

IS 10245 (Part 2) : 1994

Edition 2.1

(2002-12)

भारतीय मानक

श्वसन सुरक्षा सयंत्र — विशिष्टि

भाग 2 मुक्त प्रणाली श्वसन सयंत्र

(पहला पुनरीक्षण)

Indian Standard

**RESPIRATORY PROTECTIVE DEVICES —
SPECIFICATION**

PART 2 OPEN CIRCUIT BREATHING APPARATUS

(First Revision)

(Incorporating Amendment No. 1)

UDC 614.894

© BIS 2003

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Price Group 6

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Industrial Safety Sectional Committee had been approved by the Chemical Division Council.

This standard was first published in 1982. As breathing apparatus is one of the most important life saving equipment the need was felt to standardize this equipment to ensure the quality of production. Accordingly, the standard on breathing apparatus was issued in four parts. Part 1 dealing with closed circuit breathing apparatus, Part 2 dealing with open circuit breathing apparatus, Part 3 dealing with fresh air hose and compressed air line and Part 4 dealing with escape breathing apparatus. In view of the recent technological development, the concerned committee decided to revise Part 2 of this standard and harmonize it with EN 137 : 1986 'Respiratory protective devices: Self-contained open circuit compressed air breathing apparatus' published by European Committee for Standardization.

It is recommended that reference should be made to IS 9623 : 1980 'Recommendation for the selection, use and maintenance of respiratory protective devices' for guidance on the type of respiration protection that should be provided for particular conditions. In addition, care should be taken in the choice of breathing apparatus itself, where such equipment is to be used in very high ($60^{\circ}\text{C} \pm 3^{\circ}\text{C}$) or very low ($-30^{\circ}\text{C} \pm 3^{\circ}\text{C}$) ambient temperatures and the instructions provided by the suppliers should be carefully noted.

Certain toxic substances which may occur in some atmospheres can be absorbed by the skin. Where these do occur, respiratory protection alone is not sufficient and the whole body should be protected.

In this revision, for requirements for thread connections, mouthpiece and full facepiece, relevant Indian Standards have been referred to. The requirements for weight, frequency range of warning device, resistance to breathing, resistance to temperature and method of test for practical performance test have been modified in order to bring them in line with EN 137 : 1986.

The composition of the committee responsible for formulation of this standard is given at Annex D.

This edition 2.1 incorporates Amendment No. 1 (December 2002). Side bar indicates modification of the text as the result of incorporation of the amendment.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Indian Standard***RESPIRATORY PROTECTIVE DEVICES —
SPECIFICATION****PART 2 OPEN CIRCUIT BREATHING APPARATUS***(First Revision)***1 SCOPE**

This standard prescribes requirements of design, construction, performance and laboratory and practical tests for open circuit types of Breathing Apparatus. In these apparatus compressed air carried in cylinder/cylinders is fed either via pressure reducer and lung governed demand valve or lung governed demand valve connected to the facepiece to enable the wearer to breathe. Exhaled air passes through the non-return valve to the atmosphere.

2 REFERENCES

The following Indian Standards are the necessary adjuncts to this standard:

<i>IS No.</i>	<i>Title</i>
3624 : 1987	Pressure and vacuum gauges (<i>second revision</i>)
3933 : 1966	Colour identification of gas cylinders and related equipment intended for medical use
8347 : 1977	Glossary of terms relating to respiratory protective devices
8457 : 1977	Tyre pressure gauge for automobile (pocket type)
9623 : 1980	Recommendation for the selection, use and maintenance of respiratory protective devices
10245 (Part 3) : 1982	Breathing apparatus: Part 3 Fresh air hose and compressed air line breathing apparatus
14138 (Part 1) : 1994	Respiratory protective devices: Threads for face-piece: Part 1 Standard thread connection — Specification
14138 (Part 2) : 1994	Respiratory protective devices: Threads for face-piece; Part 2 Centre thread connection — Specification

*IS No.**Title*

14166 : 1994	Respiratory protective devices: Full-face masks — Specification
14170 : 1994	Respiratory protective devices: Mouthpiece assemblies — Specification

3 TERMINOLOGY

3.1 For the purpose of this standard the following definitions shall apply apart from those given in IS 8347 : 1977.

3.1.1 Theoretical Duration / Nominal Working Duration

A period of time in minutes arrived at by dividing the fully charged capacity of the cylinder in litre by 40 l/m (that is, assuming an airflow of 40 l/m). The reserve period is also included in the above calculation.

NOTE — The air consumption varies depending on the nature of work, the users physical condition and experience of using a breathing apparatus as well as actual task to be performed. An internationally accepted method of calculating the theoretical duration is assumption of an average consumption of 40 l/min

3.1.2 Nominal Effective Duration

Theoretical duration plus a reserve period of at least 10 minutes.

NOTE — For marine use the storage capacity of the cylinder or cylinders attached to the apparatus and carried by the wearer shall be at least 1 200 litres of free air.

3.1.3 Inhaled Air

The air breathed in by the wearer.

3.1.4 Exhaled Air

The air breathed out by the wearer.

IS 10245 (Part 2) : 1994

4 TYPES

Open circuit breathing apparatus are classified according to the effective air volume at a pressure of 1 bar absolute at a temperature of 20°C in the following types:

- a) *Type 1* — 600 litres *Min*
- b) *Type 2* — 800 litres *Min*
- c) *Type 3* — 1 200 litres *Min*
- d) *Type 4* — 1 600 litres *Min*
- e) *Type 5* — 2 000 litres *Min*

5 REQUIREMENTS

5.1 Design

5.1.1 Open-circuit compressed air breathing apparatus is designed and constructed to enable the wearer to breathe air on demand from a high pressure air cylinder (or cylinders) either via pressure reducer and a lung governed demand valve or a lung governed demand valve connected to the facepiece. The exhaled air passes without re-circulation from the facepiece via the exhalation valve to the atmosphere.

5.1.2 The apparatus shall be sufficiently robust to withstand the rough usage it is likely to receive in service and designed so that it will continue to function satisfactorily while temporarily, accidentally submerged in water at a maximum depth of one metre and thereafter until the air in the cylinder is exhausted.

The apparatus is not designed for prolonged use under water.

5.1.3 The apparatus shall be so designed that no parts or sharp edges are likely to be caught on projections in narrow passages.

5.1.4 The apparatus shall be so designed that the wearer can remove it and while still wearing the facepiece, continue to breathe air from the apparatus.

5.1.5 The apparatus shall be designed to ensure its full function in any orientation.

5.1.6 The main valve(s) of the air cylinder(s) shall be arranged so, that the wearer can operate them while wearing the apparatus.

5.1.7 The apparatus shall be so designed and constructed as to prevent ingress of the external atmosphere within the limit set out in this standard.

5.2 Materials/Components

5.2.1 All the materials used in the construction shall have adequate mechanical strength,

durability and resistance to deterioration by heat or by contact with sea water or mine water. Such materials shall be antistatic and fire resistant as far as practicable.

5.2.2 Exposed parts excluding cylinders, that is, those which may be subjected to impact during practical performance tests shall not be made of magnesium, titanium, aluminium or alloys containing such proportions of these metals which on impact, give rise to frictional sparks capable of igniting flammable gas mixtures.

Any cylinder making use of such materials shall be protected so that when tested for impact and scraping, no metal shall be exposed.

5.2.3 Materials that may come into contact with the skin shall be non-staining, soft, pliable and shall not contain known dermatitic substances.

5.2.4 Connections (Couplings)

The design and construction of the apparatus shall permit its component parts to be readily separated for cleaning, examination and testing. The couplings required to achieve this shall be readily connected and secured, where possible by hand. Any means for sealing used shall be retained in position when the joints and couplings are disconnected during normal maintenance.

5.2.5 Adjustable Parts

All parts requiring manipulation by wearer shall be readily accessible and easily distinguishable from one another by touch. All adjustable parts and controls shall be so constructed that their adjustment is not liable to accidental alteration during use.

5.2.6 Air Line Connection

If an air line is to be used with this type of apparatus, the apparatus shall be provided with a suitable, leak-tight non-return valve and connection and the apparatus shall satisfy the requirements given in IS 10245 (Part 3) : 1982.

5.2.7 Face Connector

The connection between the facepiece and the apparatus may be achieved by a permanent or special type of connection or by a screw thread connection. If a screw thread connection is used then the connection CAT for negative pressure apparatus according to IS 14138 (Part 1) : 1994 or IS 14138 (Part 2) : 1994 shall be used. If any other thread is used, it shall not be possible to connect it to the standard thread connection CA or CAT of the documents mentioned above. The

standard thread CA or CAT shall not be used for apparatus with positive pressure.

5.2.8 Facepiece

Only a full face mask or a mouthpiece conforming to IS 14166 : 1994 or IS 14170 : 1994 respectively shall be used.

5.2.9 Head Harness

5.2.9.1 The head harness shall hold the facepiece firmly and comfortably in position. It shall be simply fitted and adjusted and shall be capable of ready cleaning and decontamination. Any fabric used in the construction of a head harness shall be resistant to shrinkage and shall not have known effect of any irritation to the skin of the wearer.

5.2.9.2 The head harness shall be adjustable and, if consisting only of straps, these shall be adjustable and not less than 19 mm (nominal) wide at the points in contact with the head, and designed so as to ensure that the wearer may readjust the straps before each occasion of use.

5.2.10 Body Harness

The body harness shall be designed to allow the user to don the apparatus quickly and easily without assistance and shall be adjustable. Buckles fitted to waist and shoulder harness shall be so constructed that once adjusted they will not slip. Any fabric used in the construction of a body harness shall be resistant to shrinkage. Where the body harness incorporates means for attachment of a lifeline, the harness together with the snap hook shall be capable of withstanding a drop test of 1 m when loaded with 75 kg. The harness shall be constructed such that when tested for practical performance tests in accordance with the method prescribed in Annex A the apparatus shall be worn without avoidable discomfort and the wearer shall show no undue sign of strain attributable to wearing the apparatus and the apparatus shall impede the wearer as little as possible when in crouched position or when sitting in a confined space.

5.2.11 Flexible Hoses and Tubes

5.2.11.1 The hose may be extensible and compressible. Any flexible hose or tube connected to the facepiece shall permit free head movement and shall not restrict or close off the air supply under chin or arm pressure during practical performance test carried out in accordance with the method prescribed in Annex A. The hose shall not collapse and temporary elongation shall be not less than 20 percent and the deformation of the hose shall be not more than 10 percent when tested in accordance with the method prescribed in **5.2.11.4** and **5.2.11.5**.

5.2.11.2 High pressure tubes and couplings shall be capable of withstanding a test pressure of twice the maximum designed working pressure. It shall not be possible to fit a low pressure tube or hose into a higher pressure part of the circuit.

5.2.11.3 Tubes for the demand valve (connections included) shall withstand for at least 15 min twice the operating pressure of pressure reducer safety valve or at least 30 bar whichever is higher.

5.2.11.4 For testing the ductility of a corrugated hose it shall be suspended. Its length (without couplings) shall be measured (a).

Afterwards a force of 10 N shall be applied to the hose for a period of 5 minutes and the length is measured (b). The elongation (b-a) is calculated in percent.

5.2.11.5 For testing the permanent axial linear deformation of the corrugated hose it is submitted immediately after the ductility test to a force of 10 N for 48 hours. After a recovery period of 6 hours the length of the hose is measured again (c). The permanent deformation (c - a) is calculated in percent. This test shall be repeated after a further 7 days.

5.2.12 Lung Governed Demand Valve

5.2.12.1 Breathable air supply

The breathable air supply shall be at a flow rate of at least 300 l/min at all cylinder pressures above 20 bar and of at least 150 l/min at a cylinder pressure of 10 bar.

5.2.12.2 Without positive pressure

The negative pressure of the lung governed supply demand valve shall be between 0.5 mbar and 3.5 mbar when tested using a continuous flow of 10 l/min from maximum filling pressure down to 10 bar. A self-opening demand valve at negative pressure of less than 0.5 mbar shall not occur. At a flow rate of 300 l/min the resistance shall not exceed 10 mbar at all pressures down to 20 bar.

The cylinder pressure and the negative pressures shall be measured by precision gauges. The air flow shall be measured by flowmeter. Air flow shall be induced by a suitable device.

5.2.12.3 With positive pressure

This apparatus shall maintain a positive pressure in the cavity of the mask adjacent to the face seal up to a flow of 300 l/min at all cylinder pressure above 20 bar.

IS 10245 (Part 2) : 1994

5.2.12.4 *Supplementary supply*

The apparatus without positive pressure shall be provided with a manually operated means of providing a supply of air at a flow of between 60 l/min and 300 l/min at all cylinder pressures above 50 bar independently of the normal operation of the demand valve. Apparatus with positive pressure may be provided with such a device.

5.2.13 *Pressure Gauge*

The apparatus shall be equipped with a reliable pressure indicator which will record the pressure in the cylinder on opening the valve or valves to ensure that the individual or the equalised contents are measured respectively. It should be so placed as to enable the wearer to read gas cylinder pressure conveniently.

5.2.13.1 The pressure gauge should have a blow-out release. The blow-out release should be so located that in the event of an explosion the fracture of the pressure element of the gauge, the blast will be away from the front. The gauge window shall be made of a material of non-splintering glass or of clear plastic material. The sliding indicator pin shall be secured against accidental blow out.

5.2.13.2 When pressure gauge and connection hose are removed from the apparatus, flow shall not exceed 25 l/min at full cylinder pressure.

5.2.13.3 The pressure gauge shall be sufficiently robust to withstand rough usage. When the tube is protected by sheathing the enclosed space shall be vented to atmosphere. The pressure gauge shall be resistant to dust and water and shall withstand immersion in water at a depth of one metre for 24 hours. After the test no water shall be visible in the device. The pressure gauge shall be graduated from the zero mark up to the value of at least 50 bar above the maximum falling pressure of the cylinder. Table 1 shall apply regarding the accuracy when reading at decreasing pressure when compared with control manometer.

Table 1 Accuracy of Pressure Gauge Reading at Decreasing Pressure

SI No.	Pressure Gauge Reading	Accuracy
(1)	(2)	(3)
i)	40 bar	+ 0 bar - 5 bar
ii)	100 bar	± 10 bar
iii)	200 bar	± 10 bar
iv)	300 bar	± 10 bar

The maximum diameter of the case shall not exceed 63 mm. The design of the gauge shall allow the recording of the indicated pressure with 10 bar.

5.2.13.4 The pressure gauge (*see* IS 3624 : 1966 and IS 8457 : 1977) shall withstand pressure greater than the maximum cylinder pressure so that it will operate continuously and accurately without overstrain. The pressure gauge for use with such apparatus shall be shock-resistant.

5.2.14 *Warning Device*

The apparatus shall have a suitable warning device that operates when the cylinder pressure drops to a predetermined level to warn the wearer. The warning device shall respond at the latest when only one-fifth of the total breathing air volume is left (tolerance + 50 l) but at least 200 l are still available. After response of the warning device, the wearer shall be able to continue to breathe with difficulty. The functioning of the warning device shall be tested using a breathing machine adjusted to 20 strokes/min and 1.5 l/stroke. If there is an audible warning device the acoustic pressure level shall be a minimum of 90 dB (A) as a continuous or intermittent warning at the wearers ears. The frequency range shall be between 2 000 Hz and 4 000 Hz.

The air loss that might be caused by the warning signal shall not exceed an average of 5 l/min from response of signal to a pressure of 10 bar 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 sec for a continuous signal and 60 sec for an intermittent signal.

5.2.14.1 *Testing of warning device*

The functioning of the warning device shall be tested using a breathing machine adjusted to 20 strokes/min and 1.5 l/stroke.

5.2.15 *Cylinder and Main Valve(s)*

5.2.15.1 The air cylinder shall comply with appropriate national regulations. The cylinder shall be approved with respect to the appropriate filling pressure.

5.2.15.2 The design of the cylinder valve shall be such as to ensure safe performance. The valve shall be so designed that the valve spindle cannot be completely unscrewed from the assembly during normal operation of the valve. The valve shall be designed so that it cannot be closed inadvertently by contact with a surface by one of the following methods:

- a) The valve shall be designed so that a minimum two turns of the handwheel are required to open fully the valve.
- b) The valve shall be lockable in open position.
- c) Apparatus fitted with more than 2 cylinders may be fitted with individual valve in the cylinder.

5.2.15.3 Cylinder valve connection (valve outlet)

It shall not be possible to connect apparatus with a higher maximum filling pressure (e.g. 300 bar) to an apparatus which is designed only for a lower maximum filling pressure (e.g. 200 bar).

5.2.16 Pressure Reducer

Any adjustable medium pressure stage shall be reliably secured against accidental alteration and adequately sealed so that any unauthorized adjustment can be detected. A pressure reducer safety valve shall be provided, if the apparatus cannot take the full cylinder pressure. If a pressure reducer safety valve is incorporated, it shall be designed to operate within the manufacturers design parameters. At maximum operating pressure of the pressure reducer safety valve the apparatus still has to permit breathing. The maximum pressure built up at the inlet of the lung governed demand valve shall be such that the wearer can continue breathing. Where demand valves open with medium pressure a pressure reducer safety valve need not be installed, provided the previous requirements are met.

For testing the performance of the pressure reducer safety valve, the highest leakage which may occur during simulated malfunction of the pressure reducer is used (broken lever, broken spring, etc). The test shall be carried out at the highest approved filling pressure of the compressed air cylinder.

5.2.17 High Pressure Parts

Metallic high pressure tubes, valves and coupling shall be capable of withstanding a test pressure twice the maximum filling pressure or 50 percent of the maximum filling pressure. Non-metallic parts shall be capable of withstanding a test pressure twice the maximum filling pressure of the cylinder.

5.2.18 High and Low Pressure Connection

It shall not be possible to fit a low pressure tube or hose directly to a high pressure part of the circuit.

5.3 Weight

The weight of the apparatus as ready for use with facepiece and fully charged cylinder shall

not exceed 18 kg. The cylinder used for compressed air shall have the approval of Chief Controller of Explosives, Nagpur. Colour of the cylinder shall be in accordance with IS 3933 : 1966.

5.4 Condition of the Inhaled Air

5.4.1 Carbon Dioxide Content

When tested in accordance with Annex B the carbon dioxide content of the inhaled air (including dead space effects) shall not exceed 1.5 percent (by volume) during the nominal effective duration of the apparatus.

5.5 Cleaning and Decontamination

The design of the apparatus shall be such as to facilitate cleaning. The material shall withstand cleaning and decontamination agents recommended by manufacturer. The process shall be approved by testing authority. Testing is by visual inspection made by responsible testing authority.

5.6 Resistance to Breathing

Breathing resistance of the apparatus and its connections shall be determined using a breathing machine with a sinusoidal characteristic adjusted to 25 strokes/min and 2 l/strokes. A precision gauge shall be used.

If necessary, the breathing resistance of the tubing and dummy head shall be subtracted from the measured value to determine the breathing resistance of the apparatus.

During the measurement the apparatus has to be in normal wearing position.

5.6.1 Inhalation Resistance

5.6.1.1 Without positive pressure

The inhalation resistance of an apparatus without facepiece shall not exceed 4.5 mbar at all cylinder pressures from full to 10 bar. Where a lung governed demand valve is permanently attached to a full face mask the negative pressure shall not exceed 7 mbar.

5.6.1.2 With positive pressure

The apparatus has to be designed in such a way that at a flow rate of 300 l/min a positive pressure is maintained in a cavity of the mask adjacent to the face seal. The requirement shall be valid at all cylinder pressures above 20 bar.

5.6.2 Exhalation Resistance

5.6.2.1 Without positive pressure

The exhalation resistance of an apparatus with facepiece shall not exceed 3.0 mbar.

IS 10245 (Part 2) : 1994

5.6.2.2 *With positive pressure*

The exhalation valve shall have an opening resistance not exceeding 6 mbar, a resistance not exceeding 7 mbar at a continuous flow of 160 l/min and a resistance not exceeding 10 mbar at a continuous flow of 300 l/min.

The static pressure in the mask cavity (inner mask if applicable) under conditions of equilibrium shall not exceed 5 mbar.

5.7 Comfort

When tested in accordance with Annex A, the apparatus shall be such that it is worn with avoidable discomfort, that the wearers show no undue sign of strain attributable to wearing the apparatus, and that it impedes the wearers as little as possible when in a crouched position nor when working in a confined space.

5.8 Resistance to Temperature

5.8.1 *Storage*

Trouble free operation shall be ensured after storage at temperatures varying from -30°C to $+60^{\circ}\text{C}$ when tested in accordance with Annex C. Apparatus specially designed for temperatures beyond these limits shall be tested and marked accordingly.

5.8.2 *Performance*

The apparatus shall operate trouble-free over the temperature range -30°C to $+60^{\circ}\text{C}$ when tested in accordance with Annex C. Apparatus specially designed for temperatures beyond these limits shall be tested and marked accordingly. The supplier shall also provide clear instruction along with the apparatus for such purpose.

5.9 Protection Against Particulate Matter

The component parts of the apparatus supplying compressed air shall be reliably protected against the penetration of particulate matter that may be contained in the compressed air.

5.10 Practical Performance Test

In addition to the machine tests described above, the apparatus shall also undergo practical performance tests under realistic conditions. The general practical performance tests as described in Annex A serves the purpose of checking the apparatus for imperfections that cannot be determined by

any other tests. Practical performance tests shall be performed with at least two apparatus and four subjects.

6 INSTRUCTIONS

6.1 Breathing apparatus manufactured in compliance with this standard shall be accompanied by operating instructions for maintenance and use which shall include where appropriate:

- a) nominal working duration;
- b) guidance on fit of facepiece, and adjustment of face seal where relevant;
- c) a warning that adequate protection may not be provided by the apparatus in certain highly toxic atmospheres and that guidance should be sought from IS 9623 : 1980 for the selection, use and maintenance of respiratory protective devices;
- d) a warning, that, allowance should be made for the fact that it is likely that face seal fit will not be suitable for persons wearing spectacles or having sideburns or beards; and
- e) a warning that at very high work rates, the pressure in the facepiece of positive pressure breathing apparatus may become negative at peak inhalations.

7 MARKING

7.1 Breathing apparatus manufactured in compliance with this standard shall be marked with the following particulars.

7.2 Marking on the Facepiece

- a) Name, trade-mark or other means of identification of the manufacturer;
- b) Size (if more than one size is available); and
- c) Year and month of manufacture.

7.3 Marking on the Apparatus

- a) Name, trade-mark or other means of identifying the manufacturer;
- b) Year and month of manufacture shall be marked legibly on breathing tubes, mouth piece, facepiece and diaphragm.

ANNEX A

(Clauses 5.2.10, 5.2.11.1, 5.7 and 5.10)

PRACTICAL PERFORMANCE TEST

A-1 TEST SUBJECTS

A-1.1 Breathing apparatus is tested by test subjects who practise regularly with breathing apparatus and whose medical history is known to be satisfactory. They shall be medically examined immediately before the tests and certified fit to undertake the test procedure. Each subject is suitably clothed.

A-2 MEDICAL SUPERVISION

The tests shall be carried out under the supervision of a registered medical practitioner.

A-3 PREPARATION OF APPARATUS TO BE TESTED

The high pressure cylinder is purged with air before being fully charged to the prescribed pressure. The apparatus is assembled, the resistance to breathing is measured and the apparatus is tested for leak tightness. The cylinder pressure at the start of the test should correspond to the prescribed filling pressure.

A-4 TEST PROCEDURE

All tests shall be carried out at normal room temperature and test pressure and humidity shall be recorded.

A-4.1 Test Conditions

All tests shall be carried out at room temperature and the test temperature and humidity shall be recorded. During the test the apparatus will be subjectively assessed by the wearer and the wearers comments on the following points shall be recorded after the test:

- a) Harness comfort;
- b) Security of fastenings and couplings;
- c) Accessibility of controls and pressure gauge;
- d) Clarity of vision on the visor of the facemask;
- e) Supplementary supply (if fitted);
- f) Speech transmission;
- g) Audible warning device; and
- h) Any other comments reported by the wearer on request.

A-4.2 Two kinds of tests are made, one in which two subjects wearing the apparatus walk at a

regular rate of 6 km/h on a level course (walking test) and the one in which two different subjects work in practical conditions (work simulation test). Each test is continuous, without removal of the apparatus, for a period equal to the working duration of the apparatus or 30 minutes whichever is less.

NOTE — If the audible warning device has not operated during the 30 minute test period, the cylinder pressure shall be reduced manually to the audible warning pressure range, to check the effectiveness of the latter, which shall comply with the requirements of 5.2.14.

A-4.3 Work Simulation Test

The apparatus is tested under condition which can be expected during normal use. During this test the following activities shall be done in simulation of the practical use of the apparatus. The test shall be completed within a total working time of 30 min.

The sequence of activities is at the discretion of the test authority. The individual activities shall be arranged so that sufficient time is left for the measurements prescribed:

- a) 30 pulls on a work machine, each pull being vertical from 1.8 m towards the ground on a mass of 25 kg, giving a total work load of 13 500 N m.
- b) Walking on the level with full headroom (total distance 125 m).
- c) Walking on the level with headroom of 1.1 m to 1.5 m (total distance 200 m).
- d) Crawling on the level with headroom of less than 0.75 m (total distance 100 m).
- e) Climbing up and down a ladder, passing once, in each direction through 460 mm square opening (total vertical distance 20 m).
- f) Crawling through a narrow section (4 m long) which is so low that the test subject has to doff the apparatus and push it in front of him or pull it behind him while still breathing from the apparatus.
- g) Laying out of a fire hose of at least 15 m in length and recoiling the same.

This test shall be continuous, without removal of the apparatus, for an initial period of approximately 15 min after which the subject

IS 10245 (Part 2) : 1994

shall have a rest period of 5 min during which he can be medically assessed and allow time for the compressed air cylinder to be charged if the testing officer considers that there may be insufficient air to complete the test.

The second section of the test of the apparatus shall then continue to give a complete working of 30 min. If the exercises have been completed within a shorter period the remaining time is taken up with the subject walking at 6 km/h.

ANNEX B

(Clause 5.4.1)

LABORATORY PERFORMANCE TEST

B-1 TEST EQUIPMENT

B-1.1 A lung simulator machine designed to provide sinusoidal air flow.

B-2 TEST PROCEDURE

B-2.1 The facepiece of the apparatus is connected in an airtight manner to the breathing machine 'exhales' through the facepiece a 5 percent (by volume) carbon dioxide/air mixture at ambient temperature and 'inhales' through the facepiece of the apparatus. Tests are conducted at:

- a) a tidal volume of 2.0 litres of air with 20 respirations per minute (total inhalation 40 l/min); and
- b) a tidal volume of 2.5 litres of air with 32 respirations per minute (total inhalation 80 l/min).

In a separate test, the sinusoidal air flow is increased to 100 l/min for a period sufficient for an assessment to be made of the functioning of the apparatus at this flow.

B-2.2 Test at Low Temperature

The apparatus, including the compressed air cylinder(s) and an approved facepiece is cooled in ambient temperature of $-30 \pm 3^{\circ}\text{C}$ for 4 hours. Subsequently, the apparatus is connected to a breathing machine placed outside the cooling system. The breathing

machine is then operated at a minute volume of 50 litres (25 strokes/min and 2 litres/stroke) until the compressed air supply is exhausted (20 bar). The test shall be repeated with the same cooled apparatus, after having replaced the empty cylinders by fully charged cylinders previously stored at room temperature. During this test, the inhalation resistance shall not exceed 10 m bar. For breathing apparatus with positive pressure, a positive pressure has to be maintained in the cavity of the mask adjacent to the face seal. The exhalation resistance of all types of apparatus shall not exceed 10 m bar.

B-2.3 Test at High Temperature

The apparatus including air cylinder and facepiece is stored in a chamber at a temperature of $60 \pm 3^{\circ}\text{C}$ and at a relative humidity of 50 percent for 4 hours. The apparatus is tested using a breathing air machine. Subsequently, the apparatus is tested using a breathing machine at a minute volume of 50 litres (25 strokes/min, 2 litres/stroke) until the compressed air supply is exhausted (20 bar). During this test, the inhalation resistance shall not exceed 7 mbar. For breathing apparatus with positive pressure, a positive pressure has to be maintained in the cavity of the mask adjacent to the face seal. The exhalation resistance of an apparatus without positive pressure shall not exceed 3 mbar. The exhalation resistance of an apparatus with positive pressure shall not exceed 7 mbar.

ANNEX C

(Clause 5.8.1)

METHOD OF TEST FOR RESISTANCE TO TEMPERATURE

C-1 RESISTANCE TO TEMPERATURE**C-1.1 Laboratory Tests with a Breathing Machine****C-1.2 Tests at Low Temperature**

The apparatus, including the compressed air cylinder(s) and an approved facepiece shall be according to IS 14170 : 1994 and IS 14166 : 1994, and is cooled in an ambient temperature of $(-30 \pm 3)^{\circ}\text{C}$ for 4 hours.

Subsequently, the apparatus is connected to a breathing machine placed outside the cooling system. The breathing machine is then operated at a minute volume of 50 litres (25 strokes/min, 2 litres/stroke) until the compressed air supply is exhausted (20 bar).

The test shall be repeated with the same cooled apparatus, after having replaced the empty cylinders by fully charged cylinders previously stored at room temperature.

During this test, the inhalation resistance shall not exceed 10 mbar.

For breathing apparatus with positive pressure, a positive pressure has to be maintained in the cavity of the mask adjacent to the face seal.

The exhalation resistance of all types of apparatus shall not exceed 10 mbar.

C-1.3 Tests at High Temperature

The apparatus including compressed air cylinder(s) (filling pressure: 100 bar) and an approved facepiece conforming to IS 14166 : 1994, is stored in a chamber at a temperature of $(60 \pm 3)^{\circ}\text{C}$ and a relative humidity of not more than 50 percent for 4 hours.

Subsequently, the apparatus is tested using a breathing machine at a minute volume of 50 litres (25 strokes/min, 2 litres/stroke) until the compressed air supply is exhausted (20 bar).

During this test, the inhalation resistance shall not exceed 7 mbar. For breathing apparatus with positive pressure, a positive pressure has to be maintained in the cavity of the mask adjacent to the face seal.

The exhalation resistance of an apparatus without positive pressure shall not exceed 3 mbar. The exhalation resistance of an apparatus with positive pressure shall not exceed 7 mbar.

C-1.4 Practical Performance Tests at Different Temperatures**C-1.4.1 Tests at Low Temperature****C-1.4.2 Preparation of Apparatus to be Tested**

Two sets of apparatus, as ready for use, are pre-cooled at a temperature of $(-30 \pm 3)^{\circ}\text{C}$ for a period of 4 hours.

C-1.4.3 Test Procedure

Two warmly clothed subjects don the pre-cooled apparatus in a cold chamber and perform work in an ambient temperature of $(-15 \pm 3)^{\circ}\text{C}$. The test is continuous without removal of the apparatus over a period of 30 minutes or at least until the warning device starts to operate.

The work shall be equally divided between:

- a) walking and crawling slowly;
- b) carrying and building with wooden blocks or similar.

At the end of the test, the resistance to breathing is measured to determine whether there is any obstruction, and the apparatus is examined for malfunction due to the low temperature.

C-1.4.4 Tests with Apparatus at Room Temperature**C-1.4.5 Preparation of Apparatus to be Tested**

Two sets of apparatus are prepared ready for use and stored at room temperature $(23 \pm 2)^{\circ}\text{C}$ for at least 4 hours.

C-1.4.6 Test Procedure

Two warmly clothed subjects don the apparatus at room temperature (about 23°C) and enter a cold chamber of at least $(-6 \pm 2)^{\circ}\text{C}$. The same test programme to that described in **C-1.4.3** is carried out for a period of 30 minutes or at least until the warning device starts to operate, whichever is earlier.

ANNEX D

(Foreword)

COMMITTEE COMPOSITION

Industrial Safety Sectional Committee, CHD 008

<i>Chairman</i>	<i>Representing</i>
SHRI K. C. GUPTA	National Safety Council, Bombay
<i>Member</i>	
SHRI PREM BAWEJA	Hindustan Aeronautics Limited, Bangalore
SHRI B. VIJAY KUMAR (Alternate)	
SHRI BHAGWATI PRASAD	Employees State Insurance Corporation, Calcutta
SHRI SATISH CHANDER (Alternate)	
DR S. C. CHAWLA	Directorate General of Technical Development, New Delhi
SHRI M. K. BANERJEE (Alternate)	
SHRI P. K. CHATTERJEE	Defence Institute Fire Research, New Delhi
SHRI H. S. KAPRAWAN (Alternate)	
DIRECTOR (MINES SAFETY)	Directorate General of Mines Safety, Dhanbad
SHRI A. K. RUDRA (Alternate)	
SHRI H. S. GAHLAUT	Institute of Fire Engineers (India), New Delhi
SHRI B. R. MEHTA (Alternate)	
SHRI V. K. GOEL	Central Boiler Board, New Delhi
SHRI M. L. AHUJA (Alternate)	
SHRI S. P. GOENKA	Mining, Geological and Metallurgical Institute of India, Calcutta
SHRI N. DUTTA (Alternate)	
SHRI M. KANT	Safety Appliances Manufacturers Association, Calcutta
SHRI KIRIT MARU (Alternate)	
DR J. MAHAPATRA	Standing Committee on Safety for Steel Industries, Ranchi
SHRI M. K. MALHOTRA	Directorate General Factory Advice Services and Labour Institute, Bombay
SHRI H. N. MIRASHI	Factory Inspectorate, Government of Maharashtra, Bombay
DR H. MUKHERJEE	Chief Controller of Explosives, Nagpur
SHRI C. M. SHARMA (Alternate)	
SHRI R. N. MUKHERJEE	Central Mining Research Station, Dhanbad
SHRI A. BANARJEE (Alternate)	
SHRI S. K. MUKHERJI	Standing Fire Advisory Council, New Delhi
SHRI A. K. GHOSH (Alternate)	
SHRI P. S. PRUTHI	Indian Pesticide Association, New Delhi
SHRI SURESH KAPOOR (Alternate)	
SHRI P. RAJENDRAN	Directorate General Civil Aviation (National Airport Authority), New Delhi
SHRI H. S. RAWAT (Alternate)	
SHRI A. RAMAMURTHY	Bhabha Atomic Research Centre, Bombay
SHRI K. RAVICHANDRA	Ministry of Petroleum and Natural Gas (Oil Industries Safety Directorate), New Delhi
SHRI M. SHRIVASTVA (Alternate)	
SHRI A. J. REGO	National Safety Council, Bombay
SHRI A. K. CHATTERJEE (Alternate)	
SHRI M. R. SAMPATH	Indian Cotton Mills Federation, Bombay
SHRI O. N. DAGA (Alternate)	
SHRI SURENDRA KUMAR	Indian Chemical Manufacturers Association, Calcutta
SHRI R. PARTHASARTHY (Alternate)	
REPRESENTATIVE	Central Leather Research Institute, Madras
REPRESENTATIVE	Confederation of Indian Industries, New Delhi
REPRESENTATIVE	Indian Space Research Organization, Government of India (Department of Space), Andhra Pradesh
REPRESENTATIVE	National Institute of Occupational Health, Ahmedabad
DR R. K. SINGH, Director (Chem)	Director General, BIS (Ex-officio Member)

Member Secretary

SHRI P. MUKHOPADHYAY
Joint Director (Chem), BIS

(Continued on page 11)

(Continued from page 10)

Personal Protective Equipment (Respiratory) Subcommittee, CHD 008 : 01

Convener

SHRI R. N. MUKHERJEE

Representing

Central Mining Research Station, Dhanbad

Members

DR S. CHATTOPADHYAY

SHRI K. K. DUTT (*Alternate*)

Ministry of Defence (DGQA), New Delhi

SHRI S. K. DANGWAL

SHRI M. H. FULEKAR (*Alternate*)

Central Labour Institute, Bombay

SHRI A. N. INDURKAR

SHRI PRATAP NAIR (*Alternate*)

Mines Safety Appliances, Calcutta

SHRI S. K. MUKHERJEE

SHRI B. R. MEHTA (*Alternate*)

Institute of Fire Engineers, New Delhi

SHRI C. PERREIRA

SHRI DON RISHBERT (*Alternate*)

Joseph Leslie Drager Manufacturing, Bombay

SHRI S. SANYAL

Coal India Ltd, Calcutta

SHRI J. N. SHARMA

Indian Petrochemicals Limited, Vadodara

REPRESENTATIVE

Directorate General of Mines Safety, Dhanbad

