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(पहला पुनरीक्षण)

Indian Standard

BREATHING APPARATUS

PART 3 FRESH AIR HOSE AND COMPRESSED AIR LINE BREATHING APPARATUS — SPECIFICATION

(First Revision)

ICS 13.340.30

BUREAU OF INDIAN STANDARDS
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Price Group 7

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FOREWORD

This Indian Standard (Part 3) (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.

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 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 and 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 : 1980 'Recommendations for the selection, use and maintenance of respiratory protective devices' 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 facepiece should be worn.

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

This standard was first published in 1982. In this revision the requirements of this standard has been aligned with the requirements of relevant European standards due to the demand of the Industries. The requirements of the components have also been made in line with the relevant European standards.

In this revision the following have been modified based on the feedback received from the users:

a) duration for pull test of harness or belt;
b) flexibility test;
c) requirement of blower; and
d) requirement of demand valve.

In addition to the above two new requirements, namely permeation test for hoses and rough usage test of apparatus have also been included.

The composition of the technical committee responsible for formulating this standard is given at Annex J.

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 therounded off value should be the same as that of the specified value in this standard.

Indian Standard

BREATHING APPARATUS

PART 3 FRESH AIR HOSE AND COMPRESSED AIR LINE BREATHING APPARATUS — SPECIFICATION

(First Revision)

1 SCOPE

This standard (Part 3) specifies requirements of design, construction and performance for air line 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 Indian Standards given in Annex A contain provisions which through reference in this text, constitute provision 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 by dated or undated the possibility of applying the most recent editions of the standards.

3 TERMINOLOGY

For the purpose of this standard, the following definition shall apply in addition to those prescribed in IS 8347.

3.1 Air Hood or Blouse

Hood of rigid or flexible material completely covering the head, neck and portions of the shoulders or upper part of the body.

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.

5.2 Strength

The apparatus shall be sufficiently robust to withstand the rough usage when tested in accordance with Annex B.

5.3 Separation of Parts

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.

5.4 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.

5.5 Leak Tightness

The apparatus shall be so designed and constructed as to prevent the ingress of the external atmosphere within the limits set out in this standard at any place other than the fresh air inlet.

5.6 Cleaning and Decontamination

The design of the apparatus shall be such as to facilitate cleaning. All exposed surfaces shall be capable of withstanding treatment by one when tested in accordance with the methods prescribed in Annex C without appreciable deterioration.

5.7 Facepiece

Facepieces used for such apparatus shall conform to IS 14166.

5.8 Half Masks/Mouthpieces

Half masks or mouthpieces used for such apparatus shall conform to IS 14746.

5.9 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.

5.10 Head Harness

5.10.1 The head harness shall hold the facepiece, half mask or mouthpiece 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 head harness shall be resistant to shrinkage and shall not cause any irritation to the skin of the wearer.

5.10.2 The head harness shall be adjustable and, if consisting only of straps, these shall be adjustable and not less than 20 mm (nominal) width at the points in contact with the head, and designed so as to ensure that the wearer must readjust the straps before each occasion of use.

5.10.3 The head harness strap shall be slip proof and durable.

5.11 Harness or Belt

5.11.1 A 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.

5.11.2 The 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.

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

5.11.4 Any fabric used in the construction of a body harness shall be resistant to shrinkage.

5.12 Comfort

When tested in accordance with Annex D, the apparatus shall be such that it may be worn without avoidable discomfort. The wearers shall not show undue signs of strain attributable to wearing the apparatus, and it shall impede the wearer as little as possible, when in a crouched position or when working in a confined space.

5.13 Temperature

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

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 **6.4.1** the inhalation valve shall be located between the bag or reservoir and the mouthpiece or facepiece.

6.2.2 All apparatus except air hoods and blouses shall be provided with an exhalation valve to allow the escape of exhaled air and any excess air delivered by the air supply, and it shall be capable of being operated automatically by the pressure in the breathing circuit. The exhalation valve shall be designed so that inward leakage of the external atmosphere shall not exceed 0.002 5 percent when the moist valve is tested in accordance with Annex F. The valve shall be protected against dirt and mechanical damage.

6.2.3 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**.

6.2.4 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 to 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 equaliser for the inhalation and exhalation pulsations of the lungs, thereby producing a more continuous flow in the air tube (*see* **6.6.4**).

6.4 Condition of the Inhaled Air (Carbon Dioxide Content)

6.4.1 When apparatus using a mouthpiece is tested in accordance with Annex G, the carbon dioxide content of the inhaled air (including dead space effects) shall not exceed 1.0 percent (by volume).

6.4.2 When the apparatus with an air flow of less than 120 l/min and using a facepiece or half mask is tested in accordance with Annex G, the carbon dioxide content of the inhaled air (including dead space effects) shall not exceed 1.5 percent (by volume).

6.5 Resistance to Breathing

6.5.1 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, neither the inspiratory, nor the expiratory side of the apparatus shall have a dynamic resistance greater than 50 mm H_2O. The breathing resistance is measured before and after the tests described in Annex D and Annex G.

6.5.2 The total inspiratory resistance with the maximum length of the tube for which the apparatus has been submitted for approval, shall not be greater than 125 mm H_2O at a continuous air flow of 85 l/min.

6.6 Fresh Air Hose Supply System

6.6.1 *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.

6.6.2 *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 1 000 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 1 000 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.

6.6.3 *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.

6.6.4 *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. This test shall be applied before the tube and couplings have been submitted to the first of the group of test described in **6.6.1**, **6.6.2** and **6.6.3** 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 **6.6.1**, **6.6.2** and **6.6.3**.

6.6.5 *Flexibility*

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

6.6.6 The air supply hose shall pass the permeation test, when tested in accordance with **6.6.6.1**.

6.6.6.1 Immerse 8 m of air hose and one coupling 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 should 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 should 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 H 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 **7.6.1** the inhalation valve shall be located between the bag or reservoir and the half mask or facepiece.

7.3.2 All apparatus except air hoods and blouses shall be provided with an exhalation valve to allow the escape of exhaled air and any excess air delivered by the air supply, and it shall be capable of being operated automatically by the pressure in the breathing circuit. The exhalation valve shall be so designed that inward leakage of the external atmosphere shall not exceed 0.002 5 percent when the moist valve is tested in accordance with Annex F. The valve shall be protected against dirt and mechanical damage.

7.3.3 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**.

7.3.4 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 Condition of the Inhaled Air (Carbon Dioxide Content)

When the apparatus with an air flow of less than 120 l/min and using a facepiece or half mask is tested in accordance with Annex G, the carbon dioxide content of the inhaled air (including dead space effects) shall not exceed 1.5 percent (by volume).

7.6 Resistance to Breathing

7.6.1 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, neither the inspiratory nor the expiratory side of the apparatus shall have a resistance greater than 50 mm H_2O. The breathing resistance is measured before and after the tests described in Annex D and Annex G.

7.6.2 If any of the air supply systems (*see* **7.7**) 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 inspiratory 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 125 mm H_2O at a continuous air flow of 85 l/min.

7.7 Fresh Air Hose Supply System

7.7.1 *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 **7.7.1**(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.

7.7.2 *Low Pressure Hose*

The low pressure hose shall conform to the requirements prescribed in **6.6.2**.

7.7.3 *Strength of Hose and Couplings*

The low pressure hose shall conform to the requirements prescribed in **6.6.3**.

7.7.4 *Leak Tightness*

The hose and couplings shall be tested for leak tightness 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 **7.7.1**, **7.7.2** and **7.7.3**, 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 **7.7.1**, **7.7.2** and **7.7.3**.

7.7.5 *Flexibility*

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

7.7.6 *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 H 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 All apparatus except air hoods and blouses shall be provided with an exhalation valve to allow the escape of exhaled air and any excess air delivered by the air supply, and it shall be capable of being operated automatically by the pressure in the breathing circuit. The exhalation valve shall be designed so that inward leakage of the external atmosphere shall not exceed 0.002 5 percent when the moist valve is tested in accordance with Annex F. The valve shall be protected against dirt and mechanical damage.

8.3.3 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**.

8.3.4 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

A demand valve, when fitted, shall be connected directly or by non-kinking hose to the facepiece. When in any position the demand valve shall operate at an inlet pressure between 345 kN/m^2 and 1 035 kN/m^2 and shall be capable of supplying air at the minimum flow of 120 l/min.

The manufacturer shall specify the range of air pressure at the point of attachment of air supply hose to the air supply system. The demand valve shall be capable of supplying air at minimum rate of 120 l/min within the range of supply pressure 345 to 1 035 kN/m^2. If the supply pressure exceeds 863 kN/m^2 a pressure release mechanism shall be provided which shall operate if the pressure exceeds by 20 percent of 863 kN/m^2.

8.5 Flow Control Valve

The flow control valve when fitted shall be sited 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 1 000 kN/m^2. It shall not be possible to adjust the valve 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 Condition of the Inhaled Air (Carbon Dioxide Content)

When the apparatus with an air flow of less than 120 l/min and using a facepiece or half mask is tested in accordance with Annex G, the carbon dioxide content of the inhaled air (including dead space effects) shall not exceed 1.5 percent (by volume).

8.8 Resistance to Breathing

8.8.1 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 50 mm H_2O. The breathing resistance is measured before and after the tests described in Annex D and Annex G.

8.8.2 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 125 mm H_2O at a continuous air flow of 85 l/min.

8.9 Low Pressure Hose

8.9.1 *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 1 000 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.

8.9.2 *Resistance to Kinking*

Resistance to kinking shall be tested by clamping the hose in two places 1 000 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.

8.9.3 *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.

8.9.4 *Leak Tightness*

The hose and couplings shall be tested for leak tightness 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 **6.6.1**, **6.6.2** and **6.6.3** 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 **6.6.1**, **6.6.2** and **6.6.3**.

8.9.5 *Flexibility*

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

8.10 Compressed Air Line Supply System

8.10.1 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.

8.10.2 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 present 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.

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

8.11 High Pressure Tubing

8.11.1 *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.

8.11.2 *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.

8.11.3 *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**.

8.11.4 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.

8.11.5 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.

8.11.6 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.

8.11.7 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.

8.11.7.1 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.

8.11.8 It shall not be possible to fit a low pressure tube or hose into a higher pressure part of the circuit.

8.11.9 *Permeation Test*

The air supply hose shall pass the permeation test, when tested in accordance with **6.6.1**.

8.12 Marking

8.12.1 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 l/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.

8.12.2 *Markings on the Hose*

The hose 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 l/min (for Type 2 and Type 3 only);
c) For hoses meeting the requirements of **8.11.7** above the words 'heat resistant' (for Type 3 only); and
d) Working pressure of high pressure hose (for Type 3 only).

8.12.3 *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.

8.12.4 *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 l/min;
c) Maximum length of air hose for which the blower is designed; and
d) Direction of rotation of the crank (wherever applicable).

8.12.5 *BIS Certification Marking*

The breathing apparatus may also be marked with the Standard Mark.

8.12.5.1 The use of the Standard Mark is governed by the provisions of *Bureau of Indian Standards Act*, 1986 and Rules and Regulations made thereunder. The details of conditions under which the licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

8.13 Instructions

8.13.1 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) A warning that facepieces are not suitable for persons with beards. Unless special fabrications are made they will also not be suitable for wearers with spectacles having side arms. In such situations mouth piece with nose clip should be preferred;
f) For low pressure hose, the designed minimum air flow in l/min;
g) For hoses meeting the requirements of **8.2.7**, the words 'heat resistant';
h) Working pressure of high pressure hose;
j) Maximum and minimum working pressures of the flow control valve;
k) For the blower, the designed minimum air flow in l/min;
m) The maximum length of air hose for which the blower is designed;
n) For hoods and blouses, the designed air flow in l/min;
p) A warning that face seals are unsuitable for persons with beards, spectacles or side burns;
q) A warning that at very high work rates the pressure in the facepiece may become negative at peak inhalations; and
r) 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 INDIAN STANDARDS

IS No.	*Title*	*IS No.*	*Title*
3624 : 1987	Pressure and vacuum gauges (*second revision*)	14138 (Part 2) : 1994	Respiratory protective devices: Threads for facepieces — Specification: Part 2 Centre thread connection
8347 : 1977	Glossary of terms relating to respiratory protective devices	14166 : 1994	Respiratory protective devices: mouthpiece assemblies — Specification
9623 : 1980	Recommendation for the selection, use and maintenance of respiratory protective devices	14170 : 1994	Respiratory protective devices: full-face masks — Specification
14138 (Part 1) : 1994	Respiratory protective devices: Threads for facepieces — Specification: Part 1 Standard thread connection	14746 : 1999	Respiratory protective devices: Half masks and quarter masks — Specification

ANNEX B

(*Clause* 5.2)

ROUGH USAGE TEST

B-1 PRINCIPLE

All filters enclosed in separate rigid containers are subjected to shaking in a specified manner to ensure that they remain stable under conditions of rough usage. An alternative method is described in **B-4**. However, in case of dispute, the results of testing performed on filters subject to the method described in **B-3**, shall be considered correct.

B-2 APPARATUS

The apparatus shall consist of a tray as shown in Fig. 1. The tray shall be designed so that each filter tested has a free movement of 6 ± 1mm.

B-3 PROCEDURE

The filters shall be tested in the conditions as received. They shall be removed from their packaging, placed in the tray and arranged as shown in Fig. 1 so that each filter tested has a free 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 following:

a)	Particulate filters	10 min
b)	Gas and vapour filters, Class 1	10 min
c)	Gas and vapour filters, Classes 2 and 3	30 min

B-4 ALTERNATIVE METHOD

B-4.1 Apparatus

The apparatus shown schematically in Fig. 2 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 to a steel plate under its own mass as the cam rotates. The mass of the steel case shall be greater than 10 kg.

B-4.2 Procedure

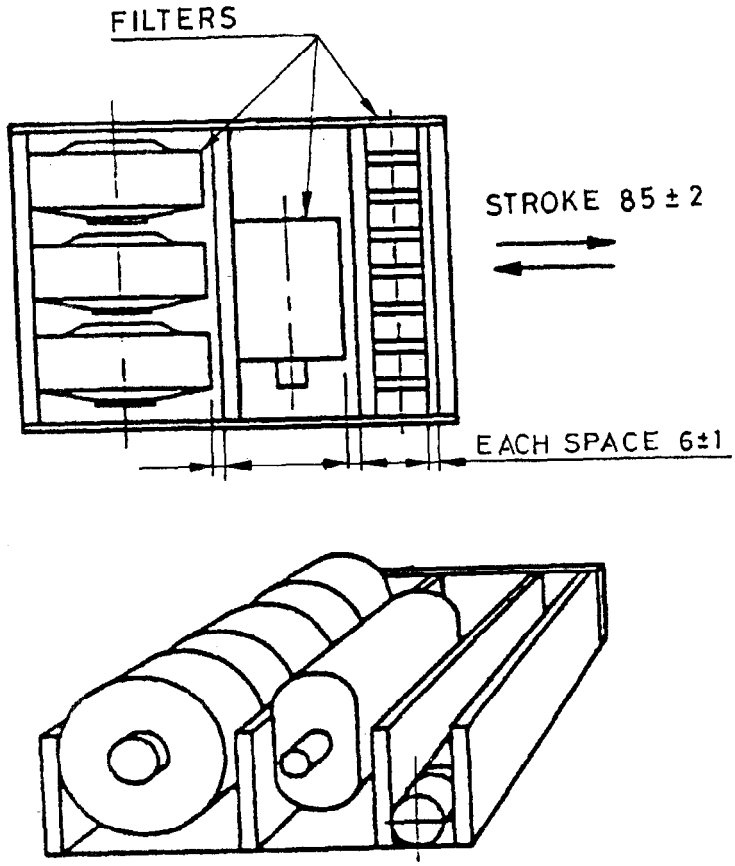
The filters shall be tested in the conditions as received. They shall be removed from their packaging, placed on their sides in the case and arranged so that they do not touch one another during the test.

The test rig is operated at the rate of approximately 100 cycles per minute for approximately 20 min and a total of 2 000 cycles.

B-4.3 Reporting

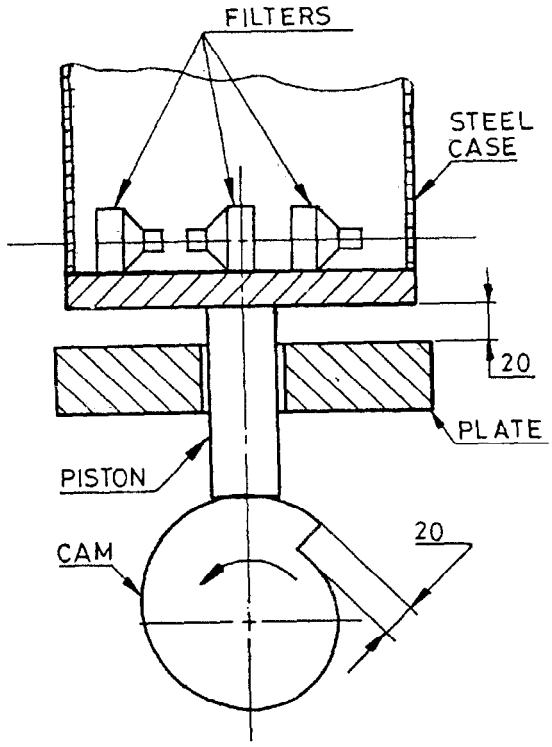
The following shall be reported:

a) Information indentifying the filter;
b) Details of any visible damaged sustained by the filter; and
c) The reference of this test method that is Annex B of this Indian Standard.



All dimensions in millimetres.

FIG. 1 TYPICAL ARRANGEMENT OF CANISTERS AND CARTRIDGES DURING ROUGH USAGE TEST



All dimensions in millimetres.

FIG. 2 TYPICAL ALTERNATIVE TEST EQUIPMENT FOR ROUGH USAGE TEST

ANNEX C

(*Clause* 5.6)

TEST FOR DURABILITY OF MATERIALS WHEN SUBJECTED TO CLEANING AND DECONTAMINATIONS

C-1 PROCEDURE

C-1.1 Components to be tested are :

a) Immersed for 10 min in a solution of formalin made by placing one part of 40 percent formaldehyde solution in 9 parts of water at a temperature of 20°C, or

b) Subjected to a moist atmosphere of antiseptic gas, preferably, formaldehyde, for a period of 10 min at a temperature of 20°C.

ANNEX D

(*Clauses* 5.12, 6.5.1, 7.6.1 *and* 8.8.1)

PRACTICAL PERFORMANCE TEST

D-1 PROCEDURE

D-1.1 Test Subjects

Breathing apparatus is tested by test subjects who practice 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 procedures. Each subject is suitably clothed.

D-1.2 Medical Attention

The test must be carried out under the supervision of a registered medical practitioner.

D-1.3 Preparation of Apparatus

The quality and the arrangement for the compressed air supplied for air line apparatus should comply with the requirements of **8.10**. The flow of air to the apparatus is measured and the apparatus then assembled. The resistance to breathing is measured (*see* **6.4 7.6** and **8.8**) and a test for leak tightness made.

D-1.4 Test Procedure

Two subjects wearing the apparatus with the maximum length of air supply tube specified for the apparatus, work in practical conditions (work simulation test). During the test the air supply system is operated in accordance with the manufacturer's instructions. Each test is continuous, without removal of the apparatus, for a period of 60 min, except the rest periods of 5 min are taken after each 15 min period of usage. For apparatus with a low pressure of air supply system, of the type described in **7.7.1**, the apparatus shall allow the men to continue work for an additional 5 min with the blower inoperative but not disconnected. The ease with which the air supply can be maintained shall be observed.

D-1.4.1 During the rest periods and at the end of each test, the compressed air pressure is recorded, the medical practitioner makes such clinical observations as he considers necessary, and when a facepiece to worn by each subject coughs, turns his head from side to side and recites the alphabet and the face seal leakage is checked subjectively using a suitable vapour of characteristic smell. At the end of each test the subjects are medically examined, the flow of air and resistance to breathing are measured and the apparatus is examined for leak tightness, excessive wear of parts and physical damage.

ANNEX E

(*Clause* 5.13)

LOW TEMPERATURE TEST

E-1 PREPARATION OF APPARATUS TO BE TESTED

E-1.1 Two apparatus are cleaned internally and reasonable attempt (by shaking) is made to remove the excess liquid that may be present in the breathing circuit. The resistance to breathing is measured at a flow of 125 l/min and the apparatus is made ready for use. Each apparatus is then pre-cooled at a temperature of – 6° + 3°C for a period of 2 h.

E-2 TEST PROCEDURE

E-2.1 Two subjects don the apparatus in the cold chamber and perform work in an ambient temperature of –6°+ 3 °C. The test is continuous, without removal

of the apparatus, for a period of 30 min. The work shall be equally divided between :

a) Walking and crawling slowly;
b) Carrying and building chalk pieces; and
c) Dragging two 25 kg weights with a rope.

E-2.1.1 At the end of the test the resistance to breathing is measured at a flow of 125 l/min to determine whether there is any obstruction and the apparatus is examined for malfunction due to the low temperature and/or formation of ice/snow.

ANNEX F

(*Clauses* 6.2.2, 7.3.2 *and* 8.3.2)

TEST FOR INWARD LEAKAGE ON EXHALATION VALVE

F-1 TEST EQUIPMENT

F-1.1 A leak-tight box connected by a tube to a breathing simulator. A flow of test gas is maintained through the box. An instrument capable of measuring the concentration of the test gas. The breathing simulator is as specified in Annex G, operating at a flow of 40 l/min with a back pressure of 50 mm H_2O.

F-2 TEST PROCEDURE

F-2.1 The valve under test is fitted in the box with a suitable adoptor. On the expiration stroke, the valve opens and air passes into the box containing the test gas. On the inspiration stroke the valve closes and any slip or leakage of the valve allows test gas to pass into the inspiratory air system. This air is monitored for test gas concentration; the difference in concentration at this point and at a suitable reference point allows the slip and leakage of the valve to be calculated. The test is run for a sufficient time to obtain a steady reading of the test gas concentration in the inspiratory air stream.

ANNEX G

(*Clauses* 6.4.1, 6.4.2, 6.5.1, 6.6.4, 7.5, 7.6.1, 8.7, 8.8.1 *and* F-1.1)

LABORATORY PERFORMANCE TEST

G-1 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).

ANNEX H

(*Clauses* 7.2.2 *and* 8.2.2)

TESTS FOR INWARD LEAKAGE OF FACEPIECES, HALF MASK HOOD AND BLOUSE

H-1 TEST FOR INWARD LEAKAGE OF FACEPIECE

H-1.1 Test Subjects

Ten clean shaven persons are selected, covering a broad spectrum of facial characteristics (excluding significant abnormalities). It is to be expected that, exceptionally, some persons cannot be fitted with a full facepiece; such exceptional subjects shall not be used for testing facepieces.

H-1.2 Facepiece

If more than one size is manufactured, the test subjects are supplied with the appropriate size.

H-1.3 Test Procedure

Each test subject wearing the facepiece under test complete with breathing tubes, is enclosed in a plastics hood which is loosely tied around his waist and around the breathing tubes so that leakage is minimized. The inside of the hood is maintained at a pressure not more than 3 mm H_2O above atmospheric pressure by supplying pure argon to the interior of the test hood. (By preliminary inflation of the test hood with argon and then by adjusting the argon supply when the test hood has been fitted, the atmosphere surrounding the facepiece or air hood is maintained at the concentration obtained; from the argon cylinder.)

H-1.3.1 Each subject walks at 6.5 km/h whilst separately carrying out various head movements and reciting the alphabet.

H-1.3.2 The subject inhales through a breathing tube from a lung governed oxygen supply and exhales through a breathing tube and a sampling bladder to atmosphere. The amount of argon in the exhaled gas is determined, for example by using a mass spectrometer, and compared with the argon present within the hood to obtain the facepiece leakage.

H-2 TEST FOR INWARD LEAKAGE OF HOOD AND BLOUSE

H-2.1 Test Subjects

Ten persons of different stature are selected.

H-2.2 Air Hood or Blouse

If more than one size of air hood or blouse is manufactured, the test subjects are supplied with the appropriate size.

H-2.3 Test Procedure

The air hood or blouse is continuously supplied with an oxygen/argon mixture at the designed air supply rate. The amount of nitrogen present in the air hood or blouse is determined and compared with the nitrogen present in the atmosphere external to the air hood or blouse to obtain the leakage.

H-2.3.1 Each test subject, wearing the air hood or blouse, performs various exercises, for example bending at the waist, raising and lowering the arms and twisting from the waist.

ANNEX J

(Foreword)

COMMITTEE COMPOSITION

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Member Secretary
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Additional Director (Chem), BIS

(*Continued on page* 15)

(*Continued from page 14*)

Panel for Respiratory Protective Equipment, CHD 08 : 01/P1

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Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Handbook' and 'Standards: Monthly Additions'.

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