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ISO 23269-1

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Ships and marine technology — Breathing apparatus for ships —

Part 1: Emergency escape breathing devices (EEBD) for shipboard use

Navires et technologie maritime — Appareils respiratoires pour les navires —

Partie 1: Dispositifs de respiration pour issues de secours (EEBD) à bord des navires

Reference number
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Foreword

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 23269-1 was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 1, *Lifesaving and fire protection*.

ISO 23269 consists of the following parts, under the general title *Ships and marine technology — Breathing apparatus for ships*:

— *Part 1: Emergency escape breathing devices (EEBD) for shipboard use*

— *Part 2: Breathing apparatus for shipboard firefighters*

— *Part 3: Self-contained breathing apparatus (safety equipment) required for IMO IBC and IGC Codes*

— *Part 4: Self-contained breathing apparatus for emergency escape required by the IMO IBC and IGC Codes*

Introduction

The amendments of 2000 to Chapter II-2 of the 1974 International Convention for the Safety of Life at Sea (SOLAS), which entered into force 1 July 2002, made the carriage of emergency escape breathing devices (EEBD) mandatory on SOLAS ships. SOLAS and the related mandatory International Code for Fire Safety Systems (FSS Code) prescribe basic performance requirements for EEBD. This part of ISO 23269 provides more detailed requirements to ensure an adequate level of safety for users of these devices.

Ships and marine technology — Breathing apparatus for ships —

Part 1:
Emergency escape breathing devices (EEBD) for shipboard use

1 Scope

This part of ISO 23269 provides performance specifications for emergency escape breathing devices (EEBD) required by regulation in Part D of chapter II-2 of the 1974 International Convention for the Safety of Life at Sea (SOLAS), as amended in 2000, and chapter 3 of the IMO International Code for Fire Safety Systems (FSS Code). These devices are intended to supply air or oxygen needed to escape from accommodation and machinery spaces with a hazardous atmosphere. They are not intended for use in fighting fires, entering oxygen-deficient voids or tanks, or to be worn by fire-fighters.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4674-1, *Rubber- or plastics-coated fabrics — Determination of tear resistance — Part 1: Constant rate of tear methods*

ISO 7854, *Rubber- or plastics-coated fabrics — Determination of resistance to damage by flexing*

ISO 9227, *Corrosion tests in artificial atmospheres — Salt spray tests*

EN 1146:1997, *Respiratory protective devices for self-rescue — Self-contained open-circuit compressed air breathing apparatus incorporating a hood (compressed air escape apparatus with hood) — Requirements, testing, marking*

International Convention for the Safety of Life at Sea (SOLAS), 1974, Chapter II-2, as amended

IMO International Code for Fire Safety Systems (FSS Code)

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
breathing bag
device which compensates for variations in the air supply or demand and provides for peak inhalation flow requirements

3.2
competent authority
administration whose flag the ship is entitled to fly, or an organization authorized by an administration to perform functions required by this International Standard

3.3
facepiece
face covering designed to form a complete seal around the eyes, nose, and mouth which is secured in position by suitable means

3.4
high pressure component
parts exposed to the pressure of the cylinder situated between the cylinder and the pressure regulator

3.5
hood
head covering which completely covers the head and neck, and may cover portions of the shoulders

3.6
medium pressure component
parts exposed to the pressure that has been reduced by a regulator

3.7
ready-for-use apparatus
complete and operational EEBD in the ready-to-use condition

3.8
relief valve
device preventing the excessive pressurization of the breathing circuit

3.9
visor
part of the facepiece or hood which meets the field of vision requirement of this International Standard and can in addition provide eye protection

4 General

4.1 System design and performance

4.1.1 The EEBD shall have a minimum duration of service of 10 min under the conditions specified in 6.1.

4.1.2 The EEBD shall include a hood or full facepiece, as appropriate, to protect the eyes, nose and mouth. Hoods and facepieces shall be constructed of flame resistant materials and include a clear window for viewing.

4.1.3 The EEBD shall be designed so that there are no protruding parts or sharp edges likely to be caught on projections in narrow passages or that may hurt the wearer.

4.1.4 The EEBD shall be designed to ensure its full function in any orientation of the EEBD.

4.1.5 If the EEBD is equipped with a compressed air/gas cylinder, it shall be equipped with a reliable and continuous means to show that the cylinder is fully charged and ready for use, without the necessity of activating the EEBD.

4.1.6 The EEBD shall be capable of being carried hands-free.

4.1.7 A pressure indicator incorporating a suitable blow-out release shall be provided, such that in the event of an explosion or fracture of the pressure indicator, the release shall be away from the wearer. The blow-out release shall be protected from dirt and mechanical damages.

4.1.8 If a window is incorporated in the pressure indicator, it shall be of non-splintering clear material.

4.1.9 The pressure indicator shall not contain oil.

4.1.10 The relief valve for the breathing bag of a closed circuit oxygen type device, if provided, shall be designed so as to function properly in any orientation in the bag and be protected from dirt and mechanical damages.

4.1.11 In the case of oxygen generated chemically, the EEBD shall be designed so as to prevent such chemical from entering the wearer’s respiratory tract, and to ensure that saliva or condensate shall not interfere with the function of the device or cause any harmful effect to the wearer.

4.1.12 The EEBD shall be designed so as to prevent inadvertent activation.

4.1.13 Dummy devices and components that are intended exclusively for training shall not be interchangeable with operational devices or components, and shall be manufactured and marked in such a way that they are clearly distinguishable from and cannot be inadvertently confused with operational devices.

4.1.14 Parts attached to the EEBD shall be firmly fixed so that they do not detach easily.

4.1.15 Compressed air/gas cylinders and their valves shall comply with appropriate national regulations.

4.1.16 Breathing hoses, if fitted, shall be flexible and non-kinking.

4.1.17 The air or gas provided in the cylinder shall be clean, dry, and free of contaminants. Compressed air or oxygen shall comply with appropriate national or international standards for breathing air.

NOTE EN 12021 and EN 13794 are typical suitable standards for this purpose.

4.1.18 An EEBD shall withstand anticipated shock, when tested in accordance with the drop and shock tests specified in Clause 5.5.

4.1.19 Where the EEBD is intended for storage in machinery spaces, a suitable container or cover such as a box, bag or case shall be provided to prevent contamination (e.g. by oil, mist, or dust).

4.2 Facepiece and hood requirements

4.2.1 The finish of any part likely to be in contact with the wearer shall be free from sharp edges and burrs.

4.2.2 All components shall be able to be donned or removed with ease.

4.2.3 Transparent components shall not distort vision to the extent to affect the movement of the wearer.

4.2.4 The connection between the breathing apparatus and the facepiece or hood may be achieved by either a permanent, special or thread type connector.

4.2.5 Dismountable connections shall be readily connected and secured, preferably by hand, and any means of sealing used between components (e.g. O-rings or gaskets) shall be retained in position when the connection(s) is (are) disconnected.

4.2.6 A mouthpiece, if fitted, shall facilitate reliable sealing and it shall not be possible to inadvertently block the breathing circuit when the device is in operation. The mouthpiece shall be fitted with an adjustable or self-adjusting harness if it is likely that an undue load is exerted on the wearer’s mouth otherwise.

4.2.7 A nose clip, if fitted, shall provide an airtight seal of the nose. It shall be flexibly attached to the mouthpiece assembly such that, when fitting the mouthpiece, the wearer’s attention is automatically drawn to the nose clip.

5 Resistance to environmental damage

5.1 General

5.1.1 The tests in 5.2 to 5.5 shall be conducted in the specified sequence with four sample EEBDs. After each of the tests, each EEBD shall be visually inspected, and shall not break or develop deformation, corrosion, or any other defects which may render it unsuitable for use.

5.1.2 At the completion of the test sequence, four of the sample EEBDs shall then be evaluated and tested against the requirements of Clause 6, 6.8 excluded.

5.2 High temperature, high humidity test

Each sample EEBD shall be subjected to a temperature of (65 ± 2) °C in an atmosphere with relative humidity of not less than 90 % for at least 48 h, and then left in an environment of 20 °C to 25 °C with a relative humidity of (65 ± 10) % for at least 48 h.

5.3 Temperature cycling test

Each sample EEBD shall be subjected to a temperature of (–30 ± 2) °C for at least 8 h, and then to a temperature of (65 ± 2) °C for at least 8 h, the cycle to be repeated 10 times.

5.4 Resonance and vibration tests

Each EEBD shall be subjected to the resonance tests specified in Table 1, followed by the vibration tests as specified in Table 1.

Table 1 —Resonance and vibration tests

		Total amplitude	Acceleration	Frequency	Sweep period	Direction of vibration	Number of tests	Total duration of tests
Resonance tests	(i)	2 mm	—	5-16 Hz continuous change	10 min	In each of the 3 planes	3 times in each direction	1,5 hours
	(ii)	—	± 1 g	16-60 Hz continuous change	As above	As above	As above	As above
Vibration test	Where resonant frequency (ies) exist(s) within the vibration test frequencies	Amplitude or acceleration used for vibration tests		Resonant frequency	—	As above	Once in each direction	4,5 hours (1,5 hours in each of the 3 planes)
	No resonant frequency within the vibration test frequencies	2 mm	—	16 Hz	—	As above	As above	As above

5.5 Drop and shock tests

5.5.1 Drop test

Each EEBD shall be dropped from a height of 1 m onto a concrete floor in each axis in its ready-for-use condition as stored.

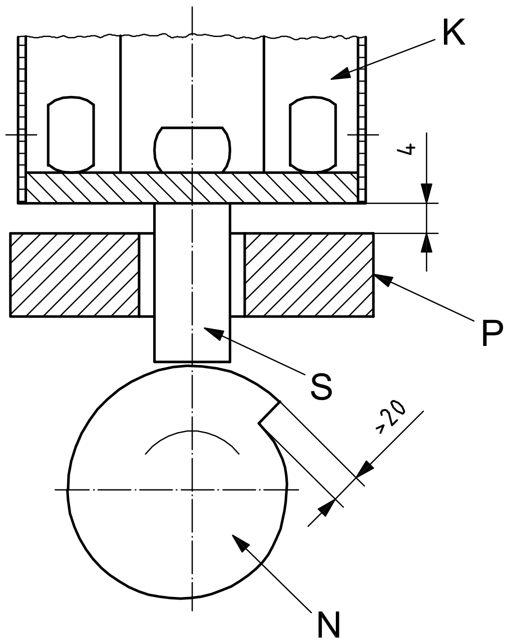
5.5.2 Shock test

The test apparatus is shown schematically in Figure 1 and consists of a steel case (K) which is fixed on a vertically moving piston (S) capable of being lifted up 20 mm by a rotating cam (N) and dropping down onto a steel plate (P) under its own mass as the cam rotates. The mass of the steel case shall be greater than 10 kg, and the mass of the base of the equipment shall be at least 10 times as much as the case, or the equipment shall be bolted to the floor.

Each EEBD in its ready-for-use condition shall be tested as stored, including fully charged compressed air or oxygen cylinder(s). Each EEBD shall be placed in the case (K) in a test.

The test rig shall be operated at the rate of approximately 100 rotation/min for a total of 500 rotations (shocks).

Dimensions in millimetres



Key

K steel case

N rotating cam

P steel plate

S vertically moving piston

Figure 1 — Test equipment for shock test

5.6 Corrosion resistance test

Each EEBD, as stored, in its ready-for-use condition shall be subject to the neutral salt spray corrosion resistance test in accordance with ISO 9227 for 250 h.

6 Performance requirements

6.1 Rated working duration

With the EEBD connected to a breathing machine as specified in Annex A and at a sinusoidal flow of 20 cycle/min × 1,75 l/stroke for the rated duration of the EEBD, but in any case at least 10 min, the EEBD shall satisfy the requirements of Clauses 6.3 and 6.4.

6.2 Overloading

With the EEBD connected to a breathing machine as specified in Annex A and at a sinusoidal flow of 25 cycle/min × 2,00 l/stroke for at least 3 min, the EEBD shall satisfy the requirements of Clauses 6.3 and 6.4.

6.3 Measurement of inhaled air/gas

6.3.1 Carbon dioxide concentration

Throughout the rated working duration test and overload test of the EEBD, the carbon dioxide concentration of the inhalation air/gas shall not exceed the value of 3 % (by volume).

6.3.2 Oxygen content (for closed circuit oxygen type only)

Throughout the rated working duration test and overload test of the EEBD, the oxygen content of the inhalation gas shall not be below 21 % (by volume), except that a short time deviation to a level of not less than 17 % and for a period of not more than 2 min of the test is permissible.

6.3.3 Temperature of inhalation gas (for closed circuit oxygen type only)

Throughout the rated working duration test and overloading test of the EEBD, the temperature of inhalation gas shall not exceed 50 °C.

6.4 Breathing resistance

6.4.1 General

Throughout the rated working duration test and overloading test, the breathing resistance of the EEBD shall be as specified in 6.4.2 and 6.4.3.

6.4.2 EEBD without positive pressure

At sinusoidal flows of 20 cycle/min × 1,75 l/stroke and 25 cycle/min × 2,0 l/stroke, the inhalation peak pressures shall be negative pressures of not more than 750 Pa and 1 kPa respectively, and the exhalation peak pressures shall be positive pressures of not more than 750 Pa and 1 kPa respectively. Alternatively, at a sinusoidal flow of 35 l/min, the sum of the inhalation and exhalation peak pressures shall not exceed 1,6 kPa. At a sinusoidal flow of 50 l/min, the peak pressure for inhalation as well as exhalation shall not exceed 2,0 kPa.

6.4.3 EEBD with positive pressure

At a sinusoidal flow of 20 cycle/min × 1,75 l/stroke, the inhalation peak pressure shall be a positive pressure, and the exhalation peak pressure shall be a positive pressure of not more than 750 Pa. At a sinusoidal flow of 25 cycle/min × 2,0 l/stroke, the inhalation peak pressure shall be a positive pressure, and the exhalation peak pressure shall be a positive pressure of not more than 1 kPa.

6.5 Surface temperature (for closed circuit oxygen type only)

The surface temperature shall be measured during performance tests on the breathing machine as specified in Annex A. Thermocouples shall be connected to points expected to turn hot. The temperature shall be measured and recorded and the highest temperature shall not exceed the temperature indicated in the specifications of the manufacturer.

6.6 Oxygen supply (for closed circuit oxygen type only)

6.6.1 General

The device shall have a mechanism which permits an adequate flow of oxygen into the breathing circuit. The flow rate of oxygen, depending on the type of mechanism, shall comply with 6.6.2 to 6.6.4.

6.6.2 Constant flow type

The flow rate of oxygen shall be not less than 4 l/min down to 5 % of the maximum filling pressure of the cylinder.

6.6.3 Lung-governed demand type

The negative opening pressure of the lung-governed supply mechanism shall not exceed 200 Pa.

6.6.4 Combined constant flow and lung-governed demand type

The constant flow rate of oxygen shall be not less than 1,2 l/min down to 5 % of the maximum filling pressure of the cylinder. The negative opening pressure of the lung-governed supply mechanism shall not exceed 200 Pa.

6.7 Leak-tightness test (for ready-for-use apparatus)

Each EEBD shall be tested for leak-tightness at a negative or positive pressure of 1 kPa. The pressure change shall not be greater than 100 Pa in 1 min. This test shall be made with various parts closed as necessary.

6.8 Total inward leakage test

Two EEBD shall be tested in accordance with EN 1146:1997, 7.10. During the rated working duration, the inward leakage shall not exceed an average of 0,05 % of the inhaled air for any of the test subjects in any of the exercises.

6.9 Pressure tests

If metallic high pressure tubes are used, valves and couplings shall be tested to prove that they are capable of withstanding a pressure of 150 % of the maximum filling pressure of the compressed air/gas cylinder. Non-metallic high pressure components shall be tested to prove that they are capable of withstanding a pressure of twice the maximum filling pressure of the compressed air/gas cylinder. Medium pressure parts shall be tested to prove that they withstand twice the pressure for which they are designed to be used.

6.10 Flammability

6.10.1 Principle

One complete set of EEBD, or the components of the EEBD which are likely to be exposed to flames during actual use, shall be tested by passing it once through a defined flame, and the effects of the flame on the EEBD shall be observed.

6.10.2 Apparatus

The apparatus shown in Figure 2 shall be oriented such that the components to be tested pass through the test flame. The apparatus is on a support that enables it to be rotated by means of motor or other device to describe a horizontal circle.

The burner shall be provided with a gas supply rig consisting of a propane (at least 95 % purity) cylinder with flow control device, pressure gauge, flash back arrester and a propane burner of inner diameter (9,5 ± 0,5) mm. The flame of the burner shall be adjustable in height. The temperature of the flame at a height of 20 mm above the burner tip shall be (800 ± 50) °C. The temperature shall be checked with a suitable measuring instrument.

NOTE A thermocouple of diameter of approximately 1,0 mm is suitable for the temperature measurement. In order to obtain a steady flame it may be necessary to provide a shield around the burner as indicated in Figure 2.

6.10.3 Procedures

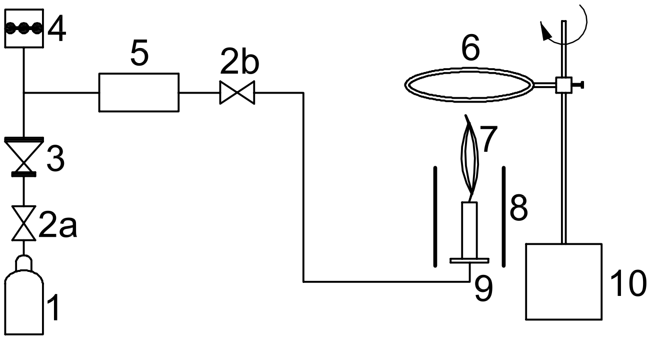
The EEBD or component of the EEBD shall be placed on the apparatus such that the EEBD or component is rotated over the burner at a speed of (60 ± 5) mm/s.

The position of the burner shall be adjusted such that the distance between the tip of the burner and the lowest part of the EEBD or the component that is to pass through the flame is 20 mm. The apparatus shall be rotated away from the burner. The gas at the burner shall be ignited and the gas pressure shall be adjusted. The burner’s air vent shall be fully closed and the flow control valve shall be adjusted to give a flame height of 40 mm above the burner tip.

Each sample shall be passed once through the flame at a speed of (60 ± 5) mm/s. When components which cannot be exposed to the flame by one test, such as valves, etc. are arranged on other parts of the apparatus, the test shall be repeated with another EEBD in the appropriate positioning. Any one component shall be passed through the flame only once.

6.10.4 Performance of EEBD after the test

After exposure to the flame, the tested sample EEBD shall not burn with any flame or glow, or show any through hole. The EEBD shall continue to satisfy the requirements of the leak-tightness test in 6.7.



Key

1 propane cylinder
2a valve
2b flow control device
3 pressure regulator
4 steel plate
5 vertically moving piston
6 support for apparatus
7 flame
8 shield
9 burner
10 motor and speed control

Figure 2 — Apparatus for flammability test

6.11 Opening pressure of the relief valve (for closed circuit oxygen type only)

The opening pressure of the relief valve shall be checked with a suitable pressure meter attached to the facepiece. 1,5 l/min of dry air shall be fed into the EEBD through the facepiece and the maximum pressure recorded shall be taken as the opening pressure of the relief valve, which shall be a positive pressure of not less than 100 Pa. When the relief valve is positioned in the breathing circuit before the regeneration cartridge then the pressure drop between the relief valve and the entry of the breathing bag shall in no case be greater than the minimum opening pressure of the relief valve.

6.12 Effective volume of the breathing bag (for closed circuit oxygen type only)

The effective volume of the breathing bag shall be at least 6 l, which is determined by removing the air from the breathing bag and measuring it with a gas meter in the following pressure ranges:

a) Constant flow type: from the opening pressure of the relief valve to a negative pressure of 500 Pa.

b) Lung-governed demand type: from the opening pressure of the relief valve to the opening pressure of the demand valve.

c) Without relief valve: from a positive pressure of 200 Pa to the opening pressure of the demand valve.

6.13 Materials and seams of hood and breathing bag

6.13.1 Flex cracking resistance

When tested in accordance with method A or B of ISO 7854, the flex cracking resistance of the material shall be at least 5 000 cycles. After the test no visible damage is permitted.

6.13.2 Tear resistance

When tested in accordance with method A of ISO 4674-1, the tear resistance of the material shall be not less than 5 N for test samples cut at 90° to each other.

6.13.3 Strength

The hood, and breathing bag if provided, shall be tested to prove that it can withstand twice the pressure for which it is designed to be used.

6.14 Materials for visor or transparent parts of non-flexible materials

The mechanical strength of the visor or transparent part shall be tested using a completely assembled facepiece mounted on a dummy head such that a steel ball (22 mm in diameter and approximately 44 g) falls normally from a height of 1,3 m onto the centre of the visor or transparent part. After the test the facepiece shall not be damaged in any way that may make it ineffective or cause injury to the wearer. After the test, the facepiece shall meet the leak-tightness requirements of 6.7.

7 Operational tests

7.1 Donning test

Two of the EEBDs shall be tested as supplied by the manufacturer, by two adult test subjects practicing regularly with breathing apparatus. They shall be able to be donned easily and correctly within 20 s. The donning test shall be conducted in both light and dark conditions.

7.2 Practical performance test

Two test subjects, who conducted the donning test, shall don the apparatus as supplied by the manufacturer, and make two return trips of the course shown in Annex B at a normal speed and confirm that:

a) Wearers can perform without difficulty each of the movements specified in the course.

b) Wearers do not experience abrasion, cuts, pain, pressure, etc. during the test.

c) Wearers do not experience breathing difficulty during the test.

d) The visor does not fog up or move such as to disturb the vision during the test.

e) The EEBD is not damaged in any way which would affect its operation.

8 Instructions for use

The manufacturer of the EEBD, or of any component of the EEBD, shall provide suitable instructions for operation, maintenance, and storage. The instructions shall be provided in the language or languages required by the competent authority. The instructions, as a minimum, shall be provided in a suitable format to include in the ship’s training manual. Brief instructions or a diagram clearly illustrating its use shall be clearly printed on the EEBD.

9 Marking

Each EEBD shall be marked with the following.

a) Name of the apparatus.

b) Type of the apparatus (e.g. “compressed air EEBD”, “compressed oxygen EEBD”, etc.).

c) Year and month of manufacture.

d) Manufacturer’s name or their trade mark.

e) Approval information, such as approval organization, including the number of this part of ISO 23269 (“ISO 23269-1”).

f) Expiration date of approval (if any).

g) Next date of servicing/retest (if any).

h) If the unit is used for training, it shall be clearly marked as such.

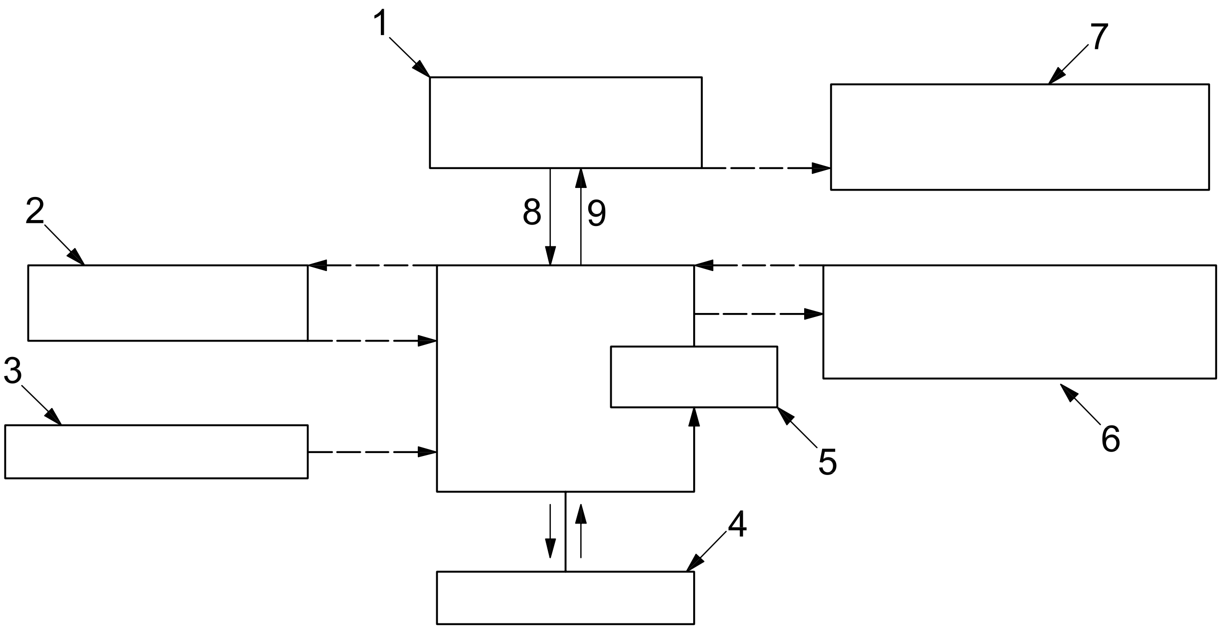
Annex A
(normative)

Breathing machine schematic diagrams

A.1 Schematic of breathing machine for closed circuit oxygen type EEBD

A.1.1 Figure A.1 shows a schematic of a typical breathing machine for testing closed circuit oxygen type EEBD.

NOTE For details of the machine, reference may be made to EN 13794 or other relevant recognized national standards.



Key

1 test specimen (breathing apparatus)

2 CO_2, O_2 gas analyser (inhalation gas)

3 carbon dioxide dosage

4 breathing machine

5 humidifier

6 CO_2 gas analyser, measurement of temperature and humidity (exhalation gas)

7 measurement of breathing resistance and temperature

8 inhalation

9 exhalation

Figure A.1 — Schematic of breathing machine for testing closed circuit oxygen type EEBD

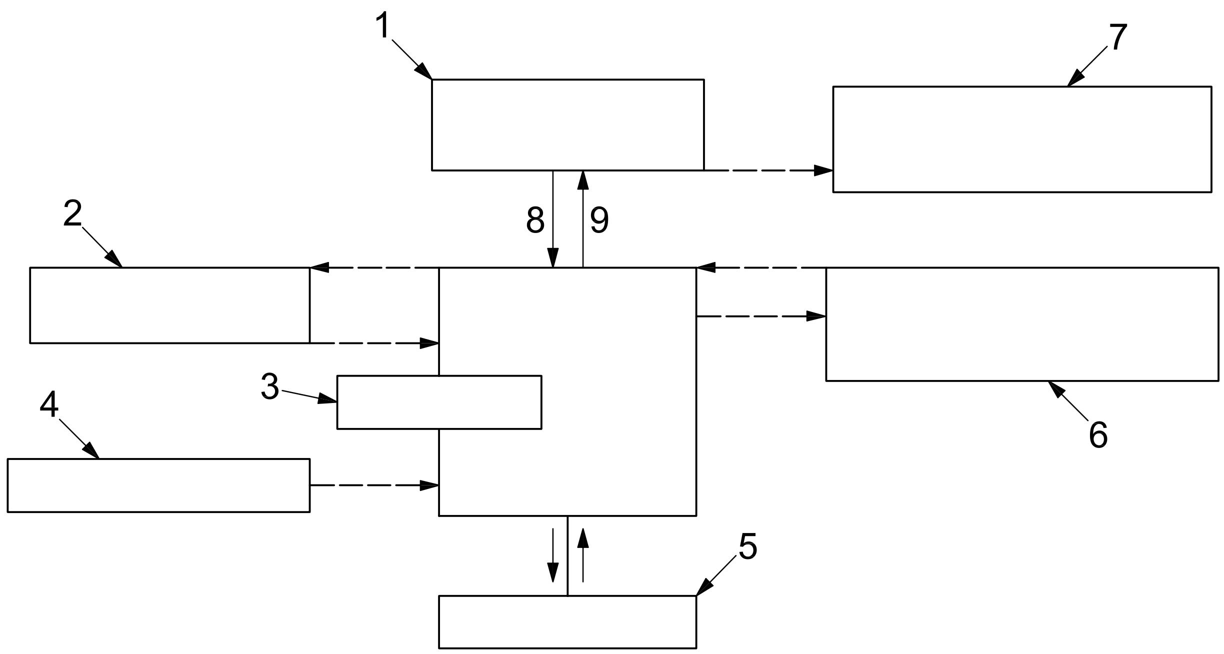
During the performance tests, the exhalation gas shall comply with the parameters in Table A.1:

Table A.1 — Exhalation gas parameters

Minute volume	CO_2 content	Temperature	Relative humidity
20 cycle/min, 1,75 l/stroke	4,0 %	(37 ± 0,5) °C	95 % to 100 %
25 cycle/min, 2,0 l/stroke	4,5 %		

A.2 Schematic of breathing machine for compressed-air type EEBD

A.2.1 Figure A.2 shows a schematic of a typical breathing machine for testing a compressed-air type EEBD.



Key

1 test specimen (breathing apparatus)
2 CO_2 gas analyser (inhalation gas)
3 CO_2 absorber
4 carbon dioxide dosage
5 breathing machine
5 humidifier
6 CO_2 gas analyser, measurement of temperature and humidity (exhalation gas)
7 measurement of breathing resistance and temperature
8 inhalation
9 exhalation

Figure A.2 — Schematic of breathing machine for compressed-air type EEBD

During the performance tests, the exhalation gas shall comply with the parameters in Table A.2:

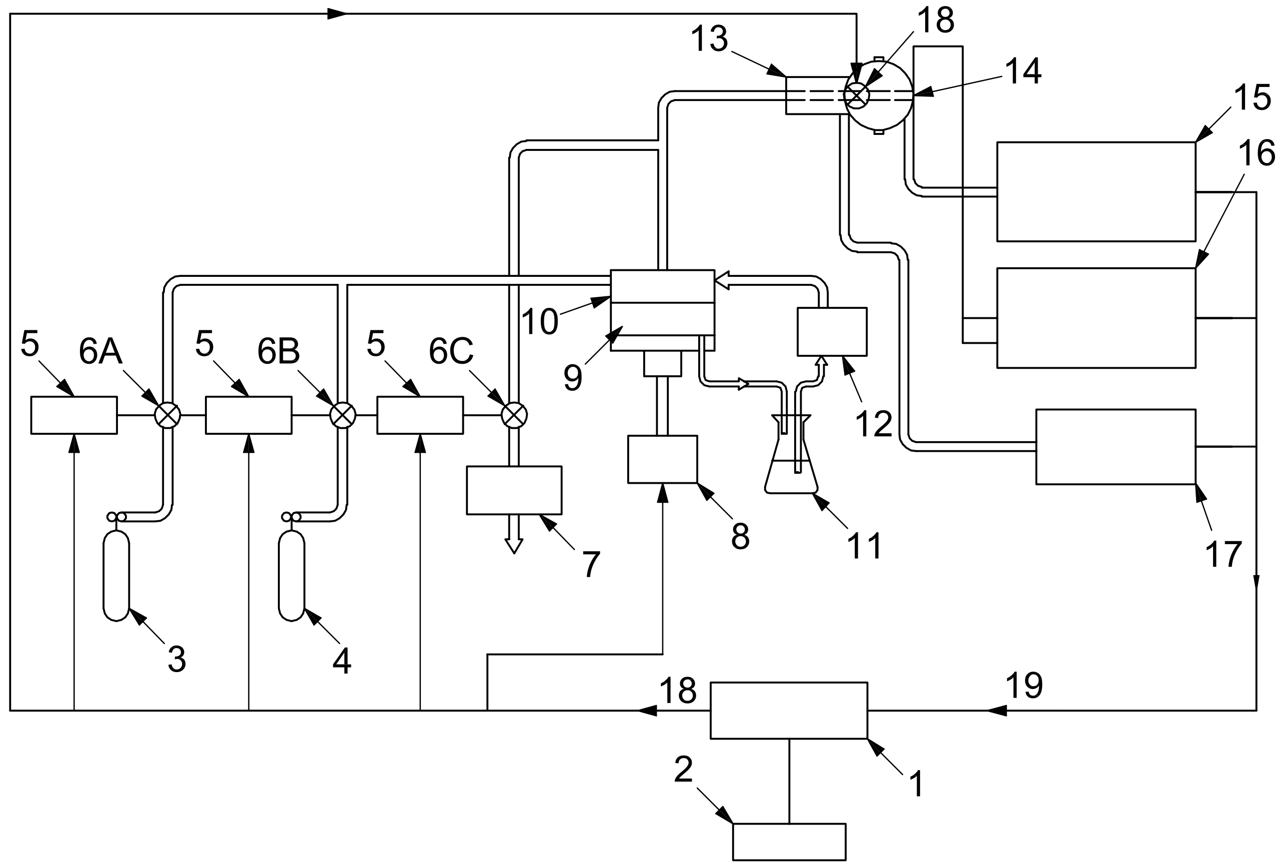
Table A.2 — Exhalation gas parameters

Minute volume	CO_2 content	Temperature
20 cycle/min, 1,75 l/stroke	4,0 %	(37 ± 0,5) °C
25 cycle/min, 2,0 l/stroke	4,5 %	(37 ± 0,5) °C

NOTE For details of the machine, reference may be made to EN 1146:1997 or other relevant recognized national standards.

A.3 Schematic of breathing metabolic simulator for self-contained closed circuit type EEBD

A.3.1 Gas ventilation is achieved through a stepper motor controlled piston programmed to produce the desired sinusoidal waveform. Breathing resistance, wet and dry bulb temperature, and oxygen and carbon dioxide concentration shall be continuously measured at the mouth during both inhalation and exhalation. Oxygen removal is achieved by continually withdrawing gas from the system through stepper motor-controlled needle valve C. The removal rate is determined by the average oxygen concentration measured at the mouth. Carbon dioxide production is simulated by injecting carbon dioxide into the system through stepper motor-controlled needle valve A at a rate equal to the desired VCO_2 plus the amount of CO_2 exhausted through valve C. Nitrogen is introduced into the system through stepper motor-controlled valve B to replace nitrogen gas exhausted through valve C. Water vapour is derived continuously from fast response wet and dry bulb temperature measurements, calculated within the system software. The lung shall be heated and humidified to condition the exhaled gas to 37 °C, 95 % to 100 % relative humidity.



Key

1 computer
2 printer
3 CO_2 supply
4 N_2 supply
5 stepper motor
6A needle valve
6B needle valve
6C needle valve
7 vacuum pump
8 stepper motor
9 piston
10 lung
11 hot water reservoir
12 pump
13 heat exchanger
14 mouth
15 rapid response O_2 and CO_2 measurement
16 wet and dry bulb temperature measurement
17 pressure measurement
18 solenoid valve

Figure A.3 — Schematic of breathing metabolic simulator for self-contained closed circuit type EEBD

A.3.2 During the performance tests, the metabolic parameters shall comply with those given in Table A.3:

Table A.3 — Metabolic parameters

Minute Volume (VE)	Oxygen Consumption (VO_2)	Carbon Dioxide Production (VCO_2)
35 l/min (20 × 1,75 l/min)	1,58 l/min	1,58 l/min
50 l/min (25 × 2,0 l/min)	2,25 l/min	2,25 l/min
NOTE All volumes are adjusted to 37º C, 47 mm Hg water vapour.		

Annex B
(normative)

Practical performance test procedure

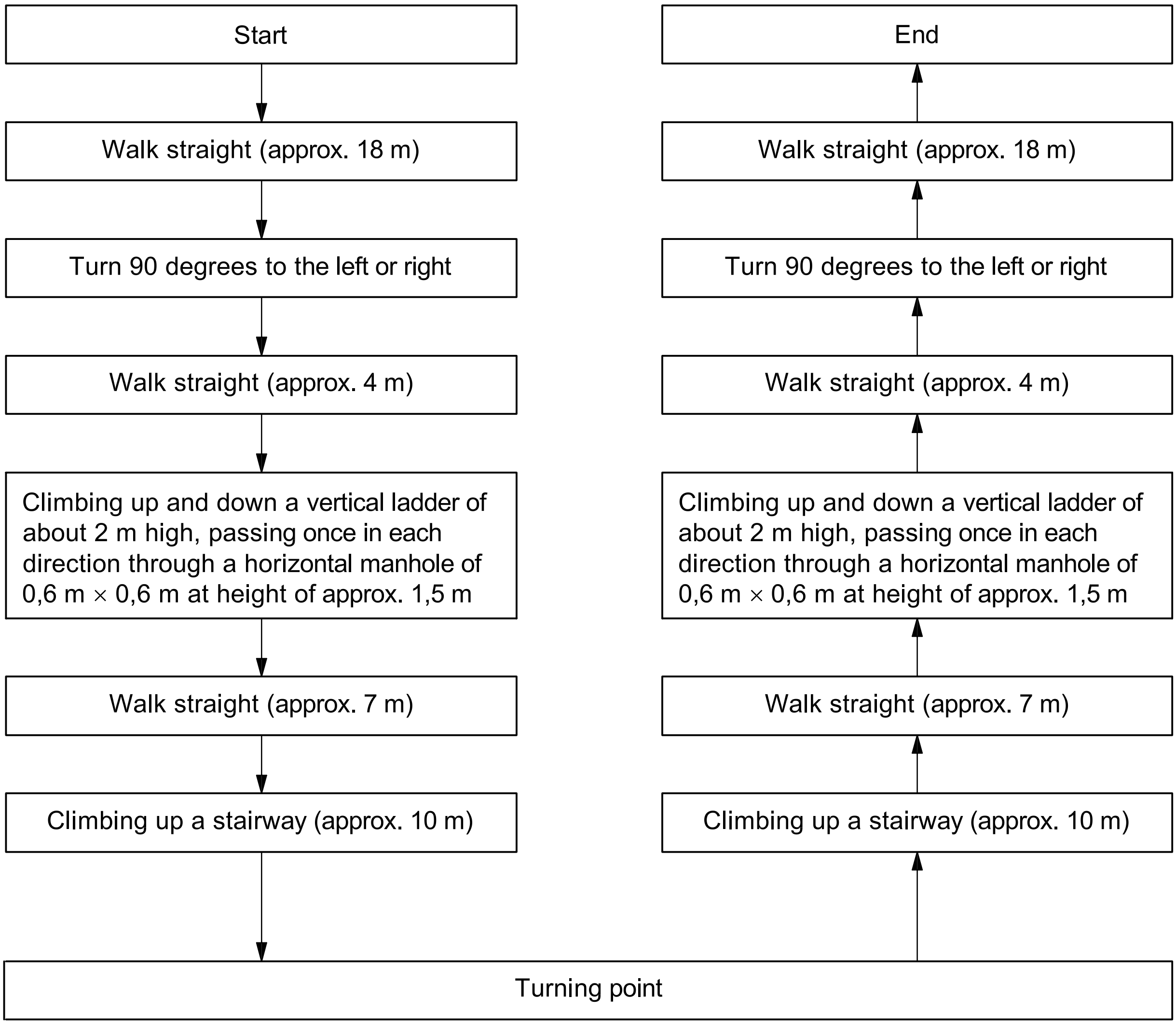


Figure B.1 — Standard procedure of practical performance test

Bibliography

[1] EN 13794, *Respiratory protective devices — Self-contained closed-circuit breathing apparatus for escape — Requirements, testing, marking*

[2] EN 12021, *Respiratory protective devices — Compressed air for breathing apparatus*

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