) Eleven minutes ascending and descending two steps, each having a rise of 220 mm, at a rate of 12 times per minute.

(b) Four minute rest.

(c) Eleven minutes walking at a rate of 6.5 km/h on level ground.

(d) Four minute rest.

(e) Repeat Steps (a), (b), (c) and (d).

During the tests the wearer shall subjectively assess the operational comfort and efficiency of the apparatus.

After the simulated escape test an assessment of the apparatus shall be made by the test subject with regard to comfort of breathing and of wearing of the apparatus.

NOTE: A suitable example of an Assessment Questionnaire/Report is provided in Appendix O.

J5 ASSESSMENT

During the testing of these respirator types, the wearer shall subjectively assess the apparatus and record the following:

(a) Harness comfort.

(b) Security of fastenings and couplings.

(c) Accessibility of controls and pressure gauge or pressure indicator where fitted.

(d) Clarity of vision from the facepiece.

(e) Accessibility and ease of operation of the supplementary supply, where fitted.

(f) Speech transmission.

(g) Audible warning device, where fitted.

(h) Manoeuvrability of the air-line.

(i) Comfort of the facepiece.

(j) Any other comments volunteered by the wearer.

J6 REPORTING OF RESULTS

The following shall be reported:

(a) Identification of the test sample.

(b) The name of the test laboratory or authority responsible for performing the test.

(c) The date(s) of the test(s).

(d) The identity of any reference material used to assist in the validation of the test result.

(e) Any observation, in relation to either the test sample or the performance of the test, which may assist in the correct interpretation of the test results.

(f) A record of the wearer's assessment regarding the suitability of the respirator as recorded in Paragraph J5 or elsewhere.

(g) The number of this test method, i.e. Appendix J of AS/NZS 1716.

NOTE: The report may be used by a regulatory authority in its assessment of the respirator for approval purposes.

APPENDIX K

VOID

APPENDIX L

APPARATUS TO BE USED IN SODIUM CHLORIDE AEROSOL TESTS

(Normative)

L1 SCOPE

This Appendix lists the apparatus and test conditions required to test both the filtering efficiency of particulate respirators and the total inward leakage of assembled respirators, using a sodium chloride aerosol.

L2 APPARATUS AND TEST CONDITIONS COMMON TO BOTH TESTS

L2.1 Aerosol generator

An aerosol of solid sodium chloride is generated from a solution of reagent grade sodium chloride in distilled water. The aerosol is polydisperse with particles mainly within the size range 0.02 to 2 µm equivalent diameter and has a mass median particle diameter of approximately 0.3 to 0.6 µm.

The aerosol is dispersed in an air stream of sufficient volume to comply with the relevant requirements of Paragraphs L3 and L4.

An example of a suitable system for filter testing, using the atomizer described in EN 13274-7, would be—

(a) concentration of NaCl solution—1%;

(b) flow rate to atomizer—12.75 ±0.25 L/min;

(c) air pressure to atomizer—345 ±14 kPa;

(d) relative humidity of aerosol/diluted air mixture—<60%; and

(e) temperature of air—23 ±2°C.

For total inward leakage testing, the generator described in BS 3928 is suitable.

NOTE: For testing supplied-air and PAPR devices, the supply of aerosol/air atmosphere must be sufficient to prevent undue dilution of the test atmosphere. Air supplies up to 5000 L/m may be necessary to ensure this.

L2.2 Detection

The concentration of the sodium chloride challenge aerosol is measured before and after passing through the filter or respirator under test. The hydrogen flame photometer, described in EN 13274-7, is acceptable. An interference filter with a band pass width of no greater than 3 nm is needed to reduce response to other elements, particularly carbon. Other methods of detection shown to be of equivalent accuracy and sensitivity may be used, e.g. a solid-state photometer.

L3 APPARATUS AND CONDITIONS FOR FILTER TESTING

L3.1 Apparatus

A schematic illustration of the set-up is shown in Figure L1.

L3.2 Conditions for filter testing

The challenge aerosol concentration should be in the range 5 to 15 mg/m^3, but shall remain constant within ±5% during a test series.

L4 APPARATUS AND CONDITIONS FOR FACIAL FIT TESTING

L4.1 Aerosol

The challenge aerosol concentration should be in the range 5 to 15 mg/m^3, but shall remain constant within ±5% during a test.

L4.2 Apparatus

A schematic illustration of the set-up for total inward leakage is shown in Figure L2.

L4.3 Detection system

L4.3.1 *General*

The detector should be capable of measuring concentrations of a sodium chloride aerosol between 15 mg/m^3 and 0.005 mg/m^3. Its response time, excluding that of the sampling system, should be greater than 500 ms. The total aerosol sample required should not be greater than 15 L/min.

L4.3.2 *Test atmosphere*

The test atmosphere preferably enters the top of the chamber through a flow distributor and is directed downwards over the head of the test subject, as shown in Figure L2. The variation in the concentration of the test atmosphere throughout the effective working volume shall not exceed 10%.

NOTE: To achieve these conditions a face velocity of at least 0.12 m/s may be required.

L4.3.3 *Sampling of chamber concentration*

The chamber aerosol concentration is monitored during the tests, using a separate sampling system, to avoid contamination of the respirator sampling lines. It is preferable to use a separate detector for this purpose. (See Figure L2.)

If a second detector is not available, the chamber concentration may be sampled with the same sampling system. However, time will then have to be allowed for the detector to return to a clean background.

L4.4 Exercise machine

An exercise machine capable of working at a rate of 25 watts (equivalent to walking 6.5 km/h on a treadmill) is required.

L4.5 Sample pumps

If no pump is incorporated into the detector, an adjustable flow pump is used to withdraw an air sample from the respirator under test. This pump is adjusted so as to withdraw a continuous flow of 1 to 3 L/min from the sample probe.

Dependent on the type of detector, it may be necessary to dilute the sample with clean air.

L4.6 Sample tubes

Sampling tubes shall be made of plastics with a nominal internal diameter of not less than 4 mm. The length of tubing shall be as short as possible. Where separate tubes are used to sample the chamber and respirator, they should be of equal size and length and follow similar paths.

L4.7 Sampling system

L4.7.1 *Sample selector*

A system is required for non-powered air-purifying respirators which will switch the sample to the detector during the inhalation phase of the respiratory cycle. During the exhalation phase, clean air is fed to the photometer. The essential elements of such a system are as follows:

(a) An electrically-operated valve with a response time of the order of 100 ms. The valve should have the minimum possible dead space compatible with straight-through, unrestricted flow when open.

(b) A pressure sensor which is capable of detecting a minimum pressure change of approximately 0.5 Pa and which can be connected to a probe inserted in the cavity of the filtering half mask. The sensor requires an adjustable threshold and be capable of differential signalling when the threshold is crossed in either direction. The sensor needs to work reliably when subjected to the accelerations produced by the head movements of the subject.

(c) An interfacing system to actuate the valve in response to a signal from the pressure sensor.

(d) An integrating recorder to average the readings over the proportion of the total respiratory cycle during which sampling took place.

(e) A timing device to record the total proportion of the time that inhalation takes place.

A typical diagram of the testing scheme is shown in Figure L2.

L4.7.2 *Sampling probe*

The probe consists of a length of 2 mm nominal bore tube fitted securely in an airtight manner to the respirator as near as possible to the centre-line. Attached to the tube is a plastic ball, 20 mm diameter, which has eight 1.5 mm holes drilled radially in the vertical plane. These holes communicate with a central hole which enters the ball at right angles to the vertical plane. The central hole is connected to the hypodermic tube. The probe is adjusted so that the ball just touches the wearer's lips.

Where the cavity of the mask is insufficient to accommodate the sampling probe an alternative probe which fulfils the same function may be used.

A typical head mount is shown in Figure L3.

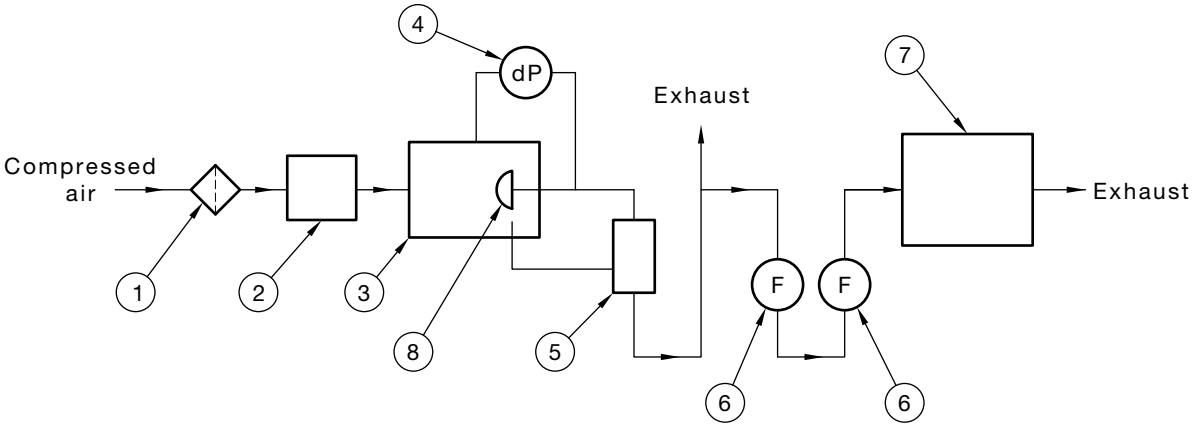
NOTE: A suitable supply of balls may be obtained from laboratory suppliers by specifying plastic balls used for temperature-controlled water baths.

L4.7.3 *Pressure detection probe (required only for non-powered air-purifying respirators)*

A second probe is fitted near to the sample probe and is connected to the pressure sensor described in Paragraph L4.7.1(b).

L4.8 Filter simulator blank (full facepiece only)

If the facepiece is to be used with a filter having a standard thread, a device which simulates the maximum weight and resistance of filters permitted for that type of facepiece is shown in Figure L4. This simulator shall be connected to a clean air supply by an ultra-lightweight flexible hose. If the facepiece uses a special connection the clean air supply shall be attached to the filter or equipment normally used with the facepiece. It is important that the attachment of the clean air-hose to the facepiece does not affect the fit of the facepiece and if necessary the hose shall be supported. (See also Figure L5.)

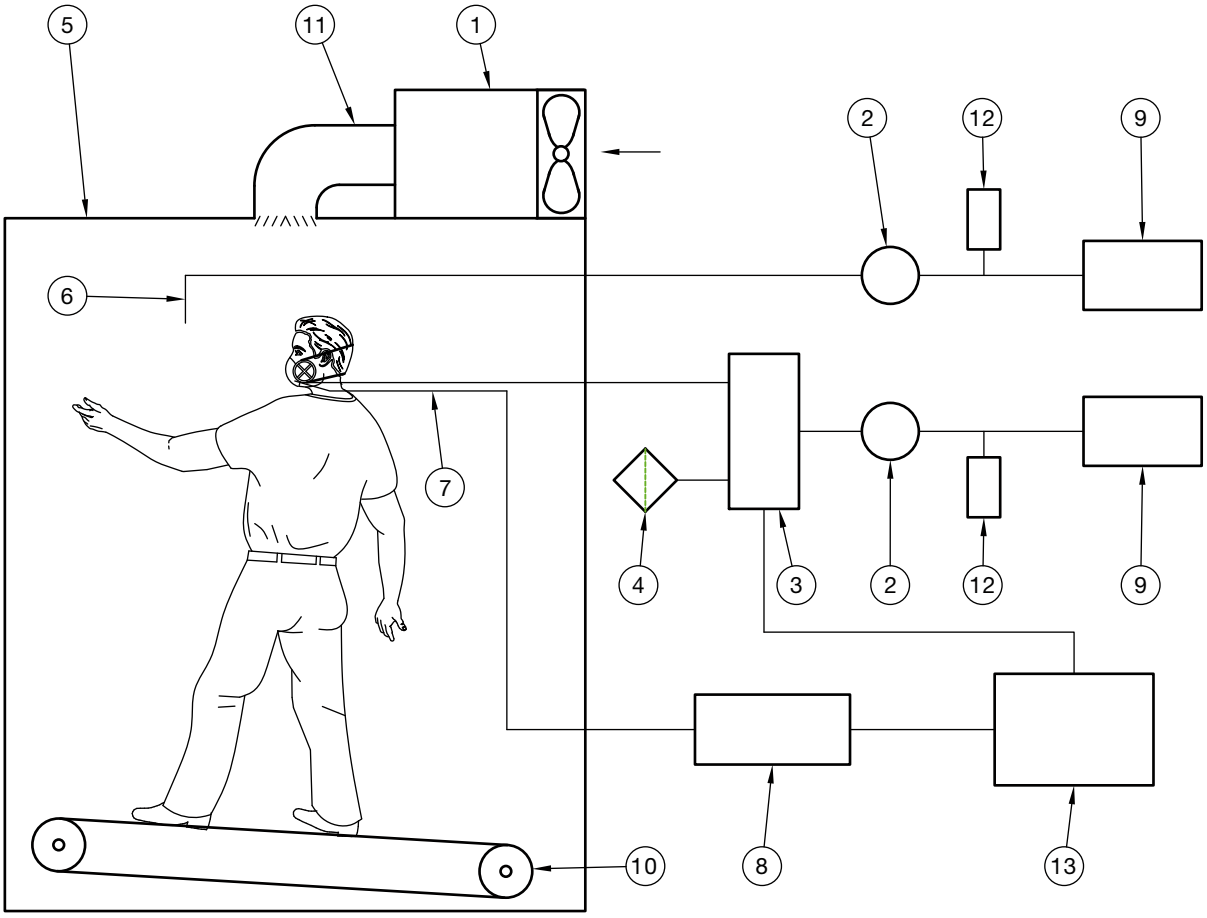


LEGEND:

1 = Air filter
2 = Test aerosol generator
3 = Test chamber
4 = Differential pressure indicator
5 = Change-over valve
6 = Flowmeter
7 = Aerosol measuring apparatus
8 = Specimen filter

DIMENSIONS IN MILLIMETRES

FIGURE L1 APPARATUS FOR SODIUM CHLORIDE TEST



LEGEND:

1 = Atomiser
2 = Pump
3 = Change-over valve
4 = Filter
5 = Test chamber
6 = Chamber sampling line
7 = Respirator sampling lines
8 = Pressure sensor
9 = Photometer
10 = Exercise machine
11 = Ducting and baffle
12 = Additional clean air supply
13 = Pulsed sampling interface

DIMENSIONS IN MILLIMETRES

FIGURE L2 APPARATUS USED IN TOTAL INWARD LEAKAGE TESTING OF NON-POWERED AIR-PURIFYING RESPIRATORS

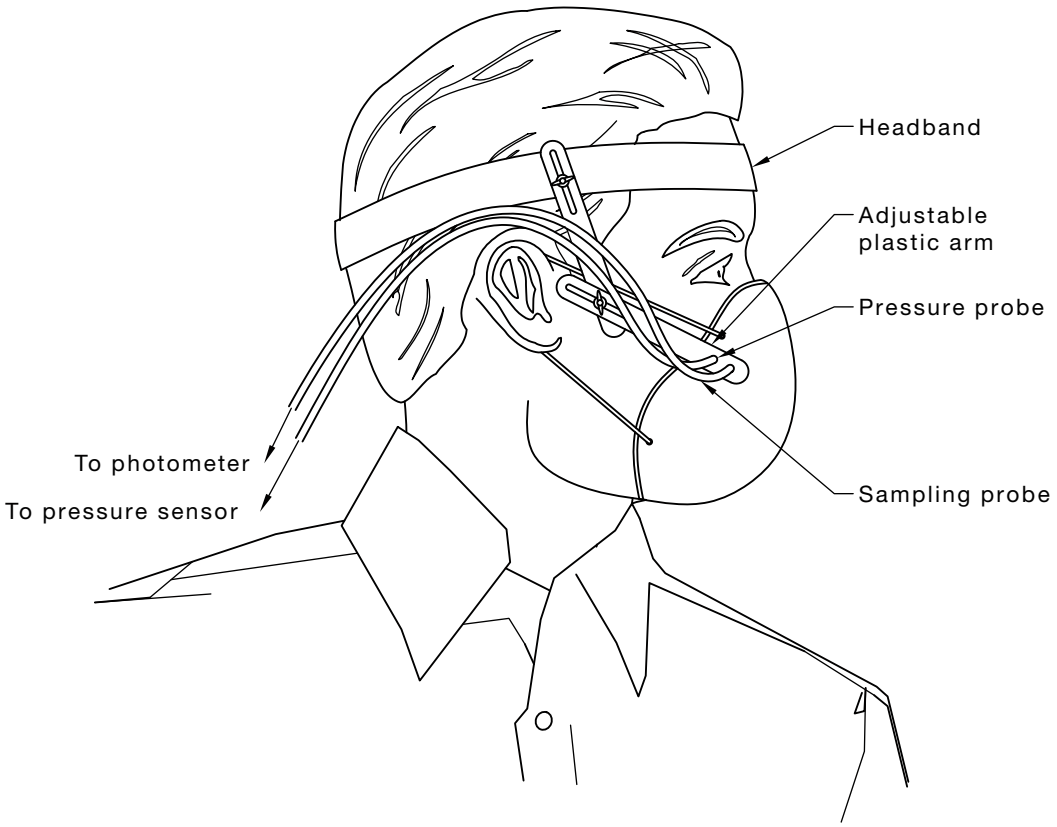
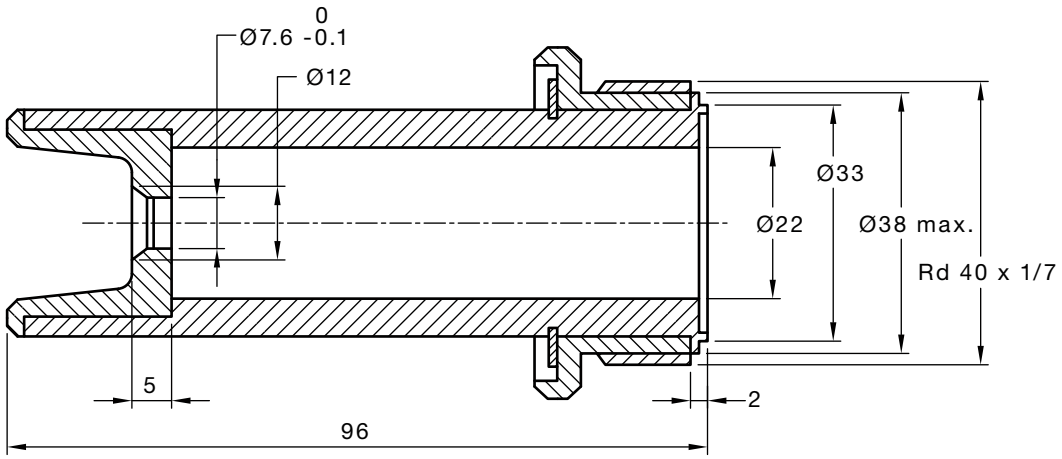


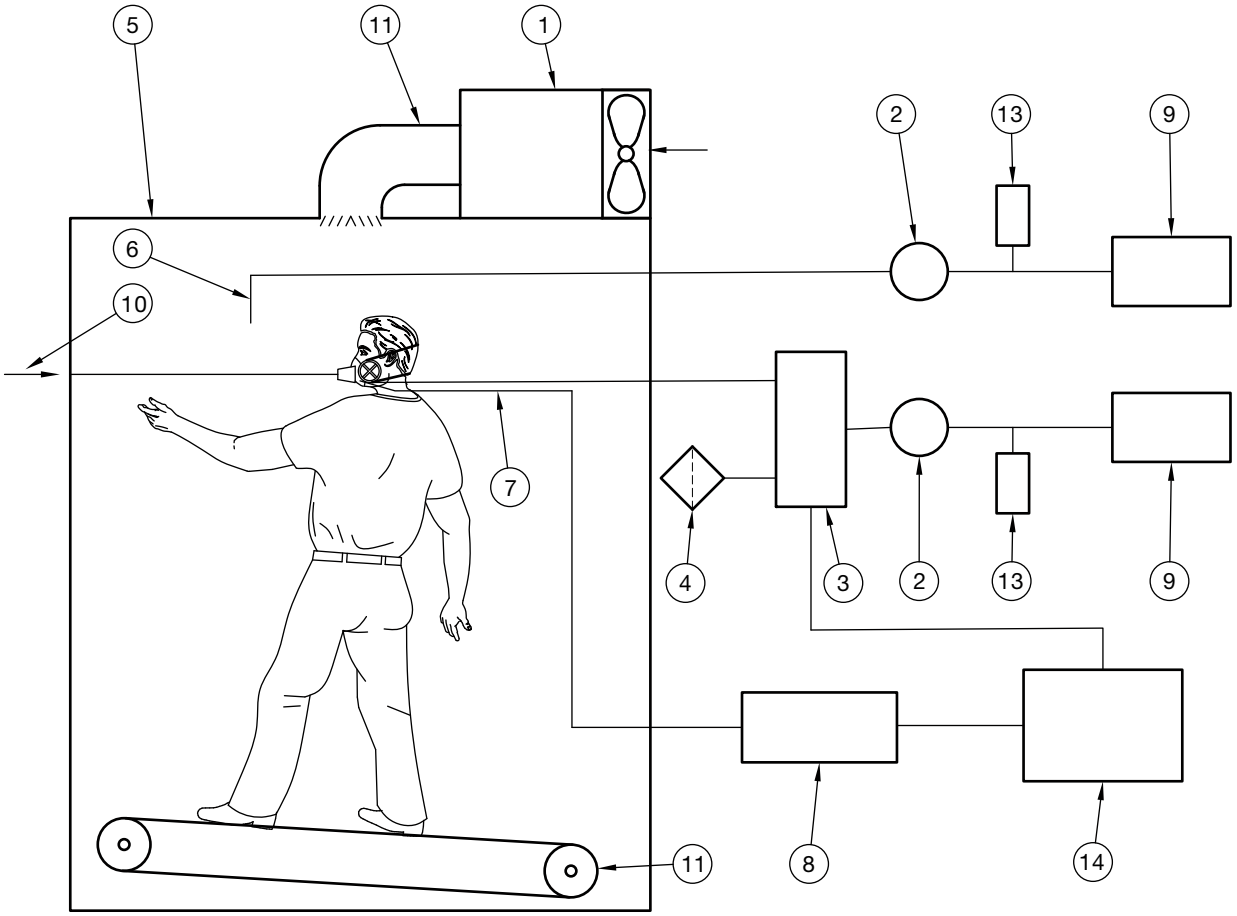
FIGURE L3 TYPICAL ARRANGEMENT OF MONITORING EQUIPMENT



Mass: 500 g, equally distributed along the length
Pressure drop: 1000 Pa at 95 ±2 L/min.

DIMENSIONS IN MILLIMETRES

FIGURE L4 FILTER SIMULATOR FOR STANDARD THREAD FILTERS/FACEPIECES



LEGEND:

1 = Atomiser
2 = Pump
3 = Change-over valve
4 = Filter
5 = Test chamber
6 = Chamber sampling line
7 = Respirator sampling lines
8 = Pressure sensor
9 = Photometer
10 = Reference simulator, air supply
11 = Exercise machine
12 = Ducting and baffle
13 = Additional clean air supply
14 = Pulsed sampling interface

FIGURE L5 TYPICAL APPARATUS USED WHEN TESTING FILTER SIMULATOR

APPENDIX M

PRESSURE CONVERSION TABLE

(Informative)

Unit of pressure	atm	mm H_2O	mm Hg	pascal (N/m^2)	lb/in^2	bar
1 atmosphere (atm)	1	1.0332×10^3	760	1.0133×10^5	14.70	1.013
1 mm H_2O at 4°C	9.678×10^{-5}	1	7.356×10^{-2}	9.807	1.4223×10^{-3}	9.81×10^{-5}
1 mm Hg at 0°C	1.316×10^{-3}	13.595	1	133.3	1.934×10^{-2}	1.333×10^{-3}
1 pascal (newtons/$metre^2$)	9.869×10^{-6}	1.0197×10^{-1}	7.5006×10^{-3}	1	1.4504×10^{-4}	10^{-5}
1 pound per square inch (lb/in^2)	6.805×10^{-2}	703.1	51.715	6.895×10^3	1	6.895×10^5
1 bar	0.9869	1.0197×10^4	7.5006×10^2	10^5	14.504	1

APPENDIX N

TESTS FOR CHEMICAL OXYGEN (KO_2) SELF-CONTAINED SELF-RESCUERS

(Normative)

N1 SCOPE

This Appendix sets out the methods for testing and assessing chemical oxygen (KO_2) self-contained respirators.

Where no special measuring devices or measuring methods are specified, commonly used methods and devices shall be applied.

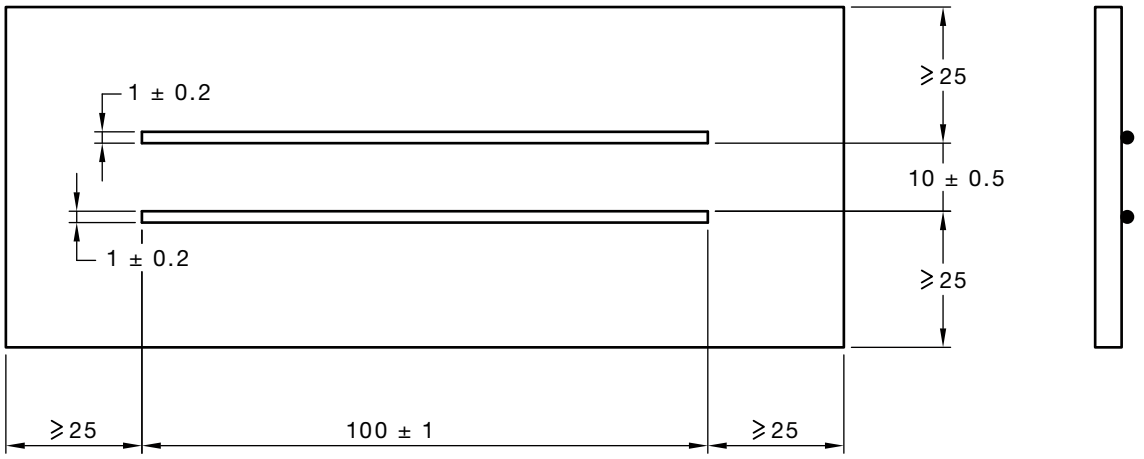
N2 INSULATION RESISTANCE OF NON-METALLIC COMPONENTS

N2.1 Insulation resistance of carrying containers

N2.1.1 *Surface cleaning and application of electrodes*

The resistance is tested on the carrying container if size permits or on a test piece with dimensions in accordance with Figure N1 on which two parallel electrodes are painted on the surface using a conductive paint with a solvent which has no significant effect on the insulation resistance.

The test piece shall have an intact surface and shall be cleaned with distilled water, then with isopropyl alcohol (or other solvent that can be mixed with water and will not effect the material of the test piece), then once more with distilled water.



DIMENSIONS IN MILLIMETRES

FIGURE N1 TEST PIECE WITH PAINTED ELECTRODES

N2.1.2 *Insulation measurements*

Untouched by bare hands, it shall then be conditioned for 24 h at 23 ±3°C and 50 ±5% relative humidity. The test shall be carried out under the same ambient conditions.

Direct voltage of 500 ±10 V shall be applied for 1 minute between the electrodes. During the test, the voltage shall be sufficiently steady so that the charging current due to voltage fluctuation will be negligible compared with the current flowing through the test piece.

The insulation resistance is the quotient of the direct voltage applied at the electrodes to the total current flowing between them when the voltage has been applied for one minute.

N2.2 Insulation resistance of breathing bags

N2.2.1 *General*

The breathing bags shall be tested as follows. Further information tests may be found in NCB Specification 245 (1985) Appendix 5.

N2.2.2 *Surface cleaning*

The test piece shall have an intact surface and shall be cleaned with distilled water, then with isopropyl alcohol (or other solvent that can be mixed with water and will not effect the material of the test piece), then once more with distilled water.

N2.2.3 *Application of electrodes*

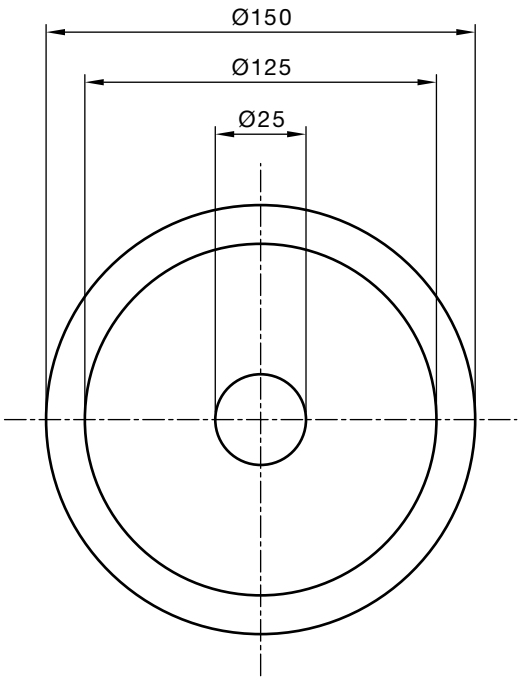
The electrode system shall comprise two electrodes of soft, thin metal foil consisting of a circular disc 25 mm in diameter with a concentric annulus having internal and external diameters of 125 mm and 150 mm respectively as shown in Figure N2. The electrode system shall be attached to the test areas by a conducting liquid contact agent consisting of—

(a) anhydrous polyethylene glycol (4 parts by mass);

(b) soft soap (1/200 parts by mass); and

(c) water (1 part by mass).

Liquid coatings of the same dimensions as the foil electrodes shall be formed on the surface. The contact agent shall not be smeared on the surface between the central disc and the annulus.



DIMENSIONS IN MILLIMETRES

FIGURE N2 SCHEMATIC DIAGRAM OF THE ELECTRODE SYSTEM FOR ANTISTATIC MEASUREMENTS

N2.2.4 *Insulation measurements*

Untouched by bare hands, the sample shall be conditioned for 24 h at 23 ±3°C and 50 ±5% relative humidity. The test shall be carried out under the same ambient conditions.

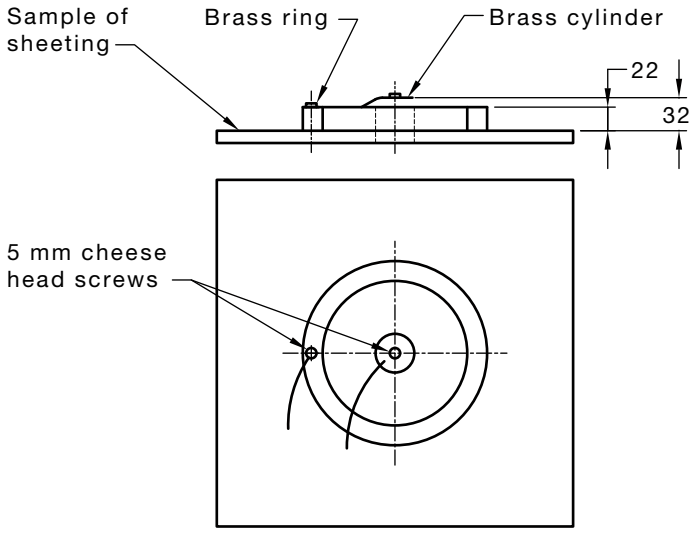
NOTE: Non-compliance with the specified limit can be proved only under the above conditions, but compliance can be proved under any condition less than the upper limits set for conditioning of the sample.

The sample shall be placed on sheet of polythene (or other material with a resistivity not less than that of polythene) not less than 2 mm thick and at least 300 mm × 300 mm (see Figure N3).

The leads from the electrodes shall be taken direct to the measuring instrument so that the outer ring electrode is always connected to the earthed or low potential terminal and the inner cylinder to the high potential terminal. These leads shall not touch each other, the sample being tested, or any part of the apparatus except the terminals to which each is connected.

The direct voltage applied for 1 minute between the electrodes shall be equal to 500 ±10 V. During the test, the voltage shall be sufficiently steady so that the charging current due to voltage fluctuation will be negligible compared with the current flowing through the test piece.

The insulation resistance is the quotient of the direct voltage applied at the electrodes to the total current flowing between them when the voltage has been applied for one minute.



DIMENSIONS IN MILLIMETRES

FIGURE N3 TEST LAYOUT SHOWING WORKING DIMENSIONS OF BRASS CONTACT PIECES

N3 CASE SEAL

This test shall be based on placing the sealed apparatus into an appropriate container, pressurising the container with dry air to 2.0 kPa. Then waiting 20 s for the pressure to stabilise and note the pressure. The pressure in the container shall be measured after a further 60 s and shall not have reduced by more than 0.3 kPa from the stabilized pressure.

N4 RELIEF VALVE OPENING PRESSURE

The relief valve shall be checked without being dismantled and with the apparatus positioned for normal use. The opening pressure shall be measured with a suitable pressure meter. It shall be attached to the facepiece for the test. Dry oxygen at a rate of 1.5 L/min shall be fed into the apparatus through the facepiece. The maximum value recorded shall be taken as the opening pressure.

N5 BREATHING BAG VOLUME

The volume is measured by means of a gas meter.

The effective volume of the breathing bag with relief valve is determined by removing the air from the breathing bag in the pressure range from the opening pressure of the relief valve to a negative pressure of 0.5 kPa.

The effective volume of the breathing bag without relief valve is determined by removing air from the breathing bag in the pressure range from a positive pressure of 0.2 kPa to a negative pressure of 0.5 kPa.

N6 TEST REPORT REQUIREMENTS

The following shall be reported:

(a) Identification of the test sample.

(b) Any sample preparation or pre-treatment.

(c) The name of the test laboratory or authority responsible for performing the test.

(d) The date(s) of the test(s).

(e) The number of replicate results from which the test result has been derived, e.g. ‘single test result’ or ‘the mean of duplicates’ or ‘the mean of three determinations on identical test material’.

(f) The identity of any reference material used to assist in the validation of the test result.

(g) Any observation, in relation to either the test sample or the performance of the test, which may assist in the correct interpretation of the test results.

(h) Results of the test expressed to the appropriate number of significant figures and in units specified in the test method.

(i) The number of this test method, i.e. Appendix N of AS/NZS 1716.

APPENDIX O

TYPICAL EXAMPLE OF A REPORT FORM FOR ASSESSMENT OF CHEMICAL OXYGEN SELF-CONTAINED SELF-RESCUERS

(Informative)

APPARATUS TYPE:	
SERIAL NUMBER	
LOCATION OF TEST:	
DATE OF TEST:	
NAME OF WEARER:	
AMBIENT CONDITIONS:	
DURATION OF APPARATUS:	
Reason test stopped:	

WEARER'S ASSESSMENT

1. How would you describe the quality of the written and illustrated operating instructions supplied with the apparatus?

   [ ] Clear and concise

   [ ] Some difficulty in understanding them

   [ ] Very difficult to understand

Comment: .....

.....

2. How would you describe the ease of donning the apparatus?

   [ ] Simple

   [ ] Difficult

   [ ] Very difficult

Comment: .....

.....

3. How would you describe the comfort of the apparatus while wearing on your belt?

   [ ] Comfortable

   [ ] Uncomfortable

   [ ] Very uncomfortable

Comment: .....

.....

4. How would you describe the comfort of the apparatus harness after donning?

[ ] Comfortable

[ ] Uncomfortable

[ ] Very uncomfortable

Comment: .....

.....

5. How would you describe the temperature of the inhaled atmosphere from the apparatus?

[ ] Comfortable

[ ] Tolerable

[ ] Very hot

Comment: .....

.....

6. How would you describe the resistance to breathing while wearing the apparatus?

[ ] Comfortable

[ ] Tolerable

[ ] Hard

Comment: .....

.....

7. How would you describe the taste of the inhaled atmosphere from the apparatus?

[ ] Pleasant

[ ] Tolerable

[ ] Unpleasant

Comment: .....

.....

8. How would you describe the comfort of the nose clip?

[ ] Comfortable

[ ] Uncomfortable

[ ] Very comfortable

Comment: .....

.....

9. How would you describe the effect of the surface temperature of the apparatus?

[ ] Warm

[ ] Tolerable

[ ] Very hot

Comment: .....

.....

10. How would you describe the effectiveness of the goggles (where supplied)?

[ ] Effective

[ ] Tolerable

[ ] Ineffective

Comment: .....

.....

OVERALL ASSESSMENT OF THE APPARATUS

.....

.....

.....

.....

.....

.....

SIGNATURE OF WEARER: .....

DATE: .....

NOTES: .....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

APPENDIX P

SUMMARY OF CONDITIONING AND TESTING REQUIREMENTS

(Informative)

TABLE P1

SUMMARY OF RELEVANT EXAMINATION AND GENERAL REQUIREMENT CLAUSES

Respirator type	Clause number requirements	
	Examination	Assembled respirator tests
Particulate filter respirators	2.1.1, 2.1.2, 2.1.3, 2.1.4, 2.1.5, 2.1.8*, 3.1.1 and 3.1.2	3.2.6, 2.1.7*, 2.1.9*, 2, 2.3*, 4.3.4, 3.2.5, 3.2.2 and 3.2.4.2
Gas and vapour filter respirators	2.1.1, 2.1.2, 2.1.3, 2.1.4, 2.1.5, 2.1.8*, 3.1.1 and 3.1.2	3.2.6, 2.1.7*, 2.1.9*, 2.2, 2.3*, 5.4.4, 5.4.5, 3.2.2 and 3.2.4.2
Powered air-purifying respirators	2.1.1, 2.1.2, 2.1.3, 2.1.4, 2.1.5, 2.1.8*, 3.1.1 and 3.1.2	3.2.6, 2.1.6. 2.1.7*, 2.1.9*, 2.2, 2.3*, 3.2.5, 3.2.2, 3.2.4.2 and 3.2.3
Escape respirators—filtration type	2.1.1, 2.1.2, 2.1.3, 2.1.4, 2.1.5, 2.1.8*, 3.1.1, 3.1.2 and 3.1.3*	3.2.6, 2.1.7*, 2.1.9*, 2.2, 2.3*, 3.2.5, 3.2.2, 3.2.4.2, and 3.2.5*
Air-hose and air-line respirators	2.1.1, 2.1.2, 2.1.5, 2.1.8, 3.1.1, 3.1.2 and 3.1.4*	3.2.6, 2.1.6*, 2.1.7*, 2.1.9*, 2.2, 2.3*, 2.4*, 8.4.4, 3.2.2, 3.2.4.2, 8.4.5* and 3.2.3
Compressed air SCBA	2.1.1, 2.1.2, 2.1.5, 2.1.8, 3.1.1,3.1.2 and 3.1.4*	3.2.6, 2.1.6*, 2.1.7*, 2.1.9*, 2.2, 2.3*, 2.4*, 9.4.2*, 3.2.2, 3.2.4.2 and 3.2.3*
Chemical oxygen self-contained self-rescuers	2.1.1, 2.1.2, 2.1.4, 2.1.8, 3.1.1 and 3.1.3*	2.1.7
Compressed oxygen SCBA	2.1.1, 2.1.2, 2.1.4, 2.1.8, 2.4, 3.1.1, 3.1.4*	3.2.6, 2.1.7*, 2.3*, 2.4

* Where applicable

TABLE P2

SUMMARY OF GENERAL PERFORMANCE REQUIREMENTS AND CORRESPONDING TESTS

Clause	Corresponding Clause, Appendix or Standard
2.1.6 Noise level	Appendix A, Table B1
2.1.7 Protection against explosion	AS/NZS 60079.1, AS/NZS 60079.11 and AS/NZS 1020*
2.1.9 Protection from flame impingement	Appendix C or EN 136*
2.2.1 Facial fit—General	Appendix B
2.2.2 Facial fit—Assessment	Appendix D
3.2.2 Accumulated carbon dioxide	Appendix E, Paragraph E5.3
3.2.3 Positive pressure screening test	Paragraph E5.5 of Appendix E
3.2.4.2 Exhalation valve leakage	Appendix F
3.2.5 Exhalation of resistance—All filtering respirators	Appendix G
4.3.4 Inhalation resistance—Particular filter resp.	Appendix G
5.4.4 Inhalation resistance—Gas and vapour filter resp.	Appendix G

* Where applicable

TABLE P3

SUMMARY OF CONDITIONING AND TESTING REQUIREMENTS FOR CLAUSES FOR COMPLETE RESPIRATORS

Respirator type	Specific performance	Simulated work
Particular filter respirators	4.3.2, 4.3.3, 4.3.4, 4.3.5	Not required
Gas and vapour filter respirators	5.4.2*, 5.4.3, 5.4.4, 5.4.5, 5.4.6*, 5.4.7*	Not required
Powered air-purifying respirators	6.3.1, 6.3.2*, 6.3.3*, 6.3.4*	Not required
Filter self-rescuer (mines)	7.3.2, 7.3.5, 7.3.6, 7.3.8, 7.3.9, 7.3.10.1, 7.3.10.2, 7.3.10.3, 7.3.10.4, 7.3.10.5	7.3.10.6
Filer self-rescuer—Smoke mask	7.4.2.1, 7.4.2.2, 7.4.2.3, 7.4.2.4, 7.4.2.5, 7.4.2.6, 7.4.27	Not required
Filter self-rescuer—Industrial type	7.5, 5.4.3, 5.4.4 , 5.4.5*, 5.4.6*, 5.4.7*	Not required
Air-hose respirator	8.2, 8.3.2, 8.4.4. 1,8.2.6.2, 8.4.6.5*, 8.4.7*	8.5
Air-line respirator	8.2, 8.3.3, 8.3.4, 8.4.2*, 8.4.3.2, 8.4.4.2*, 8.4.4.4*, 8.4.4.5*, 8.4.5*, 8.4.6.1, 8.4.6.38.4.6.4, 8.4.6.5*, 8.4.7, 8.4.8*	8.5
Compressed air SCBA-escape	9.2, 9.4.2 or 9.5, 9.6*, 9.7, 9.8, 9.9, 9.10, 9.11, 9.13, 9.13, 9.14, 9.15.3, 9.15.4	9.16
Compressed air SCBA-work	9.2, 9.4.2 or 9.5, 9.6*, 9.7, 9.8, 9.9, 9.10, 9.11, 9.12, 9.13, 9.13, 9.14, 9.15.2, 9.15.3, 9.15.4	9.16
Compressed oxygen SCBA	10.3, 10.4, 10.5, 10.6, 10.8, 10.9, 10.11, 10.12, 10.13, 10.14, 10.15, 10.16, 10.17, 10.18, 10.19, 10.20, 10.21	10.7
Chemical oxygen self-contained self–rescuers	11.3.1, 11.3.2, 11.3.3, 11.3.4, 11.3.5, 11.3.6, 11.3.7, 11.3.8, 11.3.9.2, 11.3.10, 11.3.11, 11.3.12, 11.3.13	10.3.14

* Where applicable

TABLE P4

SUMMARY OF SPECIFIC PERFORMANCE REQUIREMENTS AND CORRESPONDING TESTS—AIR FITERING RESPIRATORS

Clause		Corresponding Clause, Appendix or Standard
4.3.2	Simulated rough usage	Appendix H, Paragraph H5 or H6
4.3.3	Simulated wear treatment	Paragraph E5.6 of Appendix E
4.3.5	Test of filtering efficiency	Appendix I
5.4.2	Particulate filtration efficiency	Appendix I
5.4.3	Simulated rough usage	Appendix H, Paragraph H5 or H6
5.4.5	Filter capacity	Clause 5.4.4 and Table 5.1* or Table 5.2*
5.4.6	Additional requirements for filters	Table 5.1* or Table 5.2*
5.4.7	Desorption	Clause 5.4.4 and Table 5.1*
6.3.1	Battery	Clause 3.2.3 and Appendix Q
6.3.2	Particulate filters	Appendix I
6.3.3	Gas filters	Table 5.1* or Table 5.2* and Appendix Q* or Paragraph E4(a)* of Appendix E
7.3.10.1	Water immersion	Paragraph H 6.3 of Appendix H
7.3.10.2	Breathing resistance	E5.1 of Appendix E
7.3.10.3	Carbon monoxide filtering efficiency	E5.1 of Appendix E
7.3.10.4	Temperature of purified air	E5.2 of Appendix E
7.3.10.5	Powdered chemicals	H6.1 and H6.2 of Appendix H
7.3.10.6	Assembled respirator test	Paragraph J4.5 of Appendix J
7.4.2.1	Water immersion	Paragraphs H6.1, H6.2 and H6.3 of Appendix H
7.4.2.2	Inhalation resistance	Appendix G
7.4.2.3	Temperature of purified air	E5.2 of Appendix E
7.4.2.4	Gas Filter efficiency	Table 7.1
7.4.2.5	Particulate filter penetration	Appendix I
7.4.2.6	Total inward leakage (TIL)	Appendix D
7.4.2.7	Flammability	Appendix C
7.5	Industrial filter self-rescuer	Clause 5.4 and Table 5.1

* Where applicable

TABLE P5

SUMMARY OF SPECIFIC PERFORMANCE REQUIREMENTS AND CORRESPONDING TESTS—AIR SUPPLIED RESPIRATORS

Clause		Corresponding Clause, Appendix or Standard
8.4.4.1	Breathing resistance—Air-hose respirators—Natural breathing type	8.4.4.1 and Appendix G
8.4.4.2	Breathing resistance—Air-lines—Continuous flow type	8.4.4.2 and Appendix G
8.4.4.3	Breathing resistance—Air-lines—Negative pressure demand type	No requirement
8.4.4.4	Breathing-resistance—Air-lines—Positive pressure demand type	8.4.4.4 and Appendix G or Paragraphs E4(e) and E.5.4 of Appendix E
8.2.2.5	Breathing-resistance—Air-line respirator—Auxiliary filter	Appendix G
8.4.5	Positive pressure under peak flow	8.4.5(a) and Appendix G or Paragraphs E4(f) and E5.4 of Appendix E 8.4.5(b) and Appendix G or Paragraphs E4(d) and E5.4 of Appendix E 8.4.5(b)* and Appendix G
8.4.6.1	Strength of air-line and coupling	8.4.6.1 and Figure 8.1
8.4.6.2	Resistance to collapse or air-hose	8.4.6.2(a) and (b), 8.4.3, and Figure 8.2
8.4.6.3	Resistance of kinking of air-line	8.4.6.3 and Figure 8.3
8.4.6.4	Air tightness	8.4.6.4
8.4.6.5	Heat resistance	8.4.6.5 and Paragraph 4(e) of Appendix E
8.4.8	Durability of abrasive blasting helmets/protectors	8.4.8, Table 8.1 and 3.2.3
8.4.9	Simulated work test	Paragraph J4.2 of Appendix J
9.2	Nominal effective life	Paragraph E4(c) of Appendix E
9.4.2.2	Resistance to breathing	9.4.2.2 and Appendix G or Paragraphs E4(d), (e) and E.5.4 of Appendix E
9.4.2.3	Positive pressure under peak flow	9.4.2.3 and Appendix G or Paragraphs E4(f) and E5.4 of Appendix E. 9.4.2.3(b) and Appendix G or Paragraphs E4(d) and E5.4 of Appendix E 9.4.2.3(c)* and Appendix G
9.5.2	Noise level	Clause 2.1.6 and Appendix A
9.6	Auxiliary air supply	Section 8 as applicable
9.7	Cylinders	AS 2030.1
9.8	Cylinder valve	Appendix K
9.9	Pressure measuring devices	As described in 9.9 and AS 1349
9.10	Pressure indicator	As described in 9.10
9.12	Active warning device	As described in 9.12
9.13	Body harness and securing	Paragraph J4.2 of Appendix J
9.14	Mass	As described in 9.14

(*continued*)

TABLE P5 (*continued*)

Clause		Corresponding Clause, Appendix or Standard
9.15.3	Resistance to temperature—High temperature	Conditioned to 9.15.2(ii) and tested to Paragraph E4(e) of Appendix E
9.15.3	Resistance to temperature—Low temperature	Conditioned to 9.15.3(i) and tested to Paragraph E4(c) of Appendix E
9.15.4	Simulated work test for compressed air SCBA	Paragraph J4.2 of Appendix J
11.3.2	Nominal and rated duration	11.3.2 and Paragraph R4(a) of Appendix R
11.3.3	Extended usage period	11.3.2 and Paragraph R4(a) of Appendix R
11.3.4	Carbon monoxide leakage of the apparatus	11.3.4, 11.3.2 and Paragraph R4(a) of Appendix R
11.3.5	Breathing resistance	11.3.5, 11.3.2 and Paragraph R4(a) of Appendix R
11.3.6.1	High volume test	Paragraph R5 of Appendix R
11.3.6.2	Breathing resistance	Paragraph R5 of Appendix R
11.3.7	Rough usage—Water immersion	Paragraph H6.1, H6.2 and H6.3 of Appendix H
11.3.8	Rough usage—Examination of powdering of chemicals	11.3.8 and Paragraph H6.1 and H6.2 of Appendix H
11.3.9.2	Surface resistivity	Paragraph N2.2 of Appendix N
11.3.10	Goggles	Paragraph J4 6 of Appendix J
11.3.11	Relief valve	Paragraph N5 of Appendix N
11.3.12	Breathing bag	Paragraph N6 of Appendix N
11.3.13	Case seal	Paragraph N4 of Appendix N
11.3.14	Simulated work tests	Paragraph J4.6 of Appendix J

* Where applicable

APPENDIX Q

POWERED AIR PURIFYING RESPIRATORS AIR SUPPLY FLOW RATE TEST

(Normative)

Q1 SCOPE

This Appendix sets out the method for determining the flow rate of powered air purifying respirators both initially and after continuous operation for the manufacturer's design duration.

Q2 PRINCIPLE

The flow of filtered air is measured at zero backpressure and at ambient temperature.

Q3 APPARATUS

The following apparatus is required:

(a) A manikin of size and type suitable for testing the respirator.

NOTE: For full and half facepieces, a 'Sheffield head' (see Figure E2) is considered suitable for the purposes of this test. This is obtainable from:

Inspec International Ltd
56 Leslie Hough Way
Salford
Greater Manchester M6 6AJ
UNITED KINGDOM

OR

Phoenix Medical Ltd
Unit 3
Lancashire Enterprise Business Park
Leyland
PR26 6TZ
UNITED KINGDOM

(h) A suitable blower or suction device.

(i) Control means for blower, such as a variable power regulator for the motor or an adjustable bleed in the air supply pipework.

(b) Suitable flowmeter, e.g. calibrated from 50 L/min to 500 L/min.

(j) Micromanometer, if used, capable of detecting a pressure difference of ±0.01 mbar. An inclined liquid manometer or an electronic manometer is recommended.

(k) Light weight plastics bag as shown in Figures Q1 and Q2.

Q4 PROCEDURE

Q4.1 Preparation

The procedure shall be as follows:

(a) Fit the respirator under test with a fully charged battery and new filter(s).

(b) Depending on the design of the respirator, fit it into an appropriate test rig as shown in Figures Q1, Q2 or Q3. Ensure all joints are leak tight. Where an adaptor is used care should be taken to ensure that it does not give rise to any pressure/flow losses.

(c) Devices with tight fitting neck seals need to be fitted to the dummy head with the neck seal adjusted as if the device were being word and with the micromanometer connected to the breathing zone of the visor capacity in such a manner as to be free from velocity effects.

NOTE: It is possible that the flow past the pressure port can influence the record ed pressure.

Q4.2 Initial flow rate

Q4.2.1 *Devices tested according to Figure Q1 or Q2*

The procedure should be as follows:

(a) Switch on the device and adjust the blower (Figure Q1) or suction device (Figure Q2) until the plastic bag neither inflates nor deflates, i.e. zero back pressure.

(b) The micromanometer should indicate zero pressure but observation of the plastic bag is often a more precise method of monitoring the pressure within such a flexible enclosure.

(c) Record the reading of the flowmeter. Continue to ensure zero back pressure and repeat flow measurements at intervals of 5 min until a total time of 30 min has elapsed.

(d) Calculate the average of the seven flow measurements and report as initial flow rate.

Q4.2.2 *Devices tested according to Figure Q3*

The procedure shall be as follows:

(a) Switch on the device and adjust the suction means until the micromanometer indicates zero back pressure.

(b) Record the reading of the flowmeter. Continue to ensure zero back pressure and repeat the flow measurement at the intervals of 5 min until a total time of 30 min has elapsed.

(c) Calculate the average of the seven flow measurements and report as the initial flow rate.

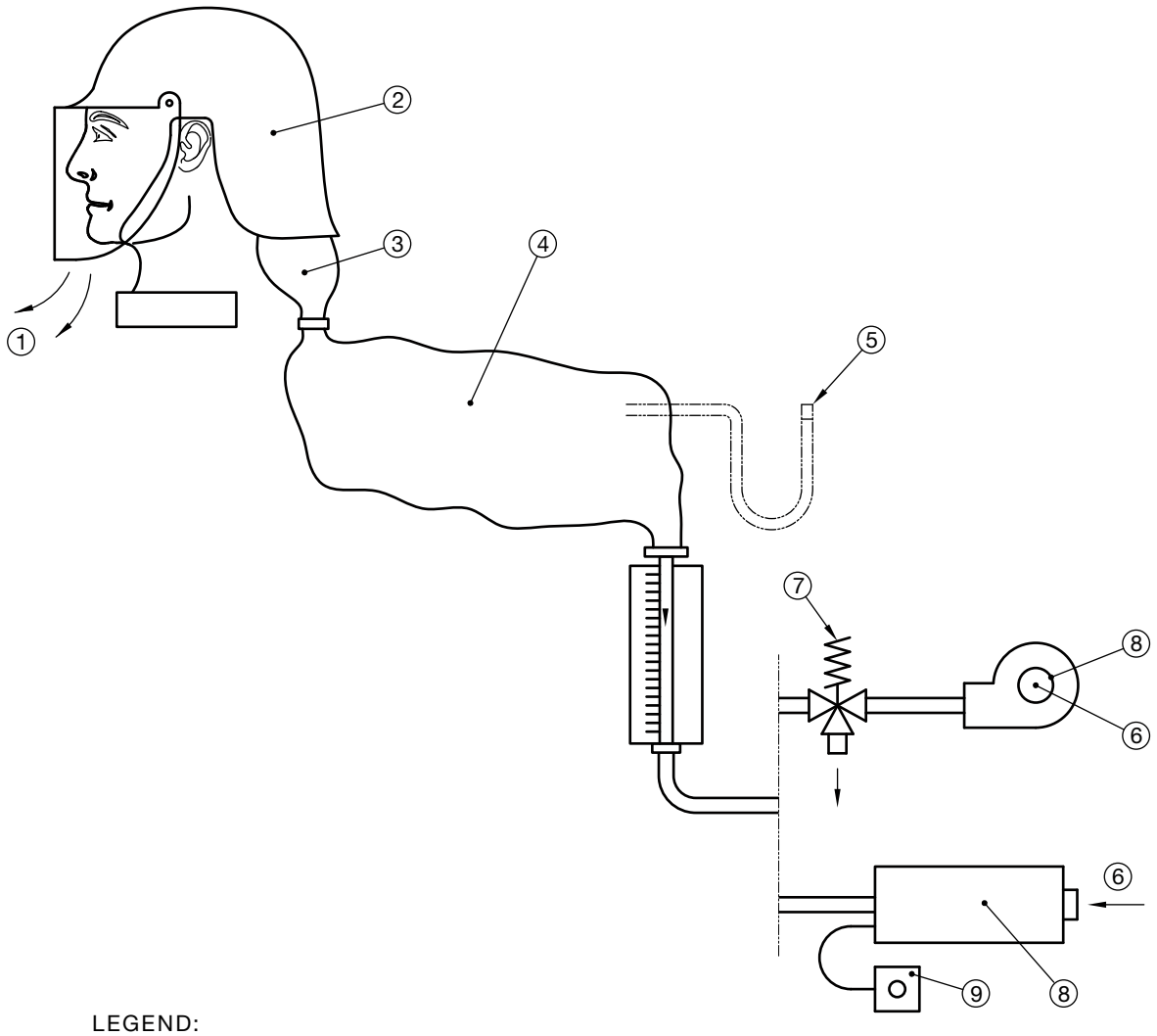
Q4.3 Design duration

The duration of the respirator shall be measured as follows:

After measuring the initial flow rate as described in Paragraph Q4.2, disconnect the measuring apparatus from the device and switch off the blower/suction device.

Leave the device running whilst fitted to the dummy head for 1 h less than the manufacturer’s design duration and then reconnect the measuring apparatus as in Figures Q1, Q2 or Q3 as appropriate.

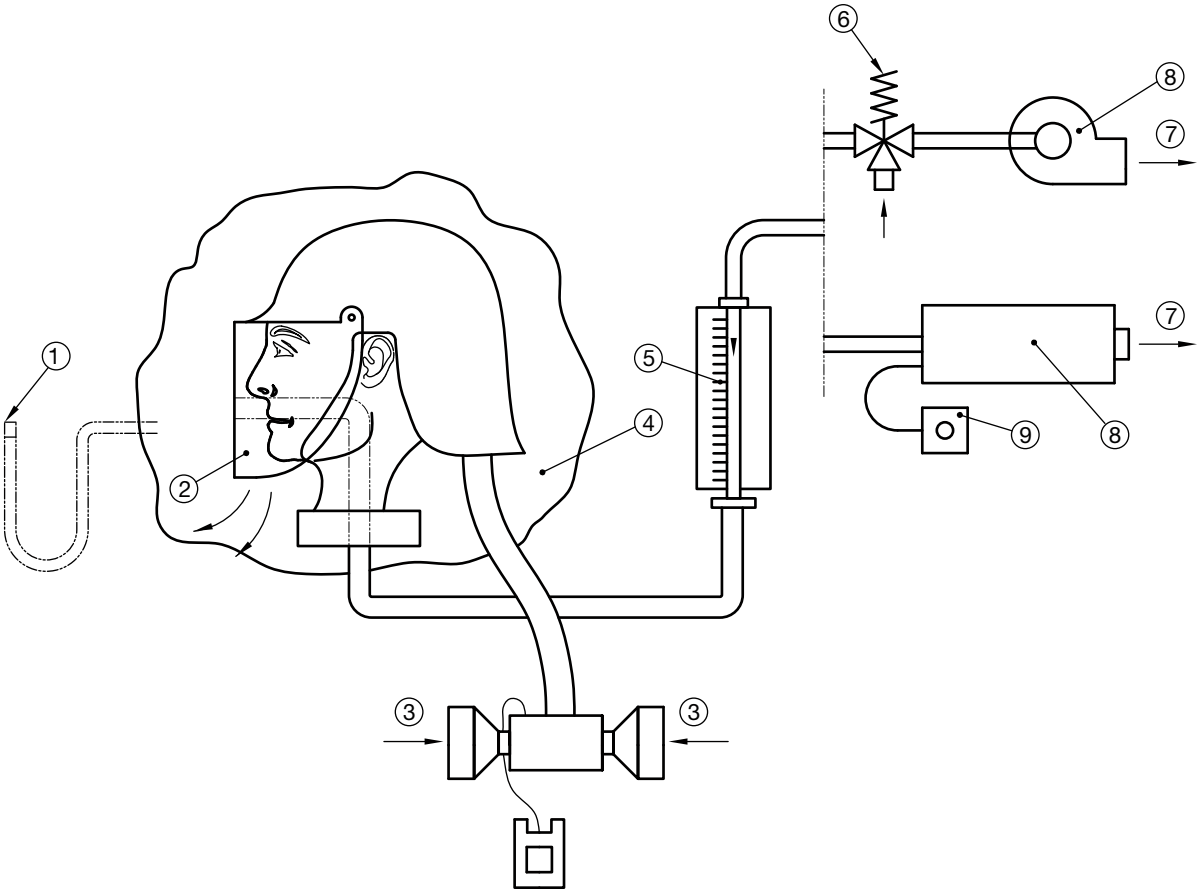
Measure and record the flow rate as described in Paragraph Q4.2 at a total elapsed time (including the first 30 min for initial flow rate measurement) equal to the manufacturer’s design duration.



LEGEND:

1 = Free flowing outlet
2 = Device under test
3 = Adaptor
4 = Light weight plastic bag
5 = Micromanometer (optional)
6 = Inlet
7 = Variable bleed out
8 = Blower
9 = Variable speed control

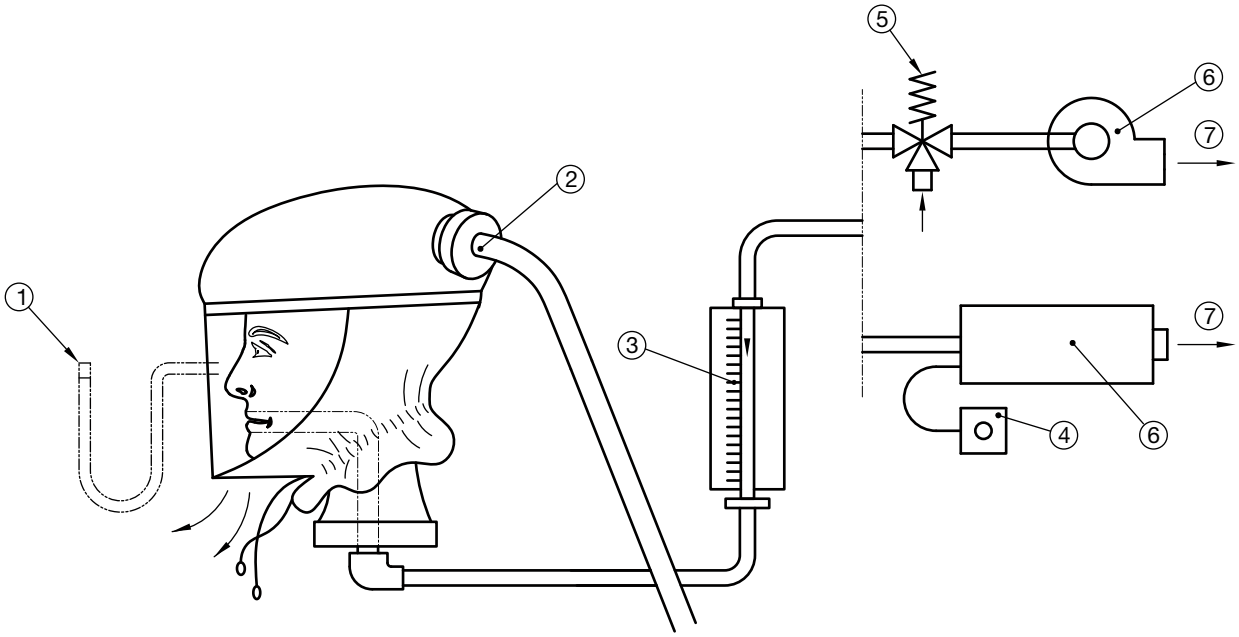
FIGURE Q1 TEST ARRANGEMENT FOR MEASUREMENT OF AIR SUPPLY FLOW RATE (HELMET/HOOD)



LEGEND:

1 = Micromanometer (optional)
2 = Loose seal around face
3 = Inlet
4 = Light weight plastic bag
5 = Flowmeter
6 = Variable bleed in
7 = Outlet
8 = Suction device
9 = Variable speed control

FIGURE Q2 TEST ARRANGEMENT FOR MEASUREMENT OF AIR SUPPLY FLOW RATE (HELMET/HOOD WITH SEPARATELY MOUNTED TURBO UNIT AND FILTERS)



LEGEND:

1 = Micromanometer
2 = Inlet(s)
3 = Flowmeter
4 = Variable speed control
5 = Variable bleed in
6 = Suction device
7 = Outlet

FIQURE Q3 TEST ARRANGEMENT FOR MEASUREMENT OF AIR SUPPLY FLOW RATE (HELMET/HOOD WITH TIGHT-FITTING NECK SEAL)

APPENDIX R

BREATHING SIMULATOR TESTS—CLOSED CIRCUIT

(Normative)

R1 SCOPE

This Appendix sets out the following test closed circuit procedures which employ machine simulation of breathing:

(a) Breathing resistance.

(b) Carbon dioxide accumulation.

(c) Temperature rise in exhaled breath.

(d) Positive pressure in facepieces.

This Appendix applies only to compressed oxygen SCBA and chemical oxygen (KO_2) self-contained self-rescuers. All other breathing simulator tests are covered in Appendix E.

R2 PRINCIPLE

The respirator to be tested is operated on a closed-circuit breathing machine which simulates natural breathing in a number of environmental and test conditions.

R3 APPARATUS

The apparatus shall consist of the following:

(a) A closed circuit breathing simulator, designed to provide sinusoidal airflow. The simulator shall exhale and inhale through the facepiece or mouthpiece of the apparatus under test. A diagram for a typical test rig with ancillary equipment is shown in Figure R1.

(b) Except where the respirator is fitted with a mouthpiece, a manikin of size and type suitable for testing the respirator.

NOTE: For full and half facepieces, a ‘Sheffield head’ (see Figure E2).

(c) Where measurements of breathing resistance are required, a manometer capable of measuring pressurized air to an accuracy of 5 Pa (0.5 mm water gauge) over the range ±1.2 kPa (120 mm water gauge) under the test conditions.

(d) Where required, a means of measuring the temperatures of the inhaled and exhaled breath. (Where a single thermocouple is used to measure both temperatures, the thermocouple wires shall be of the fast response type, with a diameter not greater than 0.05 mm.)

(e) Where required, a means of measuring the concentration of carbon dioxide in air up to at least 20% by volume.

(f) Where required, a means of measuring the concentration of oxygen in air up to at least 100% by volume.

(g) Where carbon monoxide is being used in a test, a means of measuring the concentration of carbon monoxide in the inhaled atmosphere in 5 p.p.m. increments.

Some method of periodically checking supplied concentrations of carbon monoxide up to 2% by volume shall be used.

R4 PROCEDURE

Fit the facepiece or mouthpiece of the respirator onto a breathing simulator. Adjust the head straps, support harness, and other components as necessary. Connect the manikin to the breathing simulator.

Operate the breathing simulator at 37 ±0.5°C and at a relative humidity of 95 to 100% so that the respirator under test is subjected to one of the following:

(a) A tidal volume of 1.75 L with 20 respirations per minute (total air inhalation rate of 35 L/min). Carbon dioxide content of the exhaled atmosphere shall be 4.5% (v/v).

(b) A tidal volume of 2.33 L with 30 respirations per minute (total air inhalation rate of 70 L/min). Carbon dioxide content of the exhaled atmosphere shall be 5.0% (v/v).

(c) A tidal volume of 2.0 L with 20 respirations per minute (total air inhalation rate of 40 L/min).

To measure the carbon dioxide and oxygen content of the inhaled air, an amount, equivalent to the volume of carbon dioxide that was added, shall be drawn off by an auxiliary lung during the inhalation phase and fed to the necessary analysers.

The temperature of the inhaled mixture shall be recorded continuously throughout the test. The temperature shall be measured as near to the mouthpiece as possible.

The duration of the test run shall be recorded.

The range of pressures within the cavity of the mask adjacent to the facial seal shall be measured during the respiratory cycle of the machine. The pressure recordings shall not be measured in the immediate vicinity of the inhalation point.

The maximum resistances shown on the pressure measuring device shall be noted.

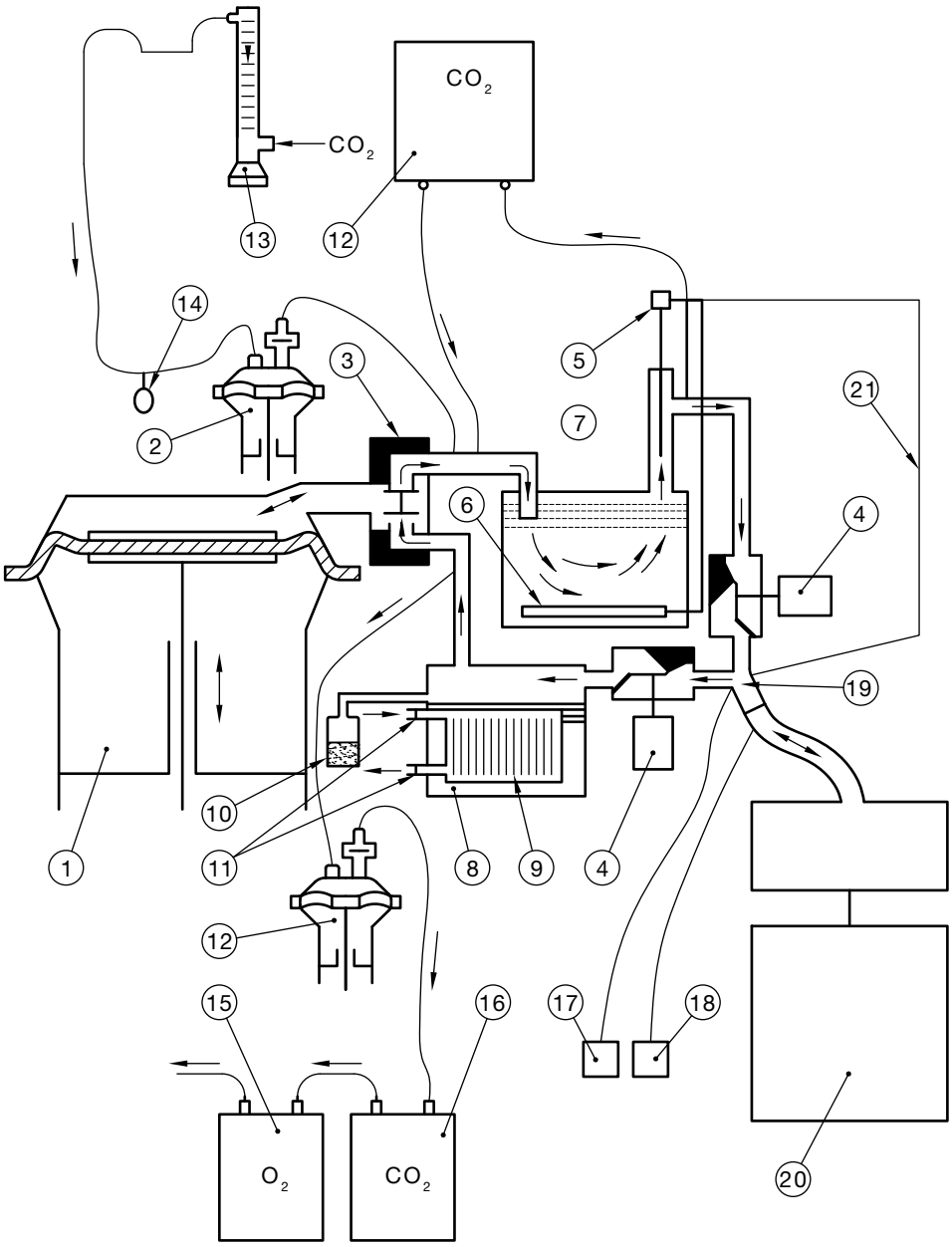
R5 PERFORMANCE AT HIGH MINUTE VOLUME

During testing on the breathing simulator the minute volume shall be increased to 70 L/min, as described in Paragraph R4(b). The time when the adjustment to the high minute volume is made, depends on the classification of the apparatus under test.

For apparatus with a rated duration of 30 minutes or more, the increase in minute volume shall be made 15 minutes before the rated duration is achieved. After five minutes the breathing simulator shall be readjusted to 35 L/min and the test completed until the apparatus no longer produces oxygen.

For apparatus with a rated duration from 10 to 25 minutes, the 70 L/min period shall be started five minutes after the start of the test. After five minutes the breathing simulator shall be readjusted to 35 L/min and the test completed until the apparatus no longer produces oxygen.

For apparatus with a rated duration of five minutes, the 70 L/min period shall apply to the entire duration.



LEGEND:

1 = Main lung of simulator
2 = Auxiliary lung
3 = Valve system
4 = Solenoid valves
5 = Thermometer with heater feedback
6 = Heater controlled by thermometer
7 = Humidifier
8 = Condenser system
9 = Cooling coil
10 = Reservoir for condensate
11 = Cooling water connections
12 = CO_2 analyser
13 = Flowmeter for CO_2
14 = Compensation bag
15 = O_2 analyser
16 = CO_2 analyser
17 = Temperature monitor
18 = Pressure monitor
19 = Y piece connector
20 = Apparatus under test
21 = Thermocouple with feedback to the humidifier heater

FIGURE R1 SCHEMATIC DIAGRAM OF BREATHING SIMULATOR WITH ANCILLARY EQUIPMENT

R6 REPORTING OF RESULTS

The following shall be reported:

(a) Identification of the test sample(s), including serial number.

(b) The name of the test laboratory or authority responsible for performing the test.

(c) The dates of the test.

(d) The nominal effective life or the rated duration of the apparatus.

(e) Oxygen content.

(f) Temperature.

(g) Carbon monoxide.

(h) Resistance to breathing at particular flow rates.

(i) For chemical oxygen self-contained self-rescuers, the extended usage period and the monitored parameters.

(j) The identity of any reference material used to assist in the validation of the test result.

(k) Any observation, in relation to either the test sample or the performance of the test, which may assist in the correct interpretation of the test results.

(l) The testing procedure used should be fully specified, e.g. procedure R4(c), Appendix R of AS/NZS 1716.

NOTES

NOTES

NOTES

Standards Australia

Standards Australia is an independent company, limited by guarantee, which prepares and publishes most of the voluntary technical and commercial standards used in Australia. These standards are developed through an open process of consultation and consensus, in which all interested parties are invited to participate. Through a Memorandum of Understanding with the Commonwealth government, Standards Australia is recognized as Australia's peak national standards body.

Standards New Zealand

The first national Standards organization was created in New Zealand in 1932. The Standards Council of New Zealand is the national authority responsible for the production of Standards. Standards New Zealand is the trading arm of the Standards Council established under the Standards Act 1988.

Australian/New Zealand Standards

Under a Memorandum of Understanding between Standards Australia and Standards New Zealand, Australian/New Zealand Standards are prepared by committees of experts from industry, governments, consumers and other sectors. The requirements or recommendations contained in published Standards are a consensus of the views of representative interests and also take account of comments received from other sources. They reflect the latest scientific and industry experience. Australian/New Zealand Standards are kept under continuous review after publication and are updated regularly to take account of changing technology.

International Involvement

Standards Australia and Standards New Zealand are responsible for ensuring that the Australian and New Zealand viewpoints are considered in the formulation of international Standards and that the latest international experience is incorporated in national and Joint Standards. This role is vital in assisting local industry to compete in international markets. Both organizations are the national members of ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission).

Visit our web sites

www.standards.org.au www.standards.co.nz

GPO Box 476 Sydney NSW 2001
Phone (02) 9237 6000
Fax (02) 9237 6010
Email mail@standards.org.au
Internet www.standards.org.au
SAI Global Customer Service
Phone 13 12 42
Fax 1300 65 49 49
Email sales@saiglobal.com

Level 10 Radio New Zealand House
155 The Terrace Wellington 6011
(Private Bag 2439 Wellington 6140)
Phone (04) 498 5990
Fax (04) 498 5994
Customer Services (04) 498 5991
Information Service (04) 498 5992
Email snz@standards.co.nz
Internet www.standards.co.nz

ISBN 978 1 74342 024 9

Printed in Australia

This page has been left intentionally blank.