BRITISH STANDARD

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Respiratory protective devices — Self-contained closed-circuit breathing apparatus for escape — Requirements, testing, marking

The European Standard EN 13794:2002 has the status of a British Standard

ICS 13.340.30

BSI
British Standards

National foreword

This British Standard is the official English language version of EN 13794:2002. It supersedes BS EN 400:1993, BS EN 401:1993 and BS EN 1061:1997 which are withdrawn.

The UK participation in its preparation was entrusted by Technical Committee PH/4, Respiratory protection, to Subcommittee PH/4/6, Self-contained breathing apparatus, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

Cross-references

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Respiratory protective devices - Self-contained closed-circuit breathing apparatus for escape - Requirements, testing, marking

Appareils de protection respiratoire - Appareils de protection respiratoire isolants autonomes à circuit fermé pour l'évacuation - Exigences, essais, marquage

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CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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Contents

Foreword

This document (EN 13794:2002) has been prepared by Technical Committee CEN/TC 79 "Respiratory protective devices", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2003, and conflicting national standards shall be withdrawn at the latest by May 2003.

This document supersedes EN 400:1993, EN 401:1993 and EN 1061:1996.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive 89/686/EEC.

For relationship with EU Directive 89/686/EEC, see informative Annex ZA, which is an integral part of this document.

The annexes A, B and C are normative, annex D is informative.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

A given respiratory protective device can only be approved when the individual components satisfy the requirements of the test specification which may be a complete standard or part of a standard and practical performance tests have been carried out successfully on complete apparatus where specified in the appropriate standard. If for any reason a complete apparatus is not tested then simulation of the apparatus is permitted provided the respiratory characteristics and mass distribution are similar to those of the complete apparatus.

1 Scope

This European Standard specifies minimum requirements for self-contained closed-circuit breathing apparatus, chemical oxygen (KO_2, $NaClO_3$) type and compressed oxygen type, for escape (short: oxygen escape apparatus). This European Standard does not apply to apparatus for work and rescue and to diving apparatus.

Laboratory and practical performance tests are included for the assessment of compliance with the requirements.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 132, *Respiratory protective devices - Definitions of terms and pictograms.*

EN 134, *Respiratory protective devices - Nomenclature of components.*

EN 136:1998, *Respiratory protective devices - Full face masks - Requirements, testing, marking.*

EN 166:1995, *Personal eye protection – Specifications.*

EN 168:1995, *Personal eye protection - Non-optical test methods.*

EN 13274-1, *Respiratory protective devices - Methods of test - Part 1: Determination of inward leakage and total inward leakage.*

EN 13274-2, *Respiratory protective devices - Methods of test - Part 2: Practical performance tests.*

EN 13274-3, *Respiratory protective devices - Methods of test - Part 3: Determination of breathing resistance.*

EN 13274-4, *Respiratory protective devices - Methods of test - Part 4: Flame tests.*

EN 13274-5, *Respiratory protective devices - Methods of test - Part 5: Climatic conditions.*

3 Terms and definitions

For the purpose of this European Standard, the terms and definitions given in EN 132 and the nomenclature given in EN 134 together with the following apply.

3.1
quick start system
mechanism which activates the oxygen generation/flow whilst opening the storage container or by pulling the facepiece

4 Description

An oxygen escape apparatus is designed and constructed so that exhaled breathing gas is ducted from the facepiece into a circuit which contains a cartridge and a breathing bag where it is available for re-breathing. The cartridge contains chemicals which absorb exhaled carbon dioxide and - in case of a KO_2 apparatus - humidity and generates also oxygen.

In case of a $NaClO_3$ apparatus a chemical oxygen source ($NaClO_3$ candle) generates the oxygen to be needed.

In case of a compressed oxygen apparatus oxygen is fed into the circuit at a suitable point by means of a constant flow device or by a lung governed demand valve or by a suitable combination of both.

The breathing gas flow may be of the pendulum or loop type and excess gas is ejected via a relief valve.

5 Classification

5.1 General

Oxygen escape apparatus are classified according to their oxygen source and rated working duration in types and classes.

5.2 Types of oxygen escape apparatus

¾ Type C $NaClO_3$ apparatus;

¾ Type D Compressed oxygen apparatus;

¾ Type K KO_2 apparatus.

5.3 Classes of oxygen escape apparatus

Oxygen escape apparatus are classified according to the rated working duration (see 6.19.1) which is defined by performing a breathing machine test in accordance with 7.10.1 with a minute volume of 35 l/min (20 cycles/min; 1,75 l/stroke).

Rated working duration will be defined in increments of 5 min up to and including a duration of 30 min and thereafter in steps of 10 min.

6 Requirements

6.1 General

All test specimens shall meet all requirements.

6.2 Design

The apparatus shall be of reliable construction and as compact as possible.

The apparatus shall be designed so as not to interfere with work activities when carried out in accordance with the manufacturers instruction.

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

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

The apparatus shall be so designed and constructed as to prevent ingress of external atmosphere within the limits set out in this European Standard.

The apparatus shall be so designed that the outside of the container can be cleaned easily.

The apparatus shall be so designed as to prevent the chemical from entering the wearer's respiratory tract and that saliva or condensate shall not interfere with the function of the apparatus or cause any harmful effect to the wearer.

Testing shall be done in accordance with 7.3 and 7.16.

It shall not be possible to initiate a quick start system (if fitted) inadvertently.

Apparatus for special use, i.e. in mining shall meet the requirements given in annex A when tested in accordance with annex A.

Apparatus for training purposes only shall meet the requirements given in annex C when tested in accordance with annex C. Training may also be carried out with the working apparatus.

Testing shall be done in accordance with 7.3.

6.3 Materials

The carrying container and the locking device (where present) shall be adequately protected against corrosion. The materials used shall be able to withstand temperatures and mechanical stress to be expected whilst being carried on the person as well as being stored on machines and vehicles.

Testing shall be done in accordance with 7.3, 7.9.1 and 7.16.

Exposed parts, i.e. those which may be subjected to impact during use of the apparatus shall not be made of aluminium, magnesium, titanium or alloys containing such proportions of these metals as will, on impact, give rise to frictional sparks capable of igniting flammable gas mixtures.

Testing shall be done in accordance with 7.3.

Any container or carrying container making use of such materials shall be adequately protected.

If national regulations allow the use of such containers or carrying containers then when tested for impact and scraping no metal shall be exposed.

Non-metallic carrying containers shall be antistatic. The insulation resistance shall not exceed 10^9 . Where the apparatus is required to be antistatic during escape, materials used shall be antistatic as far as practicable.

Testing shall be done in accordance with 7.4.

Materials which come into direct contact with the wearer's skin shall not be known to be likely to cause irritation or any other adverse effect to health.

Testing shall be done in accordance with 7.3 and 7.16.

Care shall be taken in selecting materials that may come into contact with oxygen to ensure that no oxygen ignition takes place.

Testing shall be done in accordance with 7.3.

6.4 Cleaning and disinfecting

All parts requiring cleaning and disinfecting shall be able to withstand cleaning and disinfecting agents and procedures as recommended by the manufacturer.

Testing shall be done in accordance with 7.15.

6.5 Mass

The mass of the complete apparatus including carrying container shall not exceed 5 kg when designed to be carried for at least 8 h.

Testing shall be done in accordance with 7.3.

6.6 Connections (couplings)

The design and construction of the apparatus shall permit its components to be readily separated for cleaning, inspecting and testing. Demountable connections to achieve this shall be readily connected and secured, preferably by hand.

Any means for sealing used shall be retained in position when the connection(s) is (are) disconnected during normal maintenance.

Testing shall be done in accordance with 7.3 and 7.16.

6.7 Harness

The apparatus in use shall have a harness, or other means of support, so that the wearers hands are left free, when the apparatus is in use.

Any harness shall be designed to allow quick, easy and correct donning of the apparatus without assistance.

Testing shall be done in accordance with 7.3 and 7.16.

6.8 Handling

The apparatus shall be capable of being donned and put into operation simply and without undue exertion under difficult conditions, e. g. in the dark and in restricted spaces.

If the apparatus container is fitted with a special fastening, the design shall be such that it cannot be opened inadvertently.

If the apparatus has been opened this shall be obvious by visual inspection.

Testing shall be done in accordance with 7.3 and 7.16.

6.9 Leaktightness

The ready-for-use apparatus shall be leak tight so that the pressure change does not exceed 0,3 mbar within 1 min.

Testing shall be done in accordance with 7.5.2.

6.10 Facepiece

The facepiece shall be either a mouthpiece assembly or a full face mask and shall be attached securely to the apparatus.

Type D-apparatus relying only upon a lung governed demand valve shall be fitted with a full face mask.

The mouthpiece assembly shall have two teeth bites and a permanently attached nose clip.

The mouthpiece assembly shall ensure reliable sealing and shall not be able to block inadvertently the breathing circuit when the apparatus is in operation.

The mouthpiece assembly shall be fitted with an adjustable or self-adjusting head harness if it is likely that an undue load is exerted on the wearer's mouth.

The nose clip 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.

Testing shall be done in accordance with 7.3 and 7.16.

If a full face mask is used as a facepiece the following requirements shall be met:

¾ the full face mask shall be provided with an adjustable or self-adjusting head harness;

¾ the requirements of 7.11.1 and 7.11.3.1 of EN 136:1998 shall be met.

The lens of the full face mask shall meet the requirements for eyepieces and visors in EN 136 except the requirement for the field of vision.

Testing shall be done in accordance with 7.3, 7.16 and the relevant clauses in EN 136.

The face seal leakage of the full face mask shall be tested separately and shall meet the requirements in 7.20 of EN 136:1998, when tested in accordance with EN 13274-1.

6.11 Goggles

If the device is used with goggles, then the lenses of the goggles shall be protected against fogging. The head straps of the goggles shall be flexible and easily adjustable or self-adjusting.

The goggles shall be attached to the apparatus to prevent loss when opening the carrying container. The goggles shall not interfere with the donning of the apparatus.

Testing shall be done in accordance with 7.3 and 7.16.

After the test for mechanical strength of the eyepiece(s) in accordance with 8.11 of EN 136:1998 the goggles shall not be damaged in any way that may make it ineffective or cause injury to the wearer.

Testing shall be done in accordance with 7.3 and 7.16.

The leaktightness of the goggles shall meet the requirements of 7.2.5 of EN 166:1995 when tested in accordance with clause 13 of EN 168:1995.

Testing shall be done in accordance with clause 13 of EN 168:1995.

6.12 Inhalation and exhalation valves

The valves shall function correctly in all orientations.

Valve assemblies shall be such that they can be readily maintained and cannot be incorrectly replaced.

Inhalation and exhalation valve assemblies, sub-assemblies and piece parts that are by the manufacturer's design identical, are acceptable.

Differently designed inhalation valves and exhalation valves are acceptable if an unambiguous description is given in the information supplied by the manufacturer. The information in the information supplied by the manufacturer should be supported by illustrations (photographs, drawings) on how to assemble the unit correctly.

To enable correct assembly, the parts have to be unambiguously described or marked.

Means to check the correct assembly shall be described in the manufacturer's information.

Testing shall be done in accordance with 7.3 and 7.16.

6.13 Relief valve

6.13.1 General

When the apparatus is provided with a relief valve it shall function properly irrespective of the orientation of the apparatus and shall be protected against or be resistant to dirt and mechanical damage.

Means shall be provided for sealing the relief valve to permit leak testing of the apparatus.

Testing shall be done in accordance with 7.3.

6.13.2 Opening pressure

The relief valve shall open at a positive pressure of not less than 1 mbar.

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 at no time during the rated working duration of the set be greater than the minimum opening pressure of the relief valve.

Testing shall be done in accordance with 7.7.

6.13.3 Tensile force

The connection between the relief valve housing and the attachment part shall withstand axially a tensile force of 50 N applied for (10 1) s.

Testing shall be done in accordance with 7.13.

6.14 Breathing bag

The breathing bag, or additional protective measures provided, shall withstand the foreseeable conditions of use.

The volume of the breathing bag shall be at least 6 l.

Testing shall be done in accordance with 7.8.

6.15 Flexible hose(s) (if fitted)

The breathing hose(s) shall be flexible and non-kinking. The breathing hose(s) shall permit free head movement and shall not restrict or close-off the gas supply under chin or arm pressure during practical performance tests.

Testing shall be done in accordance with 7.16.

The connections shall withstand axially a tensile force of 50 N applied for (10 1) s.

Testing shall be done in accordance with 7.13.

6.16 Mechanical strength

The apparatus shall be subjected to shock and to a vibration test as given in 7.6.1 and 7.6.2.

Following each test the apparatus shall be leaktight, provide protection and meet the performance requirements at a minute volume of 35 l/min.

Testing shall be done in accordance with 7.6.1, 7.6.2 and 7.10.

Additional requirements for apparatus designed for underground use are given in annex A.

6.17 Resistance to temperature

6.17.1 Conditioning

After conditioning in accordance with 7.9.1 and being allowed to return to room temperature the apparatus shall meet the following requirements:

the carrying container shall have no deficiencies that impair its functionability;

the materials used shall not show substantial deteriorations (severe deformations, cracks, etc.);

testing shall be done in accordance with 7.3;

the apparatus shall be leaktight and shall fulfill the requirement of 6.19;

testing shall be done in accordance with 7.5.2.

6.17.2 Performance

The apparatus shall function correctly within a temperature range of -5 °C to +60 °C and shall meet the requirements for oxygen content, carbon dioxide content and breathing resistance.

At the beginning of the test at the breathing machine the carbon dioxide content of inhalation gas may exceed the average for not more than 2 min but this average value shall not exceed 3,0 % by volume.

Testing shall be done in accordance with 7.9.2, 7.9.3 and 7.10.

Apparatus intended for use out of this temperature range shall be tested and marked accordingly.

6.18 Flammability

Two apparatus shall be examined and those parts deemed to be of an exposed nature during normal use shall be tested in accordance with EN 13274-4, method 4.

Components shall be considered to be flame resistant if they do not burn or if they are self-extinguishing within 5 s after removal from the test flame.

After the test the apparatus shall still be leaktight.

Testing shall be done in accordance with 7.5.2 and EN 13274-4, method 4.

6.19 Performance

6.19.1 Rated working duration

The apparatus shall meet the duration laid down for its class when tested at 35 l/min (see clause 5). The duration for type D, lung governed demand compressed oxygen apparatus and for type K, chemical oxygen (KO_2) apparatus shall be at least three times longer when tested at 10 l/min.

Testing shall be done in accordance with 7.10.1.

6.19.2 Oxygen content

The oxygen content of the inhaled gas shall not be below 21 % (by volume). A deviation to a level of not less than 17 % (by volume) for a period of not more than 2 min at the beginning of the test is permissible.

Testing shall be done in accordance with 7.3 and 7.16.

6.19.3 Carbon dioxide content

Throughout the rated working duration of the apparatus the carbon dioxide content of the inhalation air shall not exceed an average value of 1,5 % by volume and shall at no time exceed 3,0 % by volume.

For apparatus with a rated working duration of up to and including 15 min the carbon dioxide content shall not exceed 3,0 % by volume. After the rated working duration and up to a breathing resistance of 35 mbar the CO_2 content shall not exceed 3,0 % per volume.

Testing shall be done in accordance with 7.3 and 7.16.

6.19.4 Temperature and humidity

When tested at a minute volume of 35 l/min the temperature of the inhalation gas shall not exceed +60 °C during the rated working duration up to a relative humidity of 30 %. For levels greater than 30 % relative humidity the temperature shall not exceed +50 °C.

Testing shall be done in accordance with 7.9.2, 7.9.3, 7.10.1 and 7.16.

6.19.5 Breathing resistance

6.19.5.1 Breathing resistance at 35 l/min

For any point in the rated working duration apparatus with a rated working duration of up to and including 30 min the sum of the inhalation and exhalation resistances shall not exceed 16 mbar and the maximum individual breathing resistance for inhalation or exhalation shall not exceed 10 mbar when tested in the normal wearing position.

For any point in the rated working duration apparatus with a rated working duration of more than 30 min the sum of the inhalation and exhalation resistances shall not exceed 13 mbar and the maximum individual breathing resistance for inhalation or exhalation shall not exceed 7,5 mbar when tested in the normal wearing position.

Testing shall be done in accordance with 7.12 and EN 13274-3, method 2.

6.19.5.2 Breathing resistance at 70 l/min

For apparatus of all rated working durations the breathing resistance for inhalation as well as for exhalation shall not exceed 20 mbar when tested in the normal wearing position.

Testing shall be done in accordance with 7.12 and EN 13274-3, method 2.

6.20 Surface temperature

During laboratory tests in accordance with 7.10 the maximum surface temperature of any part of the apparatus shall be determined. This figure shall be stated in the information supplied by the manufacturer.

Testing shall be done in accordance with 7.11.

During practical performance tests the surface temperature of the apparatus shall be acceptable to the wearer when dressed in a simple cotton vest.

Testing shall be done in accordance with 7.16.

6.21 Practical performance

In addition to the machine tests described, the apparatus shall also undergo practical performance tests under realistic conditions. These general tests serve the purpose to check the apparatus for imperfections that cannot be determined by the tests described elsewhere in this European Standard.

At the time when the apparatus is rejected by the wearer or when the inhalation breathing resistance reaches 35 mbar, the level of oxygen in the inhalation gas shall be at least 17 % by volume and the level of CO_2 shall not exceed 5,0 % by volume.

If practical performance tests show the apparatus has imperfections related to wearers' acceptance, the test house shall describe the tests which revealed these imperfections. This will enable other test houses to duplicate these tests and assess the results thereof.

Testing shall be done in accordance with 7.16 and EN 13274-2.

6.22 Specific requirements for escape apparatus C type

The apparatus shall deliver an adequate flow of oxygen of not less than 4,0 l/min within the rated working duration. The chlorate candle shall incorporate a pressure safety device (e. g. burst disc).

Testing shall be done in accordance with 7.14.

6.23 Specific requirements for escape apparatus D type

6.23.1 Protection against particulate matter

The parts of the apparatus supplying compressed oxygen shall be reliably protected against the ingress of particulate matter that may be contained in the compressed oxygen. This can be achieved by mounting e.g. a sinter filter.

Testing shall be done in accordance with 7.3.

6.23.2 High and medium pressure parts

Metallic high pressure tubes, valves and connections shall be capable of withstanding a test pressure of 50 % above the maximum filling pressure of the gas containers without damage.

Non-metallic high pressure parts shall be capable of withstanding a test pressure of twice the maximum filling pressure of the gas containers without damage.

All medium pressure tubes downstream of the pressure reducer shall be capable of withstanding twice their maximum attainable working pressure without damage.

Testing shall be done in accordance with 7.3.

6.23.3 High, medium and low pressure connections

High, medium and low pressure connections shall not be interchangeable.

Testing shall be done in accordance with 7.3.

6.23.4 Gas containers

Compressed gas containers shall comply with national regulations. The gas containers shall be approved with respect to the appropriate filling pressure.

Only gas containers of equal maximum filling pressure shall be connected to an apparatus with more than one gas container.

Testing shall be done in accordance with 7.3.

6.23.5 Gas container seal

There shall be only one seal or other technical provisions to open the total gas stored. The seal or its equivalent shall be opened easily by hand or automatically when starting the apparatus.

Where a conventional valve is used it shall be so designed that the valve spindle cannot be completely unscrewed from the assembly during normal operation of the valve.

The opening device of the gas container seal shall be designed so that it cannot be closed inadvertently.

Testing shall be done in accordance with 7.3 and 7.16.

6.23.6 Gas container seal connection

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

Testing shall be done in accordance with 7.3.

6.23.7 Pressure reducer

If a pressure reducer is part of the apparatus any adjustable medium pressure stage shall be reliably secured against accidental alteration and adequately sealed so that any unauthorised adjustment can be detected.

Testing shall be done in accordance with 7.3.

6.23.8 Pressure indicator

Apparatus shall be equipped with a reliable pressure indicator which will indicate the maximum filling pressure in the gas container(s).

The pressure indicator shall function independently of the action of the gas container seal at all times.

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 elements of the indicator the explosion will be away from the front of the wearer. If the window is incorporated in the pressure indicator it shall be of non-splintering clear material.

A restrictor shall be provided so that if the indicator is damaged the outflow of breathable air at 200 bar pressure shall not exceed a rate of 5 l/min. If the nominal pressure is less the requirement shall be met at the nominal pressure.

Testing shall be done in accordance with 7.3 and 7.16.

6.23.9 Oxygen supply

6.23.9.1 Constant flow apparatus

With an apparatus using a constant flow only the flow of oxygen shall not be less than 4 l/min throughout the rated working duration.

Testing shall be done in accordance with 7.14.

6.23.9.2 Lung governed demand apparatus

The opening pressure of the lung governed supply mechanism shall be not less than 2 mbar below ambient.

The oxygen flow rate shall be at least 80 l/min at all container pressures above 10 bar.

Testing shall be done in accordance with 7.14.

6.23.9.3 Combined apparatus

The constant flow shall not be less than 1,2 l/min down to 5 % of the maximum filling pressure of the container.

The opening pressure of the lung governed supply mechanism shall not be less than 2 mbar below ambient.

On opening of the demand valve, the oxygen flow rate shall be at least 80 l/min at all container pressures above 10 bar.

Testing shall be done in accordance with 7.14.

6.24 Specific requirements for escape apparatus K type

6.24.1 Leaktightness

The carrying container shall be designed to remain leaktight even over an extended period of time.

The carrying container shall be so designed that leaktightness can also be checked by total immersion in water or an equivalent specified by the manufacturer.

Testing shall be done in accordance with 7.3 and 7.5.1.

The carrying container shall be leaktight after conditioning in accordance with 7.9.1 and being allowed to return to room temperature.

Testing shall be done in accordance with 7.5.1.

6.24.2 Oxygen supply

The apparatus shall deliver an adequate flow of oxygen into the breathing circuit.

Testing shall be done in accordance with 7.9.2, 7.9.3, 7.10 and 7.16.

7 Testing

7.1 General

Before performing tests involving human subjects account should be taken of any national regulations concerning the medical history, examination or supervision of the test subjects.

If no special measuring devices or measuring methods are specified commonly used methods and devices should be applied.

7.2 Nominal values and tolerances

Unless otherwise specified, the values stated in this standard are expressed as nominal values. Except for temperature limits, values which are not stated as maxima or minima shall be subject to a tolerance of 5 %. Unless otherwise specified, the ambient temperature for testing shall be from 16 °C to 32 °C and the temperature limits shall be subject to an accuracy of 1 °C.

7.3 Visual inspection

The visual inspection shall be carried out where appropriate by the test house prior to laboratory or practical performance tests. The visual inspection shall include marking and information supplied by the manufacturer.

7.4 Insulation resistance of non-metallic carrying containers

The resistance is tested on the carrying container if size permits, or on a test piece comprising a rectangular plate with dimensions in accordance with Figure 1 on which two parallel electrodes are painted on the surface, using a conducting paint with a solvent which has no significant effect on the insulation resistance or the container material.

The test piece shall have an intact surface and shall be cleaned with distilled water, then with isopropyl alcohol (or any other solvent that can be mixed with water and will not affect the material of the test piece), then once more with distilled water before being dried. Untouched by bare hands, it shall then be conditioned for 24 h at the temperature of (23 ± 2) °C and (50 ± 5) % relative humidity.

The test shall be carried out under the same ambient conditions.

The direct voltage applied for 1 min between the electrodes shall be equal to (500 ± 10) V.

During the test, the voltage shall be sufficiently steady so that the charging current due to voltage fluctuation will be negligible compared with the current flowing through the test piece. In certain cases this requires the use of batteries or accumulators.

The insulation resistance is the quotient of the direct voltage applied at the electrodes to the total current flowing between them when the voltage has been applied for 1 min.

Suitable test methods are described in annex B.

7.5 Leaktightness

7.5.1 Leaktightness of the carrying container

Testing of the apparatus including carrying container shall be conducted by total immersion in water of approximately +50 °C for 5 min. No bubbles shall be observed escaping from the container. Following the test the container shall be opened and no water shall be present. If the manufacturer specifies an alternative test, this shall be tested too.

7.5.2 Leaktightness of the ready-for-use apparatus

The leakage of the ready-for-use apparatus is tested before and after the tests for resistance to temperature and for flammability. The apparatus are tested with dry air at a positive and negative pressure of 7,5 mbar.

During the positive pressure test the relief valve shall be sealed.

7.6 Mechanical strength

7.6.1 Shock

In order to test the resistance to shocks the apparatus shall undergo a drop test from a height of 1,5 m on to a concrete floor in three different orientations. These orientations shall be stated in the test report.

7.6.2 Vibration

The test apparatus is shown schematically in Figure 2 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 on to a steel plate (P) under its own mass as the cam rotates. The mass of the steel case shall be over 10 kg and the base of the equipment should either weigh at least 10 times as much as the case, or be bolted to the floor.

The apparatus shall be placed in the case (K) so that they do not touch each other during the test, allowing (6 2) mm horizontal movement and free vertical movement.

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

7.7 Opening pressure of the relief valve

The relief valve shall be checked without being dismantled and when the apparatus is in use position. The opening pressure shall be measured at the facepiece. 1,5 l/min of dry oxygen shall be fed into the apparatus through the facepiece. The maximum value recorded shall be taken as the opening pressure.

7.8 Breathing bag

The volume of the breathing bag shall be determined by filling the breathing bag with air until a pressure of 5 mbar is achieved.

Then the breathing bag shall be evacuated until a negative pressure of 5 mbar is reached. In apparatus with a relief valve the relief valve shall be allowed to close before measurement commences.

7.9 Resistance to temperature

7.9.1 Conditioning

The apparatus in its container shall be conditioned by the following cycle in accordance with EN 13274-5:

a) 6.2.2; 6.3.4; 6.4.1;

b) 6.2.2; 6.3.2; 6.4.1;

c) 6.2.8; 6.3.4; 6.4.2.

7.9.2 Temperature tests at -5 °C and +60° C

7.9.2.1 Low temperature test

When testing the apparatus for performance at low temperatures the complete apparatus shall be exposed to a temperature of (-5 $^{0}_{-2}$) °C for a period of (20 1) h.

The apparatus shall be tested at room temperature with a minute volume of 35 l/min in accordance with 7.10.1.

7.9.2.2 High temperature test

When testing the apparatus for performance at high temperatures the complete apparatus shall be exposed to a temperature of (+60 $^{+2}_{0}$) °C for a period of (20 1) h.

The apparatus shall be tested at room temperature with a minute volume of 35 l/min in accordance with 7.10.1.

7.9.3 Low temperature practical performance test

7.9.3.1 Preparation of apparatus

Two apparatus, ready for use, out of the container, are stored at a temperature of (-5 $^{0}_{-2}$) °C for a period of (4 1) h.

7.9.3.2 Test procedure

Two warmly clothed subjects shall don the pre-cooled apparatus in a cold chamber with an ambient temperature between -3 °C and -5 °C and shall then walk at a steady rate of 6,5 km/h. The walking exercise may be conducted on a treadmill.

During the test the oxygen and carbon dioxide content of the inhaled gas shall be measured continuously.

The duration of the walking shall be for a period of 10 min. For apparatus with a rated working duration of 5 min, the test shall be carried out for 5 min.

After this test the test subjects shall leave the cold chamber and return to ambient conditions and continue walking at a steady rate of 6,5 km/h for a period of 5 min, except for apparatus up to 10 min rated working duration.

After the test the apparatus shall be examined for malfunctions and the subjects shall report on the breathing comfort and wearing characteristics.

7.10 Laboratory performance tests

7.10.1 General performance

A typical arrangement of the equipment required for this test is shown in Figure 3. This equipment simulates the oxygen uptake of the user and mainly consists of a breathing machine [1] regulated by frequency and amplitude. The O_2 consumption is simulated by means of an auxiliary lung [2], the mass flow regulators for CO_2 [5a] and N_2 [5b] and the valves [4a] and [4b]. During inhalation the auxiliary lung [2] withdraws a breathing gas volume corresponding to the oxygen content of the breathing gas to be consumed via the valve [4a] from the breathing circuit. During exhalation the oxygen content drawn in is replaced by CO_2 via the mass flow regulator [5a]. N_2 is supplied via the mass flow regulator [5b] to control the volume.

The test equipment shall subject the apparatus to respiration by the breathing machine such that when measured immediately after leaving the servo-valve the volume of gas shall be of a value as given in Table 1 at a relative humidity of 95 % and at a temperature of (37,0 0,5) °C. The carbon dioxide content shall be of a value as specified in Table 1 in addition to the carbon dioxide content of the inhaled gas.

Table 1 — Test conditions

Minute volume		Input of carbon dioxide l/min	Carbon dioxide content of exhaled gas %
10 cycles/min	1,0 l/stroke	0,4	4,0
20 cycles/min	1,75 l/stroke	1,575	4,5
30 cycles/min	2,33 l/stroke	3,5	5,0

To simulate those functions of human respiration relevant for the testing of closed-circuit breathing apparatus the gas is supplied via valves in the inhalation and exhalation path operated with the same cycles as the breathing machine [1]. The closed-circuit breathing apparatus to be tested is supplied with breathing air via one servo-actuated exhalation valve [3a] and inhalation valve [3b] each by the breathing machine [1]. In the exhalation path the breathing gas is saturated with water vapour by means of a humidifier [6]. The exhalation gas is analysed on CO_2 by the gas analyser of the exhalation gas [9] located behind this humidifier [6]. The inhalation and exhalation temperature is measured inside the standard connection [10] at the specified spots using a temperature sensor that - with respect to its response - corresponds to a NiCr-Ni thermoelement with a wire thickness of 0,2 mm unsheated. The breathing resistances are also measured at the specified spots in the standard connection. During inhalation the gas is supplied via the inhalation valve [3b] and a breathing gas cooler [7] to keep the gas volume at a constant level. The gas inhaled is analysed on CO_2 and O_2 via the gas analyser of the inhalation gas [8]. The dead volume of the complete gas supply is 2 000 ml.

Depending on the facepiece of the apparatus, different connectors shall be used for the test. Apparatus with full face mask shall be tested on a dummy head (Sheffield head) in accordance with Figure 4.

Apparatus with a mouthpiece assembly shall be tested using a connector in accordance with Figure 5.

The oxygen content and the carbon dioxide content as well as the temperature of the inhaled and exhaled gas and the breathing resistance shall be measured and recorded continuously. The test shall be conducted at room temperature (23 2) °C.

7.10.2 Performance at 70 l/min

During a test on the breathing machine the minute volume shall be increased to 70 l/min for a certain period. The time when the adjustment to the high minute volume is made depends on the class of apparatus under test.

For apparatus with a rated working duration of 30 min or more the increase in minute volume shall be made 15 min before the rated working duration is achieved. After 5 min the breathing machine shall be readjusted to 35 l/min and the test continued.

For apparatus with a rated working duration of 10 min to 25 min the 70 l/min period shall be started 5 min after the start of the test.

The 5 min rated working duration apparatus shall be tested separately at a minute volume of 35 l/min and 70 l/min. Each test condition applies to the entire duration.

7.11 Surface temperature

The surface temperature shall be measured during performance tests on the breathing machine. During a test with a minute volume of 35 l/min and in addition during a test with a minute volume of 35 l/min and 70 l/min thermocouples shall be connected to points expected to turn hot. The temperature shall be measured and recorded continuously until the test is finished.

The highest temperature shall be recorded.

7.12 Breathing resistance

The breathing resistance shall be measured during the breathing machine tests described in 7.10.1 and EN 13274-3, method 2 at a temperature of (23 2) °C and relative humidity of (50 30) %.

For apparatus with a full face mask the breathing resistance shall be measured at the mouth of the dummy head (see Figure 4).

For apparatus with a mouthpiece assembly the breathing resistance shall be measured at the connector (see Figure 5).

7.13 Tensile force

The test sample including connection shall be tested at the appropriate force for 10 s.

7.14 Oxygen supply

For testing the performance of the constant flow supply system the relief valve shall be sealed and the measurement shall be carried out with the facepiece of the apparatus.

The oxygen flow shall be measured at a fully opened lung demand valve.

The opening pressure of the lung governed supply mechanism shall be determined applying a continuous flow of 10 l/min.

7.15 Cleaning and disinfecting

The cleaning and disinfecting procedure shall be performed 30 times.

7.16 Practical performance

7.16.1 General

Practical performance tests shall be performed with four apparatus and four test subjects in accordance with EN 13274-2.

7.16.2 Escape tests

7.16.2.1 General

The test shall be conducted in a training gallery.

During escape tests the test subjects perform at different work levels.

Prior to the escape tests the test subjects shall be instructed using the information supplied by the manufacturer on the correct procedure of opening, donning and of the operation of the apparatus. The test subjects shall carry out the opening and donning procedure in the dark without assistance.

The exercises shall be carried out under ambient conditions. The ambient atmosphere shall be free of smoke. The air flow shall be negligible.

During the tests the test subject shall be accompanied by an assistant.

Prior to escape tests the temperature and relative humidity of the atmosphere shall be noted at various points of the escape route as well as the mass of the ready-for-use apparatus.

During tests the following shall be recorded:

¾ nature and time of the different activities;

¾ complaints e.g. discomfort from wearing the apparatus;

¾ poor visibility because of fogging of goggles.

The oxygen and carbon dioxide content of the inhaled gas and also the breathing resistance shall be monitored periodically throughout the test.

An exercise shall be terminated when the generation of oxygen ceases or the inhalation breathing resistance reaches 35 mbar or when there is evidence that the test subject is no longer capable of completing the exercise.

After the escape tests an assessment of the apparatus shall be made by the test subject.

7.16.2.2 Escape exercise for apparatus with a rated working duration of more than 30 min

The escape exercise is divided into equal sections following each other. In each of these sections the test subject shall perform the following sequence of activities in accordance with EN 13274-2: number 16, 20, 17, 18.

The number of exercises depend on the class of the apparatus. The final part of the practical exercise can be carried out on the treadmill (walking on level ground at a speed of 5,0 km/h).

7.16.2.3 Escape exercises for apparatus with a rated working duration of up to and including 30 min

During this test the test subject shall perform the following activities:

¾ number 16 in accordance with EN 13274-2;

¾ walking on a treadmill at a speed of 2,4 km/h and 20 % incline until the test is terminated.

7.16.3 Test at rest

This test shall be carried out with one apparatus and one test subject in accordance with EN 13274-2, activity number 15.

Temperature, oxygen and carbon dioxide content of the inhaled gas and breathing resistance shall be measured continuously and recorded.

The exercise shall be terminated when the generation of oxygen ceases, or the oxygen of the inhaled gas is less than 21 % by volume, or the carbon dioxide content is more than 1,5 % by volume, or when there is evidence that the test subject is no longer capable of completing the exercise.

8 Marking

The apparatus shall be marked as follows:

8.1 The manufacturer, supplier or importer shall be identified by name, trademark, or other means of identification.

8.2 Manufacturers model designation.

8.3 Type of oxygen escape apparatus, e.g. "C", "D" or "K".

8.4 Rated working duration.

8.5 Apparatus complying with annex A shall be marked with the suffix "S".

8.6 The number of this European Standard.

8.7 Serial number.

8.8 Year of manufacture/shelf life or equivalent.

8.9 Where the reliable performance of piece parts may be affected by ageing, means of identifying the date (at least the year) of manufacture shall be given (see annex D).

8.10 Sub-assemblies and components with considerable bearing on safety shall be marked so that they can be identified. If sub-assemblies with considerable bearing on safety cannot be marked, the information shall be given in the instructions for use (see annex D).

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

8.12 The marking shall be as clearly visible and as durable as possible.

9 Information supplied by the manufacturer

9.1 On delivery information supplied by the manufacturer shall accompany every apparatus.

9.2 Information supplied by the manufacturer shall be in the official language(s) of the country of destination.

9.3 The information supplied by the manufacturer shall contain all information necessary for trained and qualified persons on:

¾ explanation of type classification;

¾ application/limitation;

  ¾ maximum surface temperature during use;

¾ checks prior to use;

¾ donning and fitting;

¾ use;

¾ maintenance (preferably separately printed instructions);

  ¾ inspection intervals;

¾ storage;

  ¾ shelf life or equivalent;

¾ method for testing leaktightness

of the apparatus.

The information supplied by the manufacturer shall be precise and comprehensible.

NOTE If helpful, illustrations, part numbers, marking should be added.

9.4 The information supplied by the manufacturer should be complimented by an easy to understand picture (pictogram) on the carrying container showing the donning procedure (size at least 3 cm 3 cm).

For apparatus with a rated working duration of up to and including 30 min the pictogram may be supplied separately if there should be not sufficient place on the carrying container.

9.5 Warning should be given against possible problems likely to be encountered, for example

¾ intactness of the apparatus during carriage or transport;

¾ procedure of donning;

¾ use of the apparatus in explosive atmosphere, e.g. maximum surface temperature.

9.6 Any other information the supplier may wish to provide.

9.7 In case of a compressed oxygen type apparatus the information supplied by the manufacturer shall include that the purity of the oxygen supply shall be at least 99,5 % and the moisture content shall not exceed the values given in Table 2.

To ensure reliable operation of the device, the figures in Table 2 for moisture in the oxygen shall not be exceeded.

Table 2 — Maximum moisture content

Filling pressure bar	Moisture at 1 bar mg/m^3
200	$\leq$ 50
300	$\leq$ 35

Dimensions in millimetres

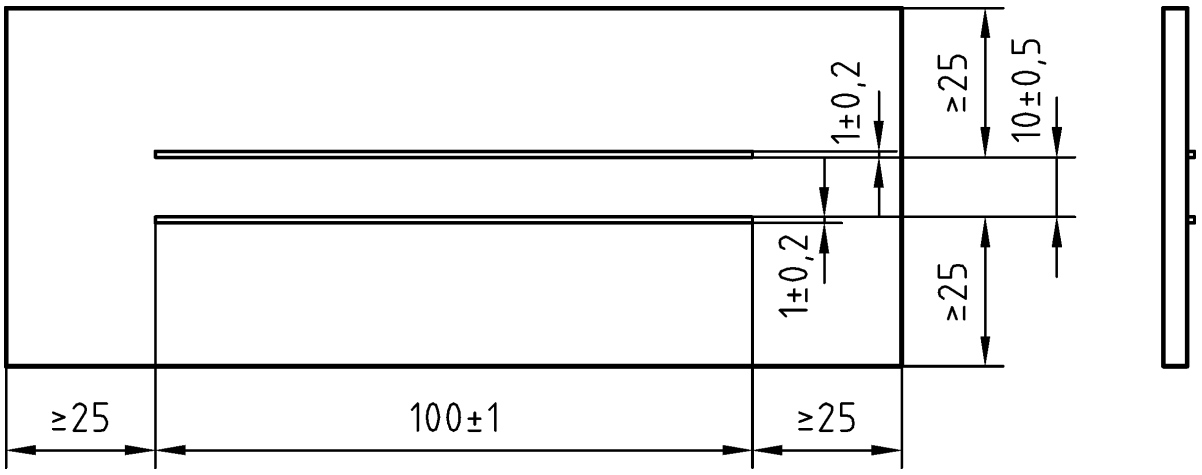
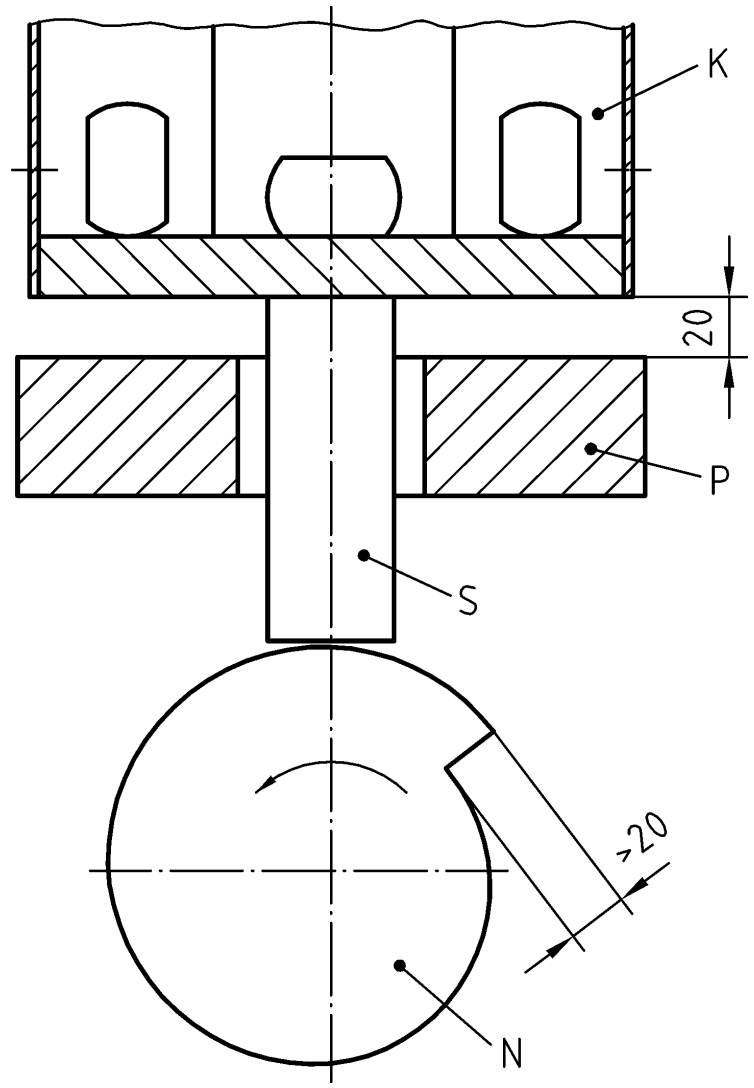


Figure 1 — Test piece with painted electrodes for insulation resistance test

Dimensions in millimetres



Key

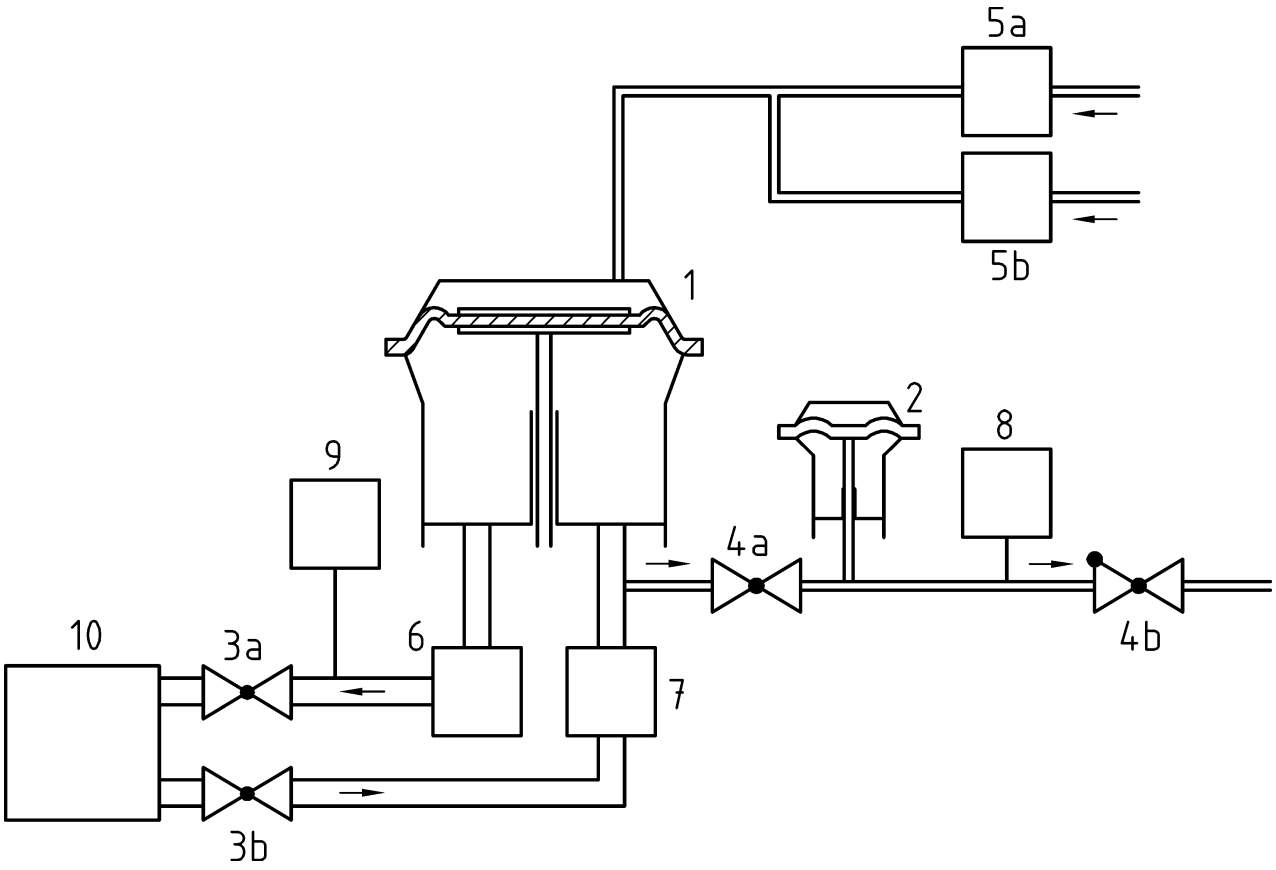
K Steel case

N Cam

P Steel plate

S Piston

Figure 2 — Test equipment for mechanical strength



Key

1 Breathing machine

2 Auxiliary lung to simulate consumption

3a Servo-actuated valve in the exhalation path

3b Servo-actuated valve in the inhalation path

4a Servo-actuated valve for consumption simulation

4b Non-return valve

5a Mass flow regulator for additional supply of CO_2

5b Mass flow regulator for additional supply of N_2

6 Breathing gas humidifier

7 Breathing gas cooler

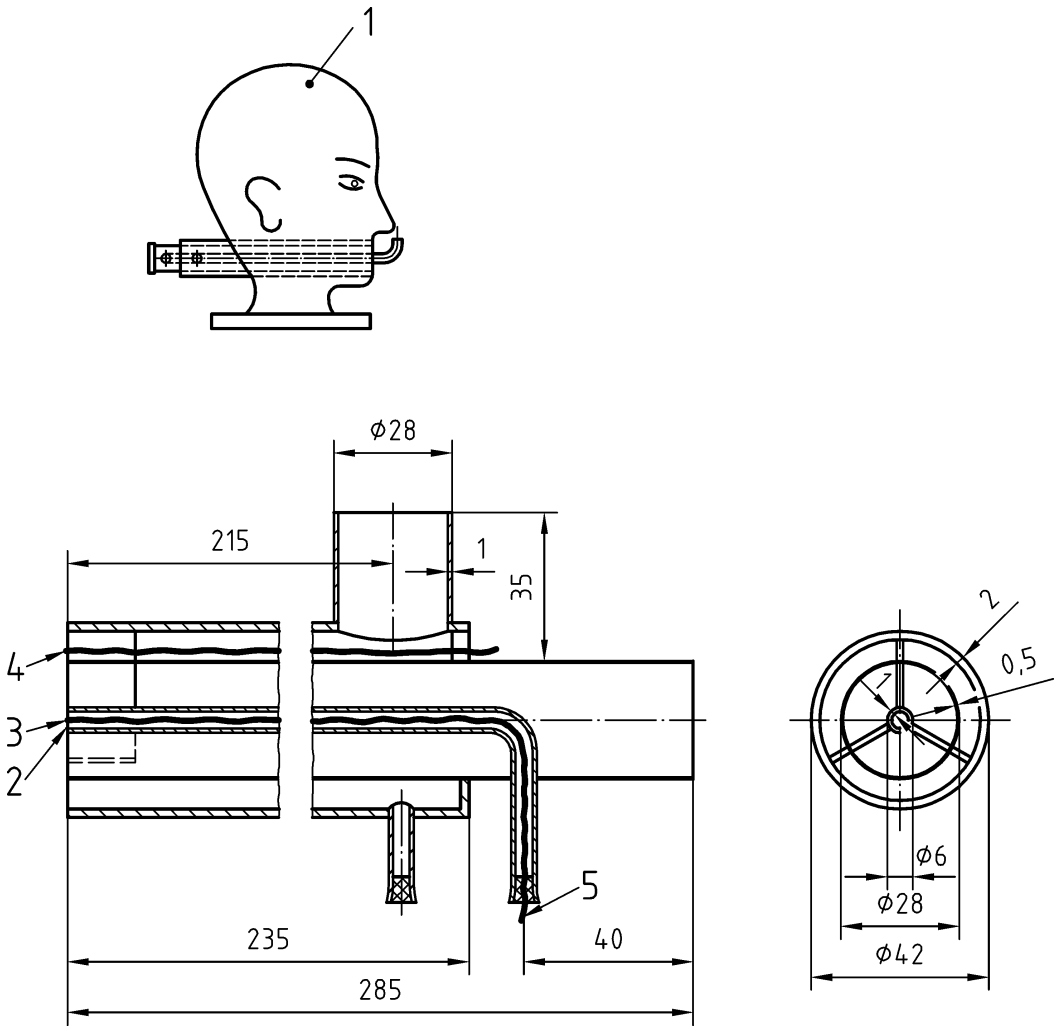
8 Gas analyzer for the gas inhaled (CO_2, O_2)

9 Gas analyzer for the gas exhaled (CO_2)

10 Standard connection for the closed-circuit breathing apparatus to be tested with integrated temperature (inhalation and exhalation temperature) and pressure measurement (inhalation and exhalation resistance)

Figure 3 — Typical arrangement of test rig for oxygen escape apparatus

Dimensions in millimetres



Key

1 Sheffield-head

2 Pressure measuring point

3 Temperature measuring point (inhalation)

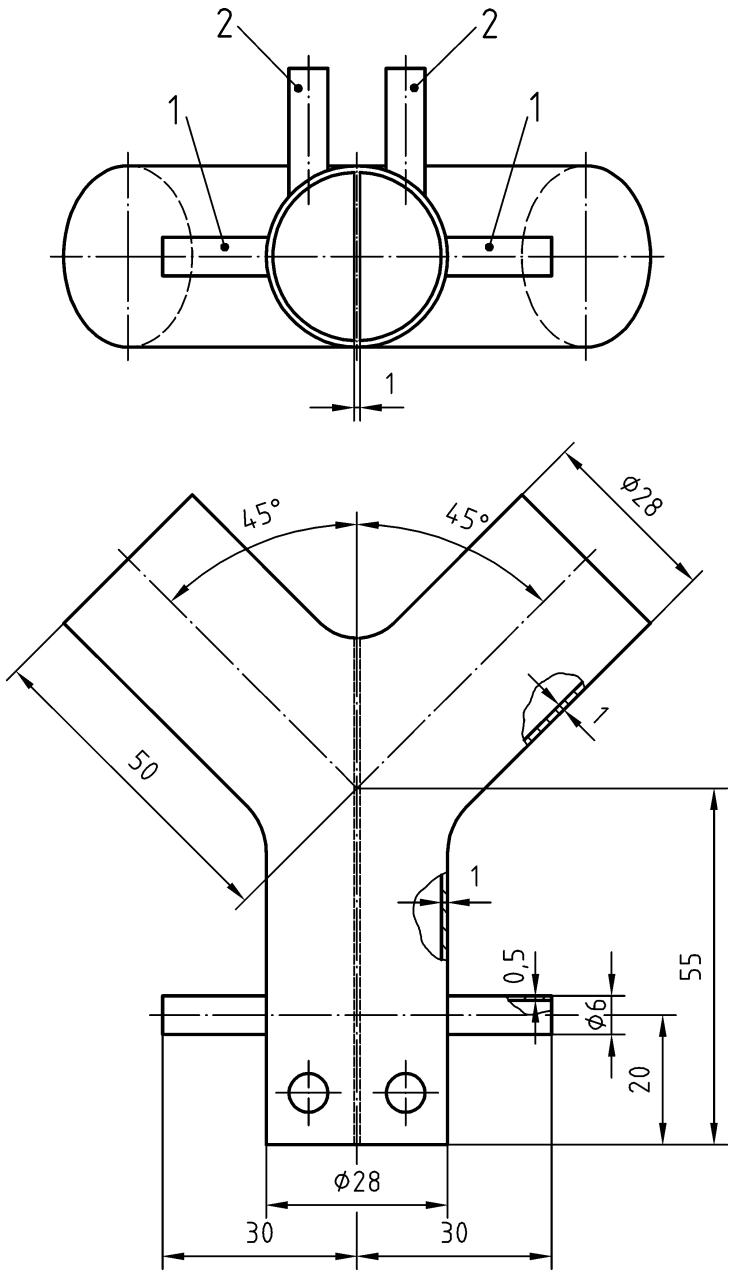
4 Temperature measuring point (exhalation)

5 Thermocouple

a) To pressure gauge

Figure 4 — Dummy head for apparatus with full face mask

Dimensions in millimetres



Key

1 Pressure measuring points

2 Temperature measuring points

Figure 5 — Connector for breathing apparatus having a permanently connected mouthpiece assembly

Annex A
(normative)

Additional requirements for apparatus designed for underground use

In addition to the requirements given in clause 6, the following requirements shall be fulfilled:

A.1 Apparatus for transportation on man, machine and vehicle shall withstand heavy mechanical stress occurring during these tests.

A.2 Ten apparatus shall be transported underground for a period of 3 months and 2 shifts per day. The apparatus may be carried on the man or transported on vehicles or machines when in use in accordance with the information supplied by the manufacturer.

After completion of the above exercises comments shall be collected from those persons taking part. The result of these comments will be taken into consideration by the test house for final evaluation of the apparatus.

A.3 Additionally, cleaning of the apparatus shall be tested during these trials.

A.4 After the tests the apparatus shall still be leaktight, provide protection and meet the performance requirements when tested at 35 l/min.

Testing shall be done in accordance with 7.3, 7.5 and 7.10.

A.5 Four escape exercises shall be carried out underground with four test subjects. These tests are supplementary exercises to those performed in the test house.

Annex B
(normative)

Methods of measurement of the insulation resistance of the carrying container

B.1 Voltmeter ammeter method

The current shall be measured directly by means of a micro-ammeter, or a galvanometer (Figure B.1), or indirectly by a d.c. amplifier which indicates the current by measuring the voltage drop which it determines in a known resistance (Figure B.2a). The voltage shall be measured by a voltmeter. In certain cases the voltage-current ratio shall be measured by an instrument indicating the resistance directly (Figure B.2b).

B.2 Comparative method

The unknown resistance shall be compared to a known resistance by determining the ratio of the currents when the same voltage is applied in succession to two resistances (Figure B.3a) or by balancing the two resistances in a Wheatstone bridge (Figure B.3b).

For all these methods, the unknown resistance shall be large in relation to any calibrated resistance connected in series with it so as to be submitted to practically all the voltage.

Voltmeter ammeter method

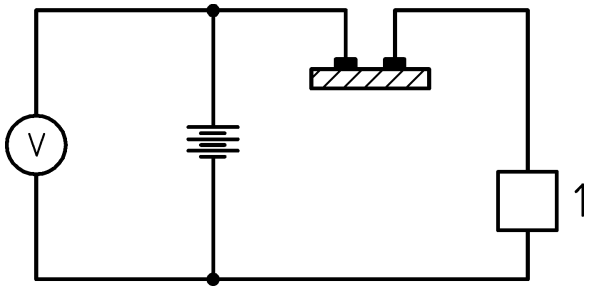


Figure B.1 — Current measurement by micro-ammeter or galvanometer

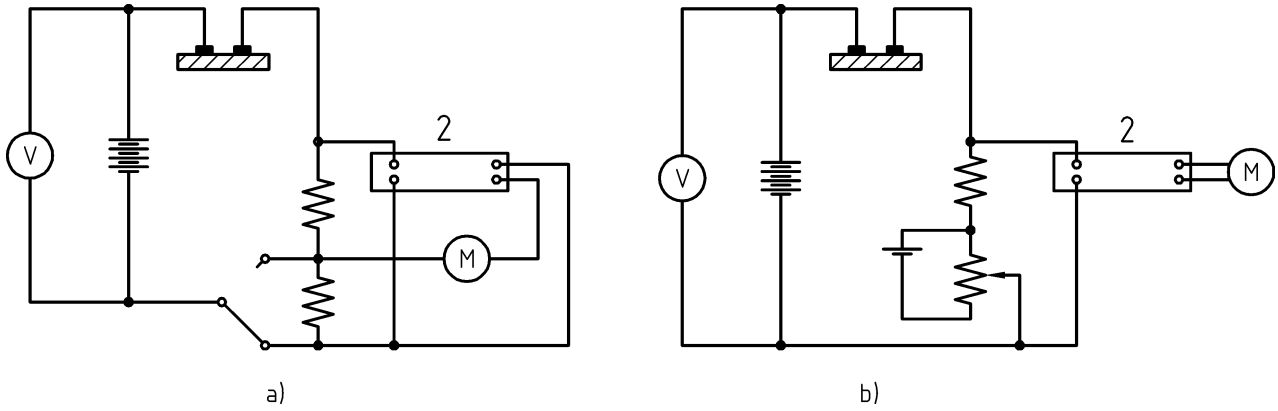


Figure B.1 — Current measurement by means of a d.c. amplifier

Comparative method

Optional

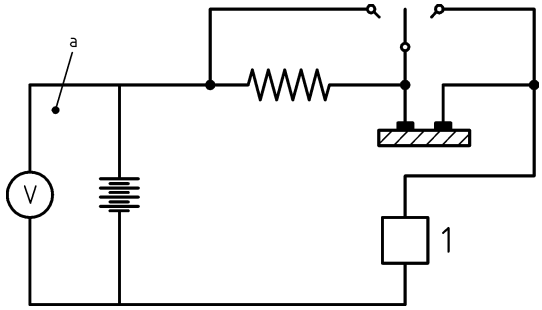
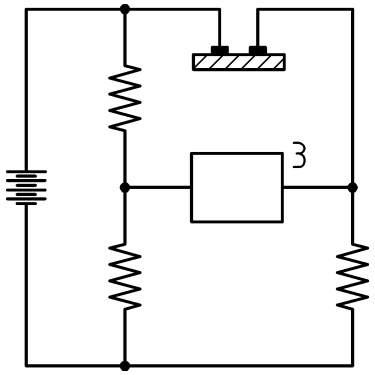


Figure B.2a — Determination of the ratio of currents when the same voltage is applied successively to the two resistances



Key

1 Galvanometer with shunt
2 d.c. amplifier
3 Detector

Figure B.3b — Wheatstone bridge method

Annex C
(normative)

Training apparatus

C.1 Definition

A training apparatus is a apparatus which allows the simulation of carrying, donning and breathing of the working apparatus.

C.2 Requirements

C.2.1 Design

Parts of a training apparatus which are in their function not identical with the corresponding parts of the working apparatus shall not be interchangeable with those of the working apparatus and shall be clearly marked.

Testing shall be done in accordance with 7.3 and 7.16.

C.2.2 Materials

The materials used shall be able to withstand the mechanical stress to be expected during training exercises.

Materials which come into direct contact with the wearer's skin shall not be known to be likely to cause irritation or any other adverse effect to health.

Testing shall be done in accordance with 7.3 and 7.16.

C.2.3 Cleaning and disinfecting

All parts requiring cleaning and disinfecting shall be able to withstand cleaning and disinfecting agents and procedures as recommended by the manufacturer.

Testing shall be done in accordance with 7.15.

C.2.4 Mass

The mass of the complete training apparatus including carrying container as well as the apparatus for training shall be similar to that of the working apparatus.

Testing shall be done in accordance with 7.3.

C.2.5 Handling

The handling of the training apparatus shall be identical to that of the working apparatus.

Testing shall be done in accordance with 7.3 and 7.16.

C.2.6 Breathing resistance at 35 l/min

The breathing resistance shall be similar to that of the working apparatus.

Testing shall be done in accordance with 7.12 and EN 13274-4, Method 2.

C.2.7 Oxygen content of the inhaled air

The oxygen content of the inhaled air shall not be below 19 %.

Testing shall be done in accordance with 7.16.1 and 7.16.2.

C.2.8 CO_2 content of the inhaled air

The CO_2 content of the inhaled air shall not exceed an average value of 1,5 % (by volume).

Testing shall be done in accordance with 7.16.1 and 7.16.2.

C.3 Marking

The training apparatus shall be marked with the manufacturers model designation plus the words "For training only".

C.4 Information supplied by the manufacturer

On delivery information supplied by the manufacturer shall accompany every apparatus. This information may be applicable to either the training or working apparatus.

The information supplied by the manufacturer shall contain all necessary information for persons to be trained in the use of the working apparatus. Particular attention shall be given to:

- application/limitation;
- checks prior use;
- donning and doffing;
- use;
- maintenance;
- storage;
- warnings.

Annex D
(informative)

Marking

It is recommended to consider for marking the following components and sub-assemblies - if applicable - to be identifiable:

Components/ subassemblies	**Part-marking**	**Date of manufacture**	**Remarks**
Pressure reducer	+	+	
Lung demand valve	+	-	2
Lung demand valve diaphragm	+	+	
Exhalation valve disc	+	+	1
Inhalation valve disc	+	+	1
Breathing hose	+	+	
Breathing bag	+	+	
CO_2-cartridge	+	+	1
CO_2-absorbent	-	-	1
$NaClO_3$-candle	+	+	1
KO_2-cartridge	+	+	1
Relief valve	+	+	1
Pressure indicator	+	-	
Facepiece			according to the relevant standards
Carrying harness	-	-	1
Carrying container	+	+	
Oxygen container			according to the relevant standards
Goggles	+	+	
Container valve			according to the relevant standards

+	The marking is necessary.
-	The marking is not necessary.
1	For parts which cannot reasonably be marked the relevant information shall be included in the information supplied by the manufacturer.
2	Means of identification may include serial No. and/or date and shall be explained in the information supplied by the manufacturer.

The components of a sub-assembly need not be marked when the sub-assembly is identifiable. Those components not offered as spare parts by the manufacturer need not be marked but the relevant information should be given in the information supplied by the manufacturer.

Annex ZA
(informative)

Clauses of this European Standard addressing essential requirements or other provisions of EU Directives

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association and supports essential requirements of EU Directive 89/686/EEC.

WARNING: Other requirements and other EU Directives may be applicable to the products falling within the scope of this European Standard.

The clauses of this European Standard are likely to support requirements of Directive 89/686/EEC, Annex II:

Table ZA.1

EU Directive 89/686/EEC, Annex II	Clauses of this European Standard
1.1.1	6.2, 6.5, 6.7, 6.21
1.1.2.1	6.9
1.1.2.2	6.9
1.2.1	6.2, 6.5, 6.14, 6.15, 6.19, 6.21
1.2.1.1	6.3, 6.15, 6.20
1.2.1.2	6.2, 6.3
1.2.1.3	6.5, 6.19
1.3.1	6.2, 6.7, 6.9, 6.10, 6.11, 6.21
1.3.2	6.5, 6.17
1.4	8
2.1	6.7, 6.9, 6.10, 6.11, 6.21
2.3	6.9, 6.10, 6.11, 6.21
2.4	8, 9
2.5	6.2, 6.21
2.6	6.3
2.7	6.2, 6.6, 6.7, 6.21
2.8	9
2.12	8
3.10.1	6.2, 6.3, 6.4, 6.8, 6.9, 6.10, 6.12, 6.14, 6,15, 6.18, 6.19.2, 6.19.3, 6.19.4, 6.19.5
3.10.2	6.11

Compliance with this standard provides one means of conforming to the specific essential requirements of the Directive concerned and associated EFTA regulations.

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