Doc: CHD 08 (23661)WC
November 2023

BUREAU OF INDIAN STANDARDS

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Draft Indian Standard

RESPIRATORY PROTECTIVE DEVICES
Part 3 Fresh Air Hose and Compressed Air Line Breathing Apparatus

(*Second Revision* of IS 10245 Part 3)

(ICS 13.340.30)

Occupational Safety and Health Sectional Committee, CHD 08	**Last Date for Comments : 22nd January 2024**

Occupational Safety and Health Sectional Committee, CHD 08

FOREWORD

(*Formal clause shall be added later*)

Breathing apparatus enables a person to remain in irrespirable and poisonous atmosphere for long or short periods and to still retain his full physical and mental capacity. It is also known as rescue apparatus, anti-gas apparatus, respirator, smoke helmet, and gas mask. The apparatus is required in mines, gas works, chemical factories, iron works, steel plants, smelting and metallurgical works, oil refineries and oil tankers. It may also be used by fire brigade, municipality, army, navy and air force personnel, and mountaineers.

Breathing apparatus should be of such efficiency and reliability as to ensure safety in toxic gases, oxygen-deficient atmosphere, extreme heat, high humidity, and wreckage and falls during disaster. It is, therefore, imperative that breathing apparatus should have an appropriate design; efficiency; and safety under various conditions including temperature; resistance; quality of materials; and workmanship. Besides, it should ensure chemical purity of air/oxygen breathed and should pass rigorous physiological, physical, chemical and mechanical tests. These are prescribed in the following four parts of IS 10245:

a) Part 1 Closed-circuit breathing apparatus in which the exhaled air is rebreathed by the wearer after the carbon dioxide concentration has been effectively reduced and the oxygen concentration is enriched. It is used either with a full-face piece or with mouthpiece and nose clip.
b) Part 2 Open-circuit breathing apparatus in which compressed air carried in cylinders is fed through a demand valve and breathing tube to a full-face piece. Exhaled air passes through a non-return value to the atmosphere.

   NOTE ― Both these types of breathing apparatus are categorized as self-contained breathing apparatus.

c) Part 3 Fresh air hose and compressed air line breathing apparatus are designed to enable a person to work in irrespirable and hazardous atmospheres for longer periods than is generally possible by self-contained breathing apparatus. These may be without blower, with hand blower or with motor operated blower; and compressed air line may be of constant flow type or demand type.
d) Part 4 Escape breathing apparatus which is a self-contained, short duration type, breathing apparatus designed for the sole purpose of enabling a person to escape from a work area in the presence of dangerous dusts, gases fumes or vapours. It may be of the open circuit or closed circuit type.

Reference should be made to IS 9623 : 2008 'Selection, use and maintenance of respiratory protective devices - Code of practice (*First Revision*)' for guidance on the type of respiratory protection that should be provided for particular conditions.

It is recommended that particular care should be taken in the choice of breathing apparatus itself, where such equipment is to be used in very high (45 ± 3) °C) or very low (-6 ± 3) °C ambient temperature.

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.

When this apparatus is being used in atmospheres immediately dangerous to life, a full face piece should be worn.

For conditions of very heavy work a flow in excess of 120 1/min is desirable.

This standard was first published in 1982. In the first revision in 1999, the requirements of the standard were aligned with requirements of relevant European standards due to industry demand. The requirements of components were also set as per relevant European standards.

During this second revision, changes due to revision of test standards on respiratory protective devices and publication of European standards on compressed air line breathing apparatus have been incorporated. Overall, changes in the following have been made:

a) Material
b) Visual inspection test
c) Water immersion requirement and test
d) Cleaning and disinfection as specified by manufacturer and visual verification
e) Practical performance test
f) Connections – hose and couplings
g) Requirement of performance after storage
h) Requirement for flammability added
j) Requirement for carbon dioxide content modified in inhaled air

In the preparation of this standard, assistance has been derived from the following standards:

EN 138 : 1994	Respiratory protective devices. Specification for fresh air hose breathing apparatus for use with full face mask, half mask or mouthpiece assembly
EN 269 : 1995	Respiratory protective devices. Specification for powered fresh air hose breathing apparatus incorporating a hood
EN 14593-2 : 2005	Respiratory protective devices. Compressed air line breathing apparatus with demand valve Apparatus with a half mask at positive pressure. Requirements, testing, marking
EN 14594 : 2018	Respiratory protective devices. Continuous flow compressed air line breathing devices. Requirements, testing and marking

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 : 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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RESPIRATORY PROTECTIVE DEVICES

Part 3 Fresh Air Hose and Compressed Air Line Breathing Apparatus

(*Second Revision*)

1 SCOPE

This standard (Part 3) specifies requirements of design, construction and performance for airline breathing apparatus, including both fresh air hose apparatus and compressed air line apparatus and their methods of tests. Laboratory and practical performance tests are included for the assessment of compliance of apparatus with the requirements.

2 REFERENCES

The standards listed in Annex A contains provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex A.

3 TERMINOLOGY

For the purpose of this standard, the definitions as per IS 8347 shall apply.

4 CLASSIFICATION

4.1 This standard covers three types of apparatus:

a) Type 1 — Fresh air hose apparatus; without blower, short distance, in which air is drawn from a fresh air source without the assistance of a blower;
b) Type 2 — Fresh air hose apparatus in which air is drawn from a fresh source with hand blower or with motor-operated blower; and
c) Type 3 — Compressed air line apparatus in which the wearer is supplied air from a source of compressed air. This may be of constant flow type or demand valve type.

5 GENERAL REQUIREMENTS

5.1 Materials

5.1.1 All materials used in the construction shall have adequate mechanical strength, durability, resistance to corrosion and resistance to deterioration by heat and where applicable by contact with sea or mine water. Such materials shall be anti-static and fire resistant as far as is practicable. The material shall also be resistant to organic vapours like tetraethyl, lead, benzene, toluene, etc.

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

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

5.1.4 The finish of any part of the apparatus likely to be in contact with wearer’s skin shall be free from sharp edges and burrs.

Testing for the above requirements shall be done as per Annex B.

5.2 Water Immersion

The apparatus shall continue to function satisfactorily after being submerged temporarily in water. Before immersion and after removal from the water the apparatus shall meet the requirements of breathing resistance. Testing shall be done as per Annex C.

5.3 Cleaning and Disinfection

All materials shall be visibly unimpaired after cleaning and disinfection by the agents and procedures specified by the manufacturer. Testing shall be done visually as per Annex B.

5.4 Practical Performance

The complete apparatus shall undergo practical performance tests under realistic conditions. These general tests serve the purpose of checking the apparatus for imperfections that cannot be determined by the tests described elsewhere in this standard.

If during any activity, by any test subject, the test subject fails to finalise the selected activity due to the apparatus being not fit for the purpose for which it has been designed, the apparatus shall be deemed to have failed.

Testing shall be done as per Annex D.

5.5 Connections

5.5.1 *General*

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.

Testing shall be done as per Annex B and Annex D.

5.5.2 *Couplings*

The apparatus shall be constructed so that any twisting of the hoses and tubes does not affect the fit or performance of the apparatus, or cause the hoses or tubes to become disconnected. For compressed line apparatus, at least one swivelling coupling shall be fitted to the compressed air supply tube adjacent to the wearer. The design of the couplings shall be such as to prevent unintentional interruption of the air supply.

Testing shall be done as per Annex B and Annex D.

5.6 Body Harness or Belt

5.6.1 A body harness or belt shall be provided to prevent a pull on the breathing tube or on the mouthpiece, half mask or facepiece. Buckles shall be so constructed that once adjusted they will not slip.

5.6.2 The body harness or belt shall be tested for strength of material and of joints and attachments and shall be required to withstand a steady pull of 1 000 N for 30 min without failure.

5.6.3 The attachment connecting the hose to the body harness or belt shall be so designed and constructed as to withstand a pull of 1 000 N for 5 minutes in all directions.

5.7 Head Harness

The head harness shall confirm to IS 14166. Testing shall be done as per Annex B and Annex D.

5.8 Adjustable Parts

All parts requiring manipulation by the 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. Parts that are not intended for adjustment by a wearer shall require the use of tools for their adjustment.

Testing shall be done in accordance with Annex B and Annex D.

5.9 Performance Requirements after Storage

After conditioning in accordance with Annex E (**E-1** and **E-2**) and returning to room temperature, all performance requirements of standard shall be met, except for **5.10**.

Apparatus specifically designed for storage in temperatures beyond the limits of storage conditioning given in **E-1** shall be tested and marked accordingly.

5.10 Flammability

5.10.1 The requirements of **5.10.2** and **5.10.3** do not apply to the compressed air source, but do include the compressed air supply tube.

5.10.2 No exposed components of the apparatus shall continue to burn for more than 5 s after removal from the flame. Testing shall be done in accordance with Annex F (**F-1**).

5.10.3 Wherever the manufacturer designs the apparatus to be used in applications with a high flammability risk, the exposed components shall be tested in accordance with Annex F (**F-2**). The exposed components shall not continue to burn for more than 5 s after removal from the flame.

5.11 Facepiece

Facepieces used for such apparatus shall conform to IS 14166. If, for a particular characteristic, the requirement prescribed in IS 14166 differs from that prescribed in this standard, the requirement prescribed in this standard shall apply.

5.12 Half Masks/Mouthpieces

Half masks or mouthpieces used for such apparatus shall conform to IS 14746. If, for a particular characteristic, the requirement prescribed in IS 14746 differs from that prescribed in this standard, the requirement prescribed in this standard shall apply.

5.13 Nose Clip

A nose clip shall be provided if a mouthpiece is used and should be designed to afford maximum security against accidental displacement. It should not slip when the nose becomes moist with perspiration, and suitable means shall be provided for attaching it to the apparatus to prevent loss. The design of the nose clip shall be such so as to afford reasonable comfort to the wearer throughout the effective use of the apparatus.

Testing shall be done as per Annex B and Annex D.

5.14 Temperature

Apparatus intended for use in low temperature shall function satisfactorily when tested in accordance with Annex D.

5.15 Carbon Dioxide Content of Inhaled Air

When complete apparatus including facepiece is tested as per suitable method given in IS 17274 (Part 9), carbon dioxide content of the inhaled air shall not exceed 1.0 percent (by volume).

5.16 Inward Leakage

The mean inward leakage of the complete device, including the facepiece, shall not exceed 0.05 percent when tested as per method 1 or method 2A of IS 17274 (Part 1).

6 FRESH AIR HOSE APPARATUS WITHOUT BLOWER (TYPE 1)

6.1 Construction

The apparatus shall consist of a full facepiece or mouthpiece with nose clip, with a valve system connected by an air hose to uncontaminated air which is drawn through a hose of adequate diameter to enable a flow of 120 l/min to be achieved by the breathing action of the wearer. The hose shall not exceed 15 m in length.

6.2 Inhalation and Exhalation Valves

6.2.1 In fresh air hose apparatus (lung operated/without blower) an inhalation valve shall be fitted in such a position as to minimize the rebreathing of exhaled air. Where a breathing bag or other flexible reservoir is fitted in order to meet the requirements of carbon dioxide content in inhaled air, the inhalation valve shall be located between the bag or reservoir and the mouthpiece or facepiece.

6.2.2 When it is possible in these types of apparatus for the pressure in the facepiece or half mask to fall below atmospheric pressure in normal use, the exhalation valve shall be shrouded or shall include an additional non-return valve or other device that may be necessary to comply with the requirements specified in **6.2.2**.

6.2.3 The design of valve assemblies shall be such that valve discs or the assemblies can be readily replaced; it shall not be possible to fit an inhalation valve assembly in the expiratory circuit or an exhalation valve assembly in the inspiratory circuit.

6.3 Breathing Tube

6.3.1 If the air supply hose is of the low pressure type, a flexible, non-kinking breathing tube (tubes) shall be used to connect it to the mouthpiece or facepiece and permit free head movement of the wearer.

6.3.2 Whatever type of mouthpiece, face mask or half mask is used, it shall be connected to the air tube by means of a short length of large diameter (inner dia 50 mm) flexible rubber hose. This air reservoir shall act as an equalizer for the inhalation and exhalation pulsations of the lungs, thereby producing a more continuous flow in the air tube (*see* **6.5.4**).

6.4 Resistance to Breathing

6.4.1 Using the fresh air hose with the maximum length of tube for which the apparatus has been submitted for approval, half of it forming a coil of inside diameter of 500 mm, the inhalation and the exhalation resistance shall not exceed 5 mbar.

6.4.2 The inhalation resistance with the maximum length of the tube for which the apparatus has been submitted for approval, shall not be greater than 12 mbar at a continuous air flow of 85 l/min.

Testing shall be carried out as per method 1 and method 2 of IS 17274 (Part 2).

6.5 Fresh Air Hose Supply System

6.5.1 *Hose*

The hose shall be fitted with a strainer at the free end to exclude debris. Provision shall be made for securely anchoring the free end of the hose and strainer so that it cannot be dragged into the contaminated atmosphere.

6.5.2 *Low Pressure Hose*

a) Resistance to collapse - Any portion of the maximum length of hose for which the apparatus has been submitted for approval and including couplings shall be subjected to a force of 1000 N, applied between two 100 mm long plates (one of which is free to move in the direction of the axis of the hose) on opposite sides of the hose. While the designed flow of air passes through it, if the flow is reduced by more than 5 percent, or if the hose is permanently distorted after the release of the force, it shall not be regarded as satisfactory.
b) Resistance to kinking -Resistance to kinking shall be tested by clamping the hose in two places 1000 mm apart so as to form a loop with the clamped portions close together; with the designed flow of air passing through the hose, a force of 500 N shall be applied to a rod 10 mm in diameter sited midway along the loop of the hose. The test shall be repeated at the same point with reverse bending. The hose shall be considered satisfactory if the flow does not drop by more than 10 percent, the tube is undamaged, and no permanent distortion remains when the force is removed.

6.5.3 *Strength of Hose and Couplings*

The hose and couplings shall be tested with a steady pull of 1 000 N for 5 min and shall be regarded as having satisfied the test if no separation or failure is observed.

6.5.4 *Leak Tightness*

The hose and couplings shall be tested for leak tightness as per Annex G by immersion in water to a depth of not more than 300 mm with an internal air pressure 7 kN/m^2. This test shall be applied before the tube and couplings have been submitted to the first of the group of tests described in **6.5.1**, **6.5.2** and **6.5.3** and again on completion of those tests. Flexible hose, used to connect the main hose to the mouthpiece or facepiece, shall be included in this test but without previously being submitted to the tests described in **6.5.1**, **6.5.2** and **6.5.3**.

6.5.5 *Flexibility*

The air supply hose shall be flexible, such that it can be wound on a drum 500 mm in diameter without difficulty.

6.5.6 The air supply hose shall pass the permeation test, when 8 m part of air hose and one coupling is immersed in gasoline. Blow air through the hose at the rate of 8 m/min for 6 h. The air from the hose shall not contain more than 0.01 percent by volume of gasoline vapour at the end of the test.

7 FRESH AIR HOSE APPARATUS WITH BLOWER (TYPE 2)

7.1 Construction

7.1.1 *Fresh Air Hose Apparatus (with Hand Blower)*

The apparatus consists of a full facepiece or mouthpiece with nose clip, with a valve system, by which uncontaminated air is forced through a hose of adequate diameter to enable a flow of 120 l/min to be achieved by a hand-operated blower, and through which the wearer can inhale in an emergency whether or not the blower is operated. The hose shall not exceed 36 m in length.

7.1.2 *Fresh Air Hose Apparatus (with Motor Operated Blower)*

The apparatus consists of a full facepiece, or half mask, with a valve system, by which uncontaminated air is forced through a hose of adequate diameter by a motor operated blower at a flow of not less than 120 l/min and through which the wearer can inhale in an emergency whether or not the blower is operated. The hose shall not exceed 36 m in length.

7.2 Air Hood or Blouse

7.2.1 The air hood or blouse shall be light in mass and comfortable to wear for long periods. It shall have a transparent area affording a good forward view.

7.2.2 A minimum air supply shall be specified by the manufacturer and when determined in accordance with Annex C of IS 14166 at the state flow (which shall not be less than 120 l/min) the inward leakage of the external atmosphere into the hood or blouse shall not exceed a value of 0.1 percent for any one of the test subjects.

7.2.3 The apparatus should be designed to minimize the noise level in the air hood or blouse. The noise level shall not be more than 80 dB(A) during the period of use.

7.3 Inhalation and Exhalation Valves

7.3.1 In fresh air hose apparatus (with hand/motor operated blower) an inhalation valve shall be fitted in such a position as to minimize the rebreathing of exhaled air. Where a breathing bag or other flexible reservoir is fitted in order to meet the requirements of **7.5.1** the inhalation valve shall be located between the bag or reservoir and the half mask or facepiece.

7.3.2 When it is possible in these types of apparatus for the pressure in the facepiece or half mask to fall below atmospheric pressure in normal use, the exhalation valve shall be shrouded or shall include an additional non-return valve or other device that may be necessary to comply with the requirements specified in**7.3.2**.

7.3.3 The design of valve assemblies shall be such that valve discs or the assemblies can be readily replaced; it shall not be possible to fit an inhalation valve assembly in the expiratory circuit or an exhalation valve assembly in the inspiratory circuit.

7.4 Breathing Tubes

If the air supply hose is of the low-pressure type, a flexible, non-kinking breathing tube(s) shall be used to connect it to the half mask or facepiece and permit free head movement to the wearer.

7.5 Resistance to Breathing

7.5.1 With the air supply system working at any flow with a blower operated in such a way that the operator would not become unduly fatigued after 30 min, then, with the maximum length of tube for which the apparatus has been submitted for approval, half of it coiled to an inside diameter of 500 mm, the inhalation and exhalation resistance shall not be more than 5 mbar.

7.5.2 If any of the air supply systems (*see* **7.6**) ceases to operate, the wearer shall still be able to inhale through the tube without undue distress. This provision shall be satisfied if the total inhalation resistance, with the air supply system is operative but not disconnected and with the maximum length of the tube for which the apparatus has been submitted for approval, is not greater than 12 mbar at a continuous air flow of 85 l/min.

7.6 Fresh Air Hose Supply System

7.6.1 *With Blower*

a) Hand-operated blowers shall be capable of being operated by one man without undue fatigue for at least 30 min. The crank speed of hand operated blower shall not exceed 60 rev/min to deliver the desired flow and the power required to deliver the desired flow shall not exceed 1/50th HP and the torque required to rotate shall not exceed a force of 2.3 kg on a 20 cm crank.
b) The blower shall be tested by operating it by a mechanical drive for a period of 100 h at the desired flow and crank speed. Blower shall work throughout without any failure or indication of excessive wear of bearings and other working parts, while delivering the air flow with maximum length of hose as defined earlier.
c) Blowers shall be capable of maintaining adequate flow of air with either direction of rotation, unless made to operate in one direction only. In the former case the direction of operation in which the blower delivers the lesser volume of air against the designed working pressures shall be used in tests.

The motor operated blowers shall conform to the requirements prescribed in **7.6.1**(a) and (b). When motor operated blowers are used where flammable surroundings may arise it is essential that suitability of the equipment for use in such surroundings be considered.

NOTES

1 It is recommended that an air flow indicator should be provided at the blower to indicate the flow rate.

2 It is also recommended that a suitable signalling device between the user and the operator is provided.

7.6.2 *Low Pressure Hose*

The low pressure hose shall conform to the requirements prescribed in **6.5.2**.

7.6.3 *Strength of Hose and Couplings*

The low pressure hose shall conform to the requirements prescribed in **6.5.3**.

7.6.4 *Leak Tightness*

The hose and couplings shall be tested for leak tightness as per Annex G by immersion in water to a depth of not more than 300 mm with an internal air pressure 7 kN/m^{2}or 7 bar. This test shall be applied before the tube and couplings have been submitted to the first of the group of tests described in **7.6.1**, **7.6.2** and **7.6.3**, and again after the last of those tests. Flexible hose, used to connect the main hose to the half mask or facepiece, shall be included in the tests described in **7.6.1**, **7.6.2** and **7.6.3**.

7.6.5 *Flexibility*

The low pressure hose shall conform to the requirements prescribed in **6.6.5**.

7.6.6 *Permeation Test*

The low pressure hose shall conform to the requirements prescribed in **6.6.6**.

8 FRESH AIR HOSE APPARATUS WITH COMPRESSED AIR (TYPE 3)

8.1 Construction

8.1.1 *Compressed Air Line Apparatus (Constant Flow Type)*

The apparatus shall consist of a full facepiece, a half mask or an air hood or blouse connected to a supply of breathable air fed continuously to the wearer. The air flow is regulated by a flow control valve from a source of compressed air.

The pressure range at the point of connection of the apparatus to the compressed air line for a specified flow rate and length of hose shall be indicated by the manufacturer. The specified pressure at the point of attachment of hose to the air supply system shall not exceed 863 kN/m^2.

If the pressure exceeds 863 kN/m^2 the respirator shall be provided with a pressure release mechanism, so that the pressure at the point of attachment does not exceed 863 kN/m^2.

8.1.2 *Compressed Air Line Apparatus (Demand Valve Type)*

The apparatus consists of a full facepiece connected to a demand valve that admits breathable air to the wearer when he inhales and closes when he exhales. An air line connects the wearer to a supply of compressed air.

8.2 Air Hood or Blouse

8.2.1 The air hood or blouse shall be light in weight and comfortable to wear for long periods. It shall have a transparent area affording a good forward view.

8.2.2 A minimum air supply shall be specified by the manufacturer and when determined in accordance with Annex C of IS 14166 at the stated flow (which shall not be less than 120 l/min) the inward leakage of the external atmosphere into the hood or blouse shall not exceed a value of 0.1 percent for any one of test subjects.

8.2.3 The apparatus should be designed to minimize the noise level in the air hood or blouse. The noise during its use shall not be more than 80 dB(A).

8.3 Inhalation and Exhalation Valves

8.3.1 In high pressure air hose apparatus an inhalation valve shall be fitted in such a position as to minimize the rebreathing of exhaled air. Whereas breathing bag or other flexible reservoir is fitted in order to meet the requirements of **8.1.1,** the inhalation valve shall be located between the bag or reservoir and the half mask or facepiece.

8.3.2 When it is possible in these types of apparatus for the pressure in the facepiece or half mask to fall below atmospheric pressure in normal use, the exhalation valve shall be shrouded or shall include an additional non-return valve or other device that may be necessary to comply with the requirements specified in **8.3.2**.

8.3.3 The design of valve assemblies shall be such that valve discs or the assemblies can be readily replaced; it shall not be possible to fit an inhalation valve assembly in the expiratory circuit or an exhalation valve assembly in the inspiratory circuit.

8.4 Demand Valve

8.4.1 *General*

The apparatus shall conform to the requirements of breathing resistance. These requirements shall be met over the pressure range of the air supplied to the apparatus as specified by the manufacturer. Testing shall be done in accordance with method 2 of IS 17274 (Part 2).

8.4.2 *Couplings*

Where a hand operated coupling is fitted between the demand valve and a connector at the waist belt or body harness it shall incorporate a self-sealing device to prevent loss of air from the compressed air supply tube. Testing shall be done as per Annex B and Annex D.

8.4.3 *Supplementary Air Supply*

Apparatus may be provided with a manually operated means of providing a supply of air. If provided, the air flow from such a device shall be at least 60 l/min at the minimum stated air supply conditions. Testing shall be done in accordance with method 2 of IS 17274 (Part 2).

8.5 Flow Control Valve

The flow control valve when fitted shall be set on the waist belt or harness in a position where it can be easily adjusted. It shall provide an adequate flow to the facepiece or hood at all stated supply pressures and the valve in the fully closed position shall pass at least 57 l/min at the minimum stated supply pressure. The flow shall remain constant within 10 percent of the initial flow for all pressures up to 1000 kN/m^2. It shall not be possible to adjust the valve setting without special tool.

8.6 Breathing Tubes

If the air supply hose is of the low pressure type, a flexible, non-kinking breathing tube (tubes) shall be used to connect it to the half mask or facepiece and permit free head movement to the wearer.

8.7 Resistance to Breathing

8.7.1 With the air supply system working at any flow chosen by the testing authority but within its designed range or pressure and air flow or with a blower operated in such a way that the operator would not become unduly fatigued after 30 min, then, with the maximum length of tube for which the apparatus has been submitted for approval, half of it coiled to an inside diameter of 500 mm, neither the inspiratory nor the expiratory side of the apparatus shall have a resistance greater than 5 mbar.

8.7.2 If any of the air supply systems detailed in **8.1** ceases to operate, the wearer shall still be able to inhale through the tube without undue distress. The provision shall be satisfied if the total inspiratory resistance with the air supply system in operative but not disconnected and with the maximum length of the tube for which the apparatus has been submitted for approval, is not greater than 12 mbar at a continuous air flow of 85 l/min.

8.8 Low Pressure Hose

8.8.1 *Resistance to Collapse*

Any portion of the maximum length of hose for which the apparatus has been submitted for approval and including couplings shall be subjected to a force of 1000 N, applied between two 100 mm long plates (one of which is free to move in the direction of the axis of the hose) on opposite sides of the hose, while the designed flow of air passes through it. If the flow is reduced by more than 5 percent, or if the hose is permanently distorted after the release of the force, it shall not be regarded as satisfactory.

8.8.2 *Resistance to Kinking*

Resistance to kinking shall be tested by clamping the hose in two places 1000 mm apart so as to form a loop with the clamped portions close together; with the designed flow of air passing through the hose, a force of 500 N shall be applied to a rod 10 mm in diameter set midway along the loop of the hose. The test shall be repeated at the same point with reverse bending. The hose shall be considered satisfactory if the flow does not drop by more than 10 percent, the tube is undamaged, and no permanent distortion remains when the force is removed.

8.8.3 *Strength of Hose and Couplings*

The hose and couplings shall be tested with a steady pull of 1 000 N for 5 min and shall be regarded as having satisfied the test if no separation on failure is observed.

8.8.4 *Leak Tightness*

The hose and couplings shall be tested for leak tightness as per Annex G by immersion in water to a depth of not more than 300 mm with an internal air pressure 7 kN/m^2. This test shall be applied before the tube and couplings have been submitted to the first of the group of test described in **8.8.1**, **8.8.2** and **8.8.3** and again after the last of those tests. Flexible hose, used to connect the main hose to the mouthpiece or facepiece, shall be included in this test but without previously being submitted to the tests described in **8.8.1**, **8.8.2** and **8.8.3**.

8.8.5 *Flexibility*

The air supply hose shall be flexible, such that it can be wound on a drum 500 mm in diameter without difficulty.

8.9 Compressed Air Line Supply System

8.9.1 The air supply should be in the range of 863 kN/m^2 to 1 035 kN/m^2, a pressure regulator being fitted if necessary.

8.9.2 When the supply of air is from high pressure cylinders the flow from a pressure regulator of constant flow type must remain constant to within 10 percent of the pre-set flow at all pressures above 1 000 kN/m^2, the pressure regulator shall not be capable of adjustment without the use of tools.

In addition where the air is supplied from cylinders the apparatus shall be provided with an alarm signal on the high pressure side to indicate the approach of the exhaustion of the air supply. This device should not substantially deplete the remaining air supply. The breathing gas used to supply in the breathing apparatus shall be respirable and contain no less than 19.5 percent by weight of oxygen and should not have any contaminant of toxic gases.

8.9.3 Pressure gauges in accordance with IS 3624 shall be provided on the high and low pressure sides if cylinders are used.

8.10 High Pressure Tubing

8.10.1 *Resistance to Kinking*

With the demand valve (if any) held fully open and with the minimum designed supply pressure applied to the supply end of the tubing a section of the tubing shall be placed on a horizontal plane surface and shaped into a one-loop coil. One end of the loop shall be held in position while the other end is pulled tangentially to the loop and in the plane of the loop until the tube takes the form of a straight line. To meet the requirements of this test the loop shall maintain a uniform near-circular shape and ultimately unfold as a spiral, without any localized deformation that decreases the flow of air by 10 percent or more of the flow when the hose is tested as a straight section.

8.10.2 *Strength of Tube and Couplings*

The tube and couplings shall be tested with a steady pull of 1 000 N for 5 min and shall be regarded as having satisfied the test if no separation or failure is observed.

8.10.3 *Leak Tightness*

With the maximum designed working pressure applied to the apparatus, the tube and couplings shall be tested for leak tightness by immersion in water. This test shall be applied before and after the tube and couplings have been submitted to the test described in **8.2.2**. Flexible tubes used to connect the main tube to the half mask or facepiece shall be tested for leak tightness by immersion in water to a depth not greater than 300 mm with an internal pressure of 7 kN/m^2 without previously being submitted to the test described in **8.2.2**.

8.10.4 The tube shall be flexible, such that when pressurized to the maximum working pressure it can wound on a drum 300 mm in diameter without difficulty.

8.10.5 High pressure tube and couplings shall be capable of withstanding without damage a test pressure of twice the maximum designed working pressure of the apparatus.

8.10.6 When the high pressure tube connects directly on the facepiece or half mask the design of the apparatus shall be such as to prevent a pull on the tube exerting a pull on the facepiece and to permit free head movement to the wearer.

8.10.7 If tubing is required to be resistant to damage from contact with hot surfaces in excess of 50 °C it shall comply with the following requirements:

8.10.7.1 When a length of tube is subjected to normal working pressure and:

a) a section of it (about 100 mm in length) is held for 15 min in contact with a flat plate maintained at 130°C; and
b) Immersed in boiling water for 15 min, there shall be no sign of damage or indication or failure and the quality of air passing through it shall not be unduly affected.

NOTE — Particular care should be taken in the choice of tubing to be used in very high or very low ambient temperatures.

8.10.8 It shall not be possible to fit a low-pressure tube or hose into a higher pressure part of the circuit. It shall not be possible to connect the compressed air supply tube directly to the breathing hose, medium pressure connecting tube or half mask.

8.10.9 *Permeation Test*

The air supply hose shall pass the permeation test, when tested in accordance with **6.5.6.1**.

8.11 Marking

8.11.1 The facepiece, half mask, hood or blouse shall be marked with the following details:

a) Name, trade-mark or other means of identification of the manufacturer;
b) Size (if more than one size is available);
c) For hoods and blouses, the designed air flow in litre/min (for Type 2 and Type 3 only); and
d) Whether or not designed for use in low temperatures; and
e) For all rubber parts, year and month of manufacture to be marked legibly.

8.11.2 *Markings on the Hose*

The hose shall be marked with the following details:

a) Name, trademark or other means of identification of the manufacturer;
b) Designed minimum air flow in l/min (for Type 2 and Type 3 only);
c) Working pressure of high pressure hose (for Type 3 only).

8.11.3 *Marking on the Flow Control Valve*

The maximum and minimum working pressures shall be marked on the flow control valve(s) fitted with apparatus of Type 3.

8.11.4 *Marking on Blower*

The blower of the apparatus of Type 2 and Type 3 shall be marked with the following details:

a) Name, trade-mark or other means of identification of the manufacturer;
b) Designed minimum air flow in litre/min;
c) Maximum length of air hose for which the blower is designed; and
d) Direction of rotation of the crank (wherever applicable).

8.11.5 *BIS Certification Marking*

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed thereunder, and the products may be marked with the standard mark.

8.12 Instructions

Breathing apparatus manufactured in compliance with this standard shall be supplied accompanied by instructions for maintenance and use. These instructions shall include the following information:

a) Size of the facepiece, half mask, hood or blouse (if more than one size is available);
b) Guidance on the fit of the facepiece, and adjustment of face seal where relevant;
c) Whether or not designed for use in low temperatures;
d) 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;
e) For low pressure hose, the designed minimum air flow in litre/min;
f) Working pressure of high-pressure hose;
g) Maximum and minimum working pressures of the flow control valve;
h) For the blower, the designed minimum air flow in litre/min;
i) For hoods and blouses, the designed air flow in litre/min; and
j) A warning that at very high work rates the pressure in the facepiece may become negative at peak inhalations.

ANNEX A
(*Clause* 2)
LIST OF REFERRED STANDARDS

IS No.	*Title*
IS 3624 : 1987	Pressure and vacuum gauges (S*econd revision)*
IS 8347 : 2008	Respiratory Protective Devices — Definitions, Classifications and Nomenclature of Components
IS 9623 : 2008	Selection, use and maintenance of respiratory protective devices — Code of practice (*First Revision*)
IS 14138 (Part 1) :1994	Respiratory protective devices: Threads for facepieces — Specification: Part 1 Standard thread connection
IS 14138 (Part 2) : 1994	Respiratory protective devices: Threads for facepieces — Specification: Part 2 Centre thread connection
IS 14166 : 1994	Respiratory protective devices — Full face masks – Specification
IS 14170 : 1994	Respiratory protective devices – Mouthpiece assemblies — Specification
IS 14746 : 1999	Respiratory protective devices – Half masks and quarter masks — Specification
IS 17274 (Part 1) : 2019	Respiratory Protective Devices — Methods of Test and Test Equipment Part 1 Determination of Inward Leakage
IS 17274 (Part 9) : 2019	Respiratory Protective Devices — Methods of Test and Test Equipment Part 9 Determination of Carbon Dioxide Content of the Inhaled Gas

ANNEX B
(*Clause*s 5.1, 5.3, 5.5.1, 5.5.2, 5.7, 5.8, *and* 5.13)
VISUAL INSPECTION

A visual inspection shall be made by prior to laboratory or practical performance tests. This may involve certain amount of dismantling in accordance with the manufacturer's instructions for maintenance. The visual inspection shall include the assessment of the device marking and information supplied by the manufacturer and any safety data sheets (if applicable) or declarations relevant to the materials used in its construction.

ANNEX C

(*Clause* 5.2)

WATER IMMERSION TEST

The facepiece of the complete apparatus is fitted to a dummy head which, in turn, is connected to a breathing machine by a flexible hose. The test is conducted with the breathing machine adjusted to 25 cycles/min and 2 l/stroke. The facepiece mounted on dummy head as worn is immersed in water to a depth of between 0.25 m and 0.80 m for a period of not less than 3 and not more than 5 full breathing cycles. A series of tests is carried out with the apparatus immersed and with the dummy head in two orientations, which represent respectively the maximum and minimum differential pressures between the lung governed demand valve and the exhalation valve. The facepiece mounted on dummy head are removed from the water after each test at each orientation. Measure the breathing resistance at the appropriate pressure sample points using a precision gauge. The breathing resistance is recorded prior to and immediately after each immersion. The presence of water in the facepiece after the test does not constitute a reason for failure and any water present may be removed prior to measurement of breathing resistance.

ANNEX D

(*Clause*s 5.4, 5.5.1, 5.5.2, 5.7, 5.8, *and* 5.14)

PRACTICAL PERFORMANCE TEST

D-1 GENERAL

Practical performance tests shall be carried out using two sets of apparatus and four test subjects. Apparatus which has satisfied the laboratory tests shall be used. The test plan shall be as given below.

a) Test subjects 1 and 2 shall use apparatus 1.
b) Test subjects 3 and 4 shall use apparatus 2.

D-2 SAMPLE PREPARATION

Before each test check the apparatus for leaktightness. For compressed air supply equipment, ensure that air supplies from compressed air systems or from compressed air cylinders are within the specified pressures.

The length of the air supply tube shall be the maximum specified by the manufacturer, including the maximum number of permitted connections.

D-3 TEST CONDITIONS

All tests shall be carried out at ambient conditions which shall be recorded.

D-4 WORK SIMULATION TEST

The work simulation test shall be carried out and evaluated as per the method prescribed in IS 17274 (Part 7). Two apparatus shall be prepared ready for use and conditioned at ambient temperature. Four test subjects shall carry out the test in accordance with IS 17274 (Part 7).

D-5 PRACTICAL PERFORMANCE TEST AT LOW TEMPERATURE

D-5.1 Temperature of Cold Chamber

Temperature of cold chamber shall be between - 6 °C and - 9 °C.

D-5.2 Test with Pre-cooled Apparatus

Two apparatus shall be cleaned according to the information supplied by the manufacturer and any excess liquid removed by shaking. The apparatus are shall then be made ready for use and pre-cooled for not less than 2 h but no more than 3 h in the cold chamber.

Two warmly clothed subjects shall each don an apparatus in the cold chamber and carry out the test in accordance with IS 17274 (Part 7).

ANNEX E

(*Clause* 5.9)

STORAGE CONDITIONING

E-1 CONDITIONING

In order to ensure that there is no thermal shock during the conditioning of the specimens, the temperature gradient shall be less than 2 °C/min between phases at different temperatures, or between the beginning and the end of a thermal cycle.

The apparatus shall be conditioned according to the following order:

a) 4 h to 16 h at (60 ± 3) °C and at least 95 % relative humidity or the manufacturer's stated maximum conditions, whichever are the higher;
b) 4 h to 16 h at (-30 ± 3) °C or the manufacturer's stated minimum condition, whichever is the lower.

The apparatus shall then be allowed to return to ambient conditions (at least 4 h) before further testing.

E-2 LABORATORY TEST AFTER CONDITIONING

After conditioning in accordance with **E-1**, the apparatus is operated for at least 30 min using a breathing machine operating at 25 cycles/min, 2 l/stroke.

ANNEX F

(*Clauses* 5.10.2 *and* 5.10.3)

FLAMMABILITY

F-1 SINGLE BURNER MOVING SPECIMEN TEST

F-1.1 Principle

The sample under test is mounted such that it may be passed through a flame at a temperature of (800 ± 50) °C at a speed of (60 ± 5) mm/s.

F-1.2 Test rig

The test rig consists mainly of a propane cylinder with flow control device, pressure gauge, flash back arrester, specimen support, rotation motor with speed controller, and burner (*see* Fig. 1). The purity of the propane shall be a minimum of 95 percent.

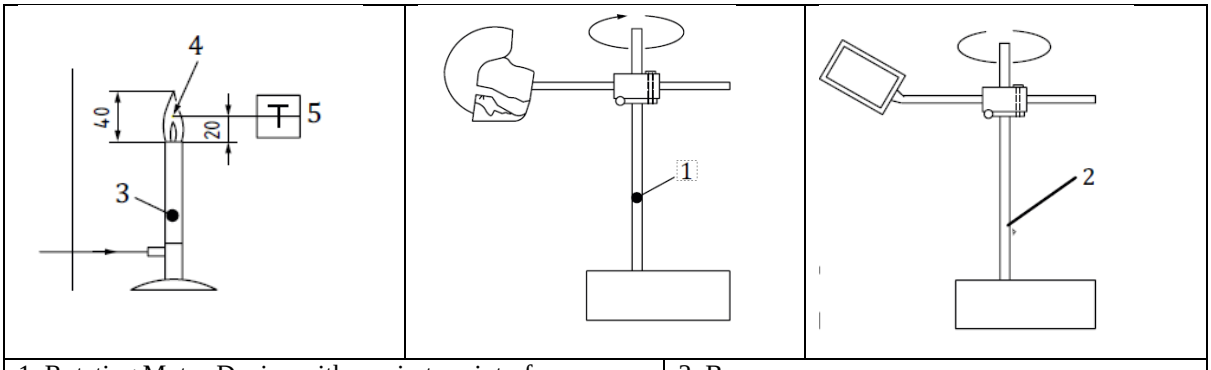
F-1.3 Procedure

F-1.3.1 Mount the sample on support, and adjust the position such that the sample under test passes directly over the tip of the burner when the support is rotated. With the sample directly over the burner, adjust the height between the tip of the burner and the lowest part of the sample to (20 ± 2) mm.

F-1.3.2 Adjust the rotation speed of the motor such that the linear speed of the sample, measured at the burner is (60 ± 5) mm/s. With the sample removed from above the burner, ignite the burner and adjust the flame height with the propane flow control valve to (40 ± 4) mm. Check that these settings give a flame temperature of (800 ± 50) °C at a point (20 ± 2) mm above the burner tip, measured with a thermocouple probe. In order to achieve the correct flame temperature at the correct flame height it may be necessary to shield the whole test rig from the effect of external airflows.

F-1.3.3 Pass the sample once through the flame. Repeat the test with the sample mounted in a different orientation or with other samples so that an assessment can be made of all materials or components. It is important that no part of the specimen passes through the flame more than once.

F-1.3.4 Observe and report whether or not the sample continues to burn or presents any additional hazard to the wearer.



1. Rotating Motor Device with respiratory interface	3. Burner
2. Rotating Motor Device with Component interface	4. Thermocouple
	5. Temperature measuring device

FIG.1 SINGLE BURNER DYNAMIC TEST

F-2 SINGLE BURNER STATIC TEST

F-2.1 Principle

The sample is exposed to a flame at a temperature of (800 ± 50) °C for (12 ± 0.5) s, such that the centre of the flame impinges on the edge of the sample under test.

F-2.2 Test Rig

The test rig consists mainly of a propane cylinder with flow control device, pressure gauge, flashback arrester, specimen support and burner (*see* Fig. 2). The purity of the propane shall be a minimum of 95 percent.

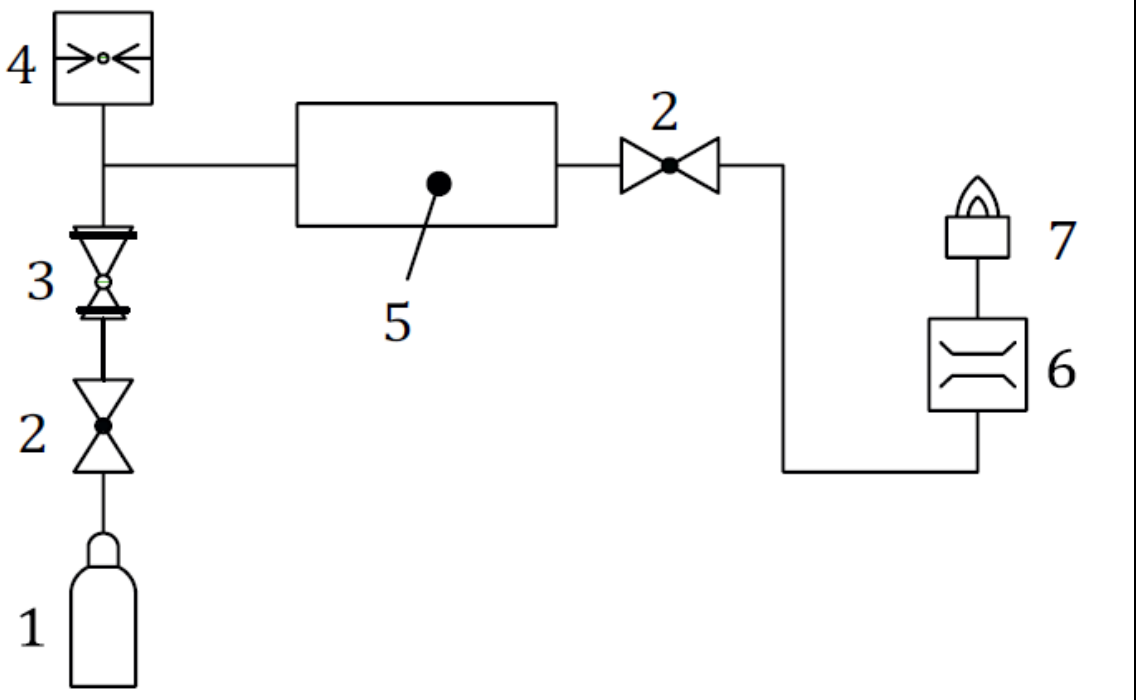
F-2.3 Procedure

F-2.3.1 Mount the sample to be tested on the support such that it is orientated horizontally above the burner. Adjust the height of the burner tip to the lowest part of the horizontal sample at a distance of (20 ± 2) mm. The edge of the sample shall be positioned directly over the burner during the test. An example is shown in Fig. 2.

F-2.3.2 With the sample removed from above the burner, ignite the burner and adjust the flame height with the propane flow control valve to (40 ± 4) mm. Check that these settings give a flame temperature of (800 ± 50) °C at a point (20 ± 2) mm above the burner tip, measured with a thermocouple probe. In order to achieve the correct flame temperature at the correct flame height, it may be necessary to shield the whole test rig from the effect of external airflows.

F-2.3.3 Expose the sample to the flame for (12 ± 0.5) s ensuring that the centre of flame impinges on the edge of the sample.

F-2.3.4 Observe and report whether or not the specimen continues to burn or presents any additional hazard to the wearer



1. Propane cylinder	5. Flash back arrester
2 flow control device,	6. Rotation motor with speed controller
3. Pressure reducer	7. Burner
4. Pressure gauge	

FIG. 2 SCHEMATIC DIAGRAM OF SINGLE BURNER STATIC TEST

ANNEX G

(*Clauses* 6.5.4, 7.6.4, *and* 8.8.4)

LEAK TIGHTNESS TEST

G-l PROCEDURE

G-1.1 Test Equipment

A breathing machine designed to provide sinusoidal air flows, operating at a rate corresponding to 20 respirations per minute.

G-1.2 Method of Test

The facepiece, or mouth piece of the apparatus is connected in an airtight manner to the breathing machine.

The apparatus is connected to an air supply appropriate to its type as follows:

a) Fresh Air Hose Apparatus - By the maximum length of hose for which the apparatus has been submitted for approval.
b) Compressed Air Line Apparatus - With the air supply system working at any flow, within the designed range of pressures and flows, chosen by the testing authority.

G-1.2.1 The breathing machine ‘exhales’ through the facepiece or mouthpiece of the apparatus a tidal volume of 2 litres of 5 percent (by volume) carbon dioxide/air mixture at ambient temperature (total exhalation 40 l/min) and ‘inhales’ through the facepiece, or mouthpieces of the apparatus 2 litres of air (total inhalation 40 l/min).