BS EN 250:2014

BSI Standards Publication

Respiratory equipment — Open-circuit self-contained compressed air diving apparatus — Requirements, testing and marking

bsi.

...making excellence a habit.™

National foreword

This British Standard is the UK implementation of EN 250:2014. It supersedes BS EN 250:2000 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PH/4/7, Underwater breathing apparatus.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

ISBN 978 0 580 78797 3

ICS 13.340.30

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 April 2014.

Amendments issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 250

April 2014

ICS 13.340.30

Supersedes EN 250:2000

English Version

Respiratory equipment - Open-circuit self-contained compressed air diving apparatus - Requirements, testing and marking

Appareils respiratoires - Appareils de plongée autonomes à air comprimé et à circuit ouvert - Exigences, essai et marquage

Atemgeräte - Autonome Leichttauchgeräte mit Druckluft - Anforderungen, Prüfung und Kennzeichnung

This European Standard was approved by CEN on 3 February 2014.

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 CEN-CENELEC 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 CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

Ref. No. EN 250:2014 E

Contents

Page

Foreword

This document (EN 250:2014) 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 October 2014, and conflicting national standards shall be withdrawn at the latest by October 2014.

This document supersedes EN 250:2000.

Annex D provides details of significant technical changes between this European Standard and the previous edition.

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(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

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

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

A given self-contained open-circuit compressed air underwater breathing apparatus 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 are similar to those of the complete apparatus.

1 Scope

This European Standard specifies minimum requirements for self-contained open-circuit compressed air underwater breathing apparatus and their sub-assemblies to ensure a minimum level of safe operation of the apparatus down to a maximum depth of 50 m.

2 Normative references

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

EN 144-1, *Respiratory protective devices - Gas cylinder valves - Part 1: Thread connections for insert connector*

EN 148-1, *Respiratory protective devices - Threads for facepieces - Part 1: Standard thread connection*

EN 148-2, *Respiratory protective devices - Threads for facepieces - Part 2: Centre thread connection*

EN 148-3, *Respiratory protective devices - Threads for facepieces - Part 3: Thread connection M 45 x 3*

EN 12021, *Respiratory protective devices - Compressed air for breathing apparatus*

EN ISO 12209, *Gas cylinders - Outlet connections for gas cylinder valves for compressed breathable air (ISO 12209)*

ISO 263, *ISO inch screw threads — General plan and selection for screws, bolts and nuts — Diameter range 0,06 to 6 in*

3 Terms and definitions

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

3.1
self-contained, open-circuit Compressed air Underwater Breathing Apparatus
SCUBA
apparatus which has a portable supply of compressed air carried by the diver, allowing him to breathe under water and exhale into the ambient water

Note 1 to entry: The self-contained, open-circuit compressed air underwater breathing apparatus, when ready to use, consists of a number of compatible sub-assemblies each of which complies with the appropriate requirements of this standard. When connected together, the complete self-contained, open-circuit compressed air underwater breathing apparatus is designed to enable the wearer to breathe air on demand from a high pressure cylinder (or cylinders) via a demand regulator connected to a facepiece. The exhaled air passes, without recirculation, from the demand regulator via the exhalation valve to ambient water.

3.2
high pressure
pressure inside the cylinder(s) and between the cylinder(s) and any pressure reducer

3.3
medium pressure
pressure between the pressure reducer and the demand valve

3.4
rated working pressure
maximum working pressure of the respective components

3.5
reference pressure
equilibrium pressure which exists in the face piece when there is no respiratory flow at the end of exhalation

3.6
respiratory pressure
differential pressure in the face piece relative to the reference pressure measured during inhalation and exhalation

3.7
opening negative pressure (cracking pressure)
respiratory pressure during inhalation required to open the inhalation valve

3.8
displaced (tidal) volume
volume of breathing gas displaced by the breathing simulator during one half cycle (inhalation or exhalation) measured in litres

3.9
breathing frequency
setting of the breathing simulator measured in cycles per minute

3.10
Respiratory Minute Volume (RMV)
product of the tidal volume and breathing frequency measured in litres per minute

3.11
pressure volume diagram
diagram generated during one breathing cycle by plotting the respiratory pressure against the displaced volume

3.12
Work Of Breathing (WOB)
external work expended during one breath divided by the tidal volume of that breath, measured in Joule per litre, i.e. specific work

Note 1 to entry: This is equivalent to volume average respiratory pressure (kPa). This work of breathing is, in general, proportional to the area bounded by the pressure volume diagram. Work associated with positive pressures during inhalation does not count towards the total work of breathing.

3.13
facepiece
device that connects the apparatus to the wearer's respiratory tract and isolates the respiratory tract from the environment

Note 1 to entry: It may be a mouthpiece assembly, an oro-nasal half mask or a full face mask.

3.14
mouthpiece assembly
device usually held by the teeth, sealing against the lips and through which air is inhaled and exhaled

3.15
full face mask
facepiece covering mouth, nose, eyes and chin which may be fitted with either a mouthpiece or an inner mask

3.16
oro-nasal half mask
facepiece, covering mouth, nose and chin and retained by straps

3.17
dead space
volume of the cavity formed between the mouth and the inhalation and exhalation parts

3.18
package of air cylinder(s)
assembly of one or more air cylinders with cylinder valve(s) and a carrying frame (if applicable)

3.19
demand regulator
device which consists of a pressure reducer connected to a demand valve that is fitted to a facepiece

3.20
demand valve
that part of a demand regulator which reduces the medium pressure air to approximately ambient pressure

3.21
carrying system
carrying frame or holding device for air cylinder(s) with possibility to mount the harness (if applicable)

3.22
pressure reducer
that part of a demand regulator which reduces the high pressure air to medium pressure

3.23
auxiliary emergency breathing system
additional breathing system as part of the apparatus

Note 1 to entry: This can also be referred to as an octopus.

3.24
upstream demand valve
demand valve that will close and not let gas out with an increasing medium pressure

3.25
downstream demand valve
demand valve that will open and let gas out with an increasing medium pressure

3.26
dive/pre-dive control
switch on the demand regulator that in the pre-dive position prevents free-flow when not connected to the respiratory tract

3.27
hose assembly
hose with an interface connection at each end that are intended to be fitted to other interfaces

3.28
breathing hose
flexible hose that contains air at approximately ambient pressure

4 Minimum equipment

The apparatus consists of sub-assemblies. During use the sub-assemblies shall comprise at least:

a) cylinder(s) with cylinder valve(s);

b) demand regulator;

c) pressure indicator;

d) facepiece;

e) carrying system.

The apparatus shall also be delivered with information supplied by the manufacturer.

Any further sub-assembly which is integral to the apparatus shall comply with the relevant requirements of this European Standard.

The apparatus may also include the following sub-assemblies:

f) auxiliary breathing system;

g) lifting harness;

h) depth/time measuring device;

i) additional safety device(s);

j) voice communication system.

5 Requirements

5.1 Design

The apparatus and sub-assemblies shall be so designed that its components are located so that it is possible to perform the required pre-dive functional checks.

The combination of sub-assemblies shall not adversely affect the safe operation and use of the apparatus.

The apparatus and sub-assemblies shall not have any projecting parts or corners and edges which may injure the diver.

All parts, which have to be manually actuated during use, shall be accessible and controllable even when wearing protective gloves (three fingers, with 6 mm to 7 mm padding on either side). These parts shall be designed such that their setting cannot be altered inadvertently during use.

Check compliance by visual inspection (see 6.3) and test in accordance with 6.14.

5.2 Auxiliary emergency breathing system

If the manufacturer allows more than one diver to use the apparatus at the same time, to protect the diver, the requirements of Annex B shall apply.

All applicable requirements and tests of this standard shall be applied to each demand regulator when used and tested alone.

Test in accordance with Annex B.

5.3 Materials

Materials that may come into contact with the wearer's skin, mouth and/or the respirable gas shall not be known to be likely to cause irritation or any other adverse effects to health.

Check compliance by visual inspection (see 6.3) and test in accordance with 6.14.

The materials used shall have adequate mechanical strength and feature sufficient resistance to changes caused by the effect of temperature individually and in the assembled, ready-to-use apparatus.

Check compliance by visual inspection (see 6.3) and test in accordance with 6.5, 6.12 and 6.14.

5.4 Air cylinder(s)

The air cylinder(s) shall comply with the appropriate national or European specifications and shall be approved and tested with respect to the rated working pressure.

The air cylinder shall be marked with the appropriate neck thread designation according to EN 144-1 where the preferred threads are M 18 x 1,5 and M 25 x 2.

Cylinder(s) shall be designed for use at the maximum diving depth.

Check compliance by visual inspection (see 6.3).

5.5 Cylinder valves

Cylinder valves(s) shall comply with EN 144-1 and shall be tested and approved for use at the rated working pressure and gas.

NOTE When designing cylinder valves for use in apparatus covered by this standard, manufacturers can use information and guidance from other standards, e.g. EN ISO 10297.

Check compliance by visual inspection (see 6.3).

The threads shall be as specified in EN 144-1 where the preferred threads are M 18 × 1,5 and M 25 × 2.

Safe connection between the cylinder valve(s) and the demand regulator shall be ensured by applying EN ISO 12209.

The valve shall be so designed or so located that it cannot be closed inadvertently. This is met, e.g. by at least two turns from fully open to fully closed position.

Check compliance by visual inspection (see 6.3) and test in accordance with 6.14.

The function of the cylinder valve shall not be impaired by the ingress of water.

The cylinder valve shall be protected against the entrainment of dirt, solid particles and water from inside the cylinder. If provided, an additional filter shall have a surface area of at least 900 mm^2 and be reliably connected to the protective tube.

EXAMPLE By means of a protective tube with a length of at least 30 mm and an inside diameter of at least 2,5 mm.

Check compliance by visual inspection (see 6.3).

The pressure drop measured across the complete cylinder valve shall not exceed 10 bar. If there is more than one connection on the cylinder valve, the pressure drop shall be tested for each of these outlets.

Test in accordance with 6.9.

5.6 High pressure parts and connections

The rated working pressure of the sub-assemblies of high pressure tubes, valves and couplings shall be specified by the manufacturer. It shall not be possible to connect medium pressure hose assemblies to high pressure outlets.

Check compliance by visual inspection (see 6.3).

High pressure outlet(s), if threaded, shall have 7/16-20 UNF in accordance with ISO 263 (see Figure 1 and Figure 2).

Check compliance by visual inspection (see 6.3).

All metallic high pressure tubes, valves and couplings shall be capable of withstanding a pressure 50 % above the working pressure of the sub-assemblies specified by the manufacturer.

Non-metallic high pressure tubes, valves and couplings shall be capable of withstanding a pressure of twice the rated working pressure of the sub-assemblies specified by the manufacturer.

There shall be no leakage or burst.

Check compliance by visual inspection (see 6.3) and test in accordance with 6.4.

Dimensions in millimetres

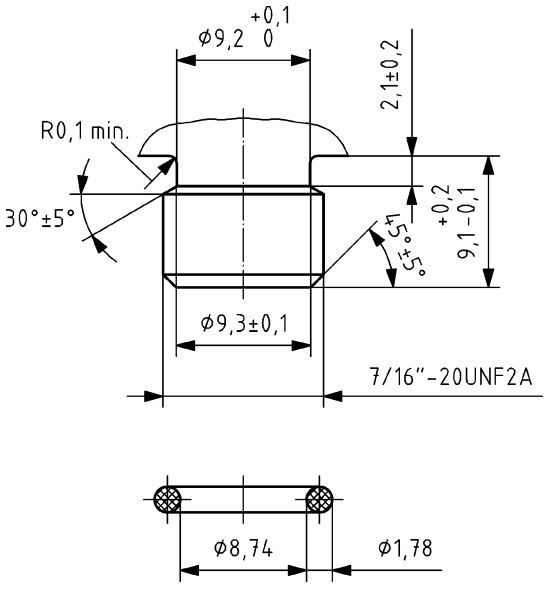


Figure 1 — High-pressure male fitting, 7/16-20 thread, fitted with O-ring

Dimensions in millimetres

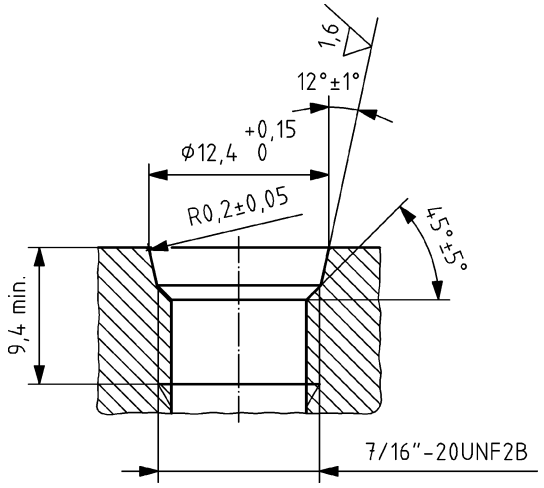


Figure 2 — High pressure female fitting, 7/16-20 thread

5.7 Demand regulator performance

5.7.1 General

The demand regulator shall be provided with a pressure relief system.

The demand regulator performance at 6 bar absolute pressure and in water at 10 °C shall meet the following requirements in the upright position:

a) the work of breathing for demand regulators without sensitivity adjustment shall not exceed 2,5 J/l;

b) the work of breathing for demand regulators with sensitivity adjustment shall not exceed 2,5 J/l at the maximum sensitivity and 3,0 J/l at the minimum sensitivity;

c) the peak respiratory pressure during inhalation and exhalation shall be within the range of ± 25 mbar;

d) the positive work of breathing during inhalation shall not exceed 0,3 J/l;

e) pressure spikes (during inhalation) with no measurable positive work of breathing shall not exceed 10 mbar;

f) pressure peaks (during inhalation) with measurable positive work of breathing shall not exceed 5 mbar.

Except for a temporary free-flow of 10 s maximum, the regulator shall not free-flow with the sensing diaphragm in the position tested.

Demand regulators which incorporate adjustable sensitivity controls shall be tested with the settings both at minimum and maximum.

It may also have a separate dive/pre-dive control. If fitted, this control shall be a two-position switch. If this is a rotational control the rotation shall not be greater than 180°. The pre-dive setting shall be clearly defined and shall be marked accordingly. Demand regulators which incorporate a dive/pre-dive control shall be tested with the control set to dive position.

Test in accordance with 6.7.

5.7.2 Cold water

If a demand regulator is intended to be used at water temperatures below 10 °C, its performance at 6 bar absolute pressure and in water at 4 °C, and at a lower temperature if specified by the manufacturer, shall meet the requirements of 5.7.1 in the upright position.

If a demand regulator is intended to be used at water temperatures below 10 °C, its performance at 6 bar absolute pressure and in water at 4 °C, and at a lower temperature if specified by the manufacturer, shall meet additionally the requirements of 5.7.1 a), b) and c) in the swimming position at the maximum sensitivity control setting.

Test in accordance with 6.7.2.

5.7.3 Pressure reducer

On the pressure reducer of the demand regulator any adjustable medium pressure setting shall be reliably secured against accidental alteration.

Check compliance by visual inspection (see 6.3).

All pressure reducers (first stages) shall meet the requirements of Annex B.

5.7.4 Pressure relief system

5.7.4.1 Upstream demand valve

A demand regulator with an upstream demand valve shall have a means of relieving an increasing medium pressure and shall be manufactured so that the inhalation respiratory pressure shall not exceed −25 mbar and the exhalation respiratory pressure shall not exceed 25 mbar when a flow of 400 l/min passes through the relief valve at a medium pressure not exceeding 30 bar.

Test in accordance with 6.6.1.

5.7.4.2 Downstream demand valve

A demand regulator with a downstream demand valve shall be manufactured so that the inhalation respiratory pressure shall not exceed −25 mbar and exhalation respiratory pressure shall not exceed 40 mbar when a continuous flow of 400 l/min through the demand valve is recorded.

Test in accordance with 6.6.2.

5.7.5 Demand valve

The demand valve shall be constructed such that air bubbles emerging would not impede the diver's vision in the swimming position.

The demand valve shall be such that it can easily be cleaned, assembled and tested for its function.

The demand valve shall incorporate a device to expel water.

Test in accordance with 6.14.

5.7.6 Exhalation valve

The design and configuration of the exhalation valve shall prevent the ingress of water in all positions.

The operation of the exhalation valve shall not be impaired by high flow through the valve.

Test in accordance with 6.8 a).

The operation of the exhalation valve shall not be impaired by negative pressures up to 80 mbar.

Test in accordance with 6.8 b).

The leakage of the exhalation valve (when in the wetted condition) shall not exceed 0,25 ml/min at standard temperature and pressure when tested with a negative pressure of 7 mbar (equivalent to 0,5 mbar with a proof volume of 500 ml during 1 min).

Test in accordance with 6.8 c).

5.8 Hose assemblies

5.8.1 Tensile strength of high and medium pressure hose assemblies that may be subjected to external tensile force

The unpressurised hose assembly shall withstand a tensile force of 1 000 N.

There shall be no separation of parts.

Test in accordance with 6.5.2.

5.8.2 Flexibility of high and medium pressure hoses

The unpressurised hose shall be capable of being bent around a cylinder with a diameter of (65 ± 2,5) mm.

There shall be no permanent deformation.

Test in accordance with 6.5.3.

5.8.3 Leakage of high pressure hose assembly

Any high pressure hose assembly shall withstand the rated working pressure.

There shall be no leakage.

Test in accordance with 6.5.4.

5.8.4 Leakage of medium pressure hose assembly

Any medium pressure hose assembly shall withstand twice the operating pressure of a safety valve or at least 30 bar, whichever is the higher.

There shall be no leakage.

Test in accordance with 6.5.5.

5.8.5 Burst pressure of high pressure hose assembly

Any high pressure hose assembly shall withstand a pressure of four times the rated working pressure.

There shall be no leakage or burst.

Test in accordance with 6.5.6.

5.8.6 Burst pressure of medium pressure hose assembly

Any medium pressure hose assembly shall withstand four times the rated working pressure or at least 100 bar, whichever is the higher.

There shall be no burst.

Test in accordance with 6.5.7.

5.8.7 Kinking of medium pressure hoses

Any hose assembly used in the apparatus shall be resistant to kinking.

When tested, the hose assembly shall maintain a uniform near-circular loop and spiral from this loop. It shall not deform during the test to an extent that decreases the flow of air through it by more than 10 %, when compared with that measured when the hose assembly is straight and unstressed.

Test in accordance with 6.5.8.

NOTE Hose assemblies with swivel and shorter than 1,5 m are deemed not to kink in the foreseen conditions of use.

5.8.8 Breathing hose

Any breathing hose shall be flexible and non-kinking. The breathing hose shall permit free head movement and shall not restrict or close off the gas supply during practical performance tests.

Test in accordance with 6.14.

The connections at the ends of the breathing hose shall withstand an axial tensile force of 250 N.

There shall be no separation or permanent deformation of the parts.

Test in accordance with 6.5.9.

5.8.9 Length and arrangement of medium pressure hose assembly

The length and the arrangement of the medium pressure hose assembly shall neither impede the fit of the facepiece nor hinder the diver.

Test in accordance with 6.14.

5.9 Safety devices

5.9.1 General

The apparatus shall be equipped with at least one pressure indicator (see 5.9.2) which displays the high pressure.

Optional additional safety devices include:

a) reserve device,

b) other active warning device.

If more than one safety device is used, they shall be compatible to each other.

The optional safety device shall clearly indicate that the remaining cylinder pressure after the activation is at least 50 bar. In the case of multi-cylinder equipment this pressure shall exist in all cylinders.

All safety devices that give a visual indication to the diver shall be capable of being read by a person with normal (or appropriately corrected) visual acuity at all pressures and temperature conditions and under the visibility conditions specified in the information supplied by the manufacturer. Safety devices shall provide an appropriate indication for colour blind people.

Check compliance by visual inspection (see 6.3).

The safety device shall be effective at a cylinder pressure above 50 bar.

Test in accordance with 6.11 and 6.14.

5.9.2 Pressure indicator

Each independent air supply cylinder shall be fitted with a pressure indicating system. The apparatus shall be designed and fitted so as to enable the diver to receive the information without difficulty during all phases of the dive.

Pre-dive, any pressure indicator shall be able to be activated either manually or automatically.

Any flexible hose(s) connecting the pressure indicator(s) shall be sufficiently strong so as to provide protection against damage by external mechanical influences occurring during use. If the flexible hose connection has a cover, which is not permeable to air, the space enclosed by this cover shall be vented.

Any pressure indicator shall be automatically activated and remain active during dive. If a flexible link is required for this purpose it shall be protected against damage by external mechanical influences occurring during use. If the connection has a cover which is not permeable to air, the space enclosed by this cover shall be vented to the ambient atmosphere.

Check compliance by visual inspection (see 6.3).

The pressure indicator hose connector at the pressure supply point, or if no hose fitted the pressure indicator connector, shall, with an upstream pressure of 100 bar and no indicator fitted, have a flow rate ≤ 100 l/min of gas measured at STP.

Test in accordance with 6.11.1.1.

The display range of a pressure indicator shall extend from zero to a value of at least 20 % in excess of the rated working pressure of the air cylinder.

Scale divisions or increments shall not exceed 10 bar. The range below 50 bar shall be clearly differentiated to emphasize low air supply. The accuracy of any indicator tested at the following fixed decreasing pressures shall be:

a) ± 15 bar at 300 bar;

b) ± 10 bar at 200 bar;

c) ± 10 bar at 100 bar;

d) ± 5 bar at 50 bar.

Check compliance by visual inspection (see 6.3).

Any pressure indicator shall be waterproof to at least 11 bar absolute pressure.

Test in accordance with 6.11.1.3.

Any transparent window(s) shall be splinter-proof. A pressure indicator (if mechanical) shall feature a pressure relief facility that in the event of a high pressure air leak protects the diver against injury.

The pressure relief facility of a mechanical pressure indicator shall relieve safely at a pressure not higher than 50 % of the burst pressure of the case. The safety device shall also relieve a minimum flow rate of 300 l/min.

Check compliance by visual inspection (see 6.3) and test in accordance with 6.11.1.2 and 6.14.

5.9.3 Reserve valve (if fitted)

A reserve valve shall

— cause an increase in inhalation resistance when the cylinder pressure falls to a pre-set level, and

— cancel this effect totally through a release control.

The reserve valve shall be able to be switched on prior to the dive, either manually or automatically into the standby position.

The reserve valve shall not lead to a sudden increase in inhalation respiratory pressure.

It shall be possible to check the status of the reserve valve at all times.

The release control shall not allow unintentional or accidental operation and actuation shall be completed in one operation.

Check compliance by visual inspection (see 6.3) and test in accordance with 6.11.2 and 6.14.

In the case of an automatic reserve valve it shall be ensured that

— during charging it automatically resets at a cylinder pressure of not more than 150 bar, and

— it remains open after actuation below a cylinder pressure of 80 bar.

Check compliance by visual inspection (see 6.3) and test in accordance 6.14.

5.9.4 Other active warning devices

Other active warning devices shall be automatic in operation. The warning characteristics of the active warning device shall be specified by the manufacturer and shall be effective.

If applicable, any loss of air caused by operation of any other active warning device shall not be greater than 5 l/min STP.

Check compliance by visual inspection (see 6.3) and test in accordance with 6.11.3 and 6.14.

5.10 Facepiece

5.10.1General

The facepiece shall be a mouthpiece assembly, an oro-nasal half mask or a full face mask.

5.10.2Inspired carbon dioxide

If the internal dead space of the facepiece and demand valve assembly is greater than 200 ml it shall be tested for inspired carbon dioxide level.

The volume-weighted average inspired partial pressure of carbon dioxide shall not exceed 20 mbar at an RMV of 10 l min^{-1}.

The volume-weighted average inspired partial pressure of carbon dioxide shall not exceed 10 mbar at an RMV of 62,5 l min^{-1}.

Test in accordance with 6.10.2.1.

5.10.3Mouthpiece assembly

The mouthpiece shall be constructed such that it does not degrade the perceived performance of the regulator when worn during practical performance. Particular attention shall be given to the wearer's mouth action on the assembly.

Test in accordance with 6.14.

When pulled, the mouthpiece shall neither be detached nor alter its shape and/or position permanently.

Test in accordance with 6.10.1.

It shall be possible to breathe from the demand regulator without the mouthpiece if detachable.

Test in accordance with 6.14.

5.10.4Head harness

The head harness shall be designed so that the facepiece can be donned and doffed easily. Once fitted, it shall be easily adjustable by the wearer or self-adjusting and shall hold the facepiece mask firmly and comfortably in position.

Each strap of the head harness shall withstand a pull of 150 N.

Buckles and attachment lugs (if present) shall withstand the same pull.

The permanent linear deformation of each strap shall not be greater than 5 %.

Test in accordance with 6.10.3 and 6.14.

5.10.5Full face mask or oro-nasal half mask

5.10.5.1 General

All requirements for the full face mask and the oro-nasal half mask are the same except those related to the visor which is not present on a diving oro-nasal half mask.

An inner mask may be used to separate the nose and mouth from the eye (visor) area(s) of the full face mask.

The connection between the full face mask or diving oro-nasal half mask and the apparatus may be achieved by a permanent or special type of connection. If a thread connection is used then it shall not be possible to interchange with threads specified in EN 148-1, EN 148-2 and EN 148-3.

The connection between the faceblank and the demand valve connector shall be sufficiently robust to withstand axially a tensile force of 300 N.

Test in accordance with 6.10.2.2.

All demountable connections shall be readily connected and secured, where possible by hand. Any means of sealing used shall be retained in position when the connection is disconnected during normal maintenance.

Check compliance by visual inspection (see 6.3) and test in accordance with 6.14.

5.10.5.2 Visor(s)

Visors shall be attachable in a reliable and tight manner to the faceblank of a full face mask and shall have adequate mechanical strength as demonstrated by the impact test (mechanical resistance). The leak of the full face mask shall not exceed a change in pressure of 1 mbar in 1 min.

They shall not distort vision as determined in practical performance test.

Test in accordance with 6.10.2.4 and 6.14.

A full face mask shall be designed so that the effective field of vision shall be not less than 40 %, related to the natural field of vision. The overlapped field of vision related to the natural overlapped field of vision shall be not less than 50 %, when equipped with a single visor and 20 %, when equipped with two visors.

Test in accordance with 6.10.2.3.

The manufacturer shall provide means to reduce misting of the eyepiece. It shall be ensured that vision is not impaired while diving.

Test in accordance with 6.14.

Where anti-fogging compounds are used as intended or specified by the manufacturer they shall be compatible to eyes, skin and the components of the facepiece.

Check compliance by visual inspection (see 6.3) and test in accordance with 6.14.

5.11 Body harness

The air cylinder(s) shall be attached to a body harness which may consist for example of a carrying frame and/or carrying straps to attach it to the body of the diver. The harness shall not have a single action buckle which releases the entire body harness from the diver’s body when activated.

The body harness shall be so designed that the apparatus remains securely in position. It shall not be possible for the apparatus and parts of it to become accidentally detached from the diver. The body harness shall not impair the diver's freedom of movement any more than is absolutely necessary.

It shall be possible to secure loosely suspended parts, e.g. demand regulator, pressure gauge and straps in position on the apparatus.

The body harness including straps shall be so designed that the diver can don and doff the apparatus during use without interrupting breathing.

The fit of the harness shall be maintained during the use of the apparatus. If adjustment to the harness is possible, for example by adjusting the length of straps, then it should be possible for this to be achieved easily and at any time.

Check compliance by visual inspection (see 6.3) and test in accordance with 6.14.

5.12 Resistance to temperature

5.12.1Storage

Trouble free operation shall be ensured after storage at temperatures of +70 °C and −30 °C.

Test in accordance with 6.12.1 and 6.12.2.

5.12.2Performance

The apparatus and/or sub-assemblies shall be designed such that no leak or free-flow shall be observed or detected when tested at a temperature of 55 °C.

Test in accordance with 6.12.3.

The apparatus and/or sub-assemblies designed for use in water temperatures below 10 °C shall not permanently leak and shall not free-flow when tested at a temperature of −20 °C.

Test in accordance with 6.12.4.

5.12.3Cold water performance

An apparatus and/or sub-assemblies designed for use in water temperatures below 10 °C shall also comply with all relevant requirements at a water temperature of 4 °C or at a lower temperature if specified by the manufacturer.

Test in accordance with 6.7.2.

5.13 Cleaning and disinfection

All parts that on the recommendation of the manufacturer have to be cleaned and/or disinfected shall be easy to clean and be insensitive to the cleaning agents and disinfectants recommended by the manufacturer.

Check compliance by visual inspection (see 6.3).

5.14 Seawater resistance

The apparatus shall be seawater resistant and shall remain functional after testing in accordance with 6.13.

Check compliance by visual inspection (see 6.3).

5.15 Practical performance

In addition to the unmanned tests described in Clause 6, the apparatus shall also undergo practical performance tests. These practical performance tests are to check the ergonomics of the apparatus, its compatibility with other PPE, ease of use and the application of the information supplied by the manufacturer.

Where, in the opinion of the testing authority, approval is not granted because practical performance tests show the apparatus has imperfections related to wearer's acceptance, the testing authority shall describe the tests that revealed these imperfections.

Test in accordance with 6.14.

6 Testing

6.1 General

The apparatus shall only be approved when the apparatus or all apparatus sub-assemblies satisfy the requirements of the tests specified in this European Standard, and practical performance tests have been carried out successfully on the complete apparatus where specified in the standard.

6.2 Procedure

6.2.1 General

When required to test components or sub-assemblies of the apparatus separately, complimentary components that comply with the relevant standards shall be used. See Clause 4.

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

Prior to conducting any other test the following tests shall be performed in the order below:

— temperature resistance (6.12);

— seawater resistance (6.13);

— one cycle of cleaning and disinfection in accordance with the manufacturer's instruction for use.

6.2.2 Nominal values and tolerances

Unless otherwise specified, the values shall be subjected to a limit deviation of ± 5 %. Unless otherwise specified, the room temperature for testing shall be (24 ± 8) °C and at a relative humidity of at least 50 %. The temperature limits with no specified tolerance shall be subject to a limit deviation of ± 3 °C.

6.2.3 Breathable air

Unless otherwise specified, testing shall be carried out with compressed air which complies with EN 12021.

6.2.4 Test equipment and calibration test procedures

The performance characteristics of the breathing simulator test equipment shall be verified by the use of a calibration test orifice shown in Figure 3. This calibration test orifice shall be inserted into the test equipment in place of the breathing system and the breathing simulator test equipment shall be tested with air at 62,5 l min^{-1} (25 cycles/min, 2,5 l tidal volume) at 6,0 bar absolute. The recorded WOB shall be 3,3 J $l^{-1,}$ the recorded inhalation pressure shall be −25 mbar and the recorded exhalation pressure shall be + 25 mbar using air.

The performance of the volume weighted average carbon dioxide test equipment shall be defined by the use of a calibration tube. The calibration tube shall be attached to the ‘mouth’ of the breathing simulator, have an internal diameter of (30,0 ± 0,2) mm and a length of (150 ± 1) mm. It shall be tested at ambient pressure with air and the breathing simulator at 62,5 l min^{-1} (25 cycles/min, 2,5 l tidal volume) with a carbon dioxide injection of 2,5 l min^{-1} STP. A 0,2 m s^{-1} forced ventilation shall be provided across the open end of the tube to remove the exhaled carbon dioxide. The value for the volume weighted inspired carbon dioxide shall be in the range of 2,1 mbar and 4,4 mbar.

For the measurement of the inspired carbon dioxide, see 6.10.2.1.

The test and measurement equipment shall be appropriate for the pressures and frequencies occurring during tests.

The measuring equipment for respiratory pressure variations in the system shall be able to measure at frequencies up to 50 Hz with less than 3 dB damping.

Dimensions in millimetres

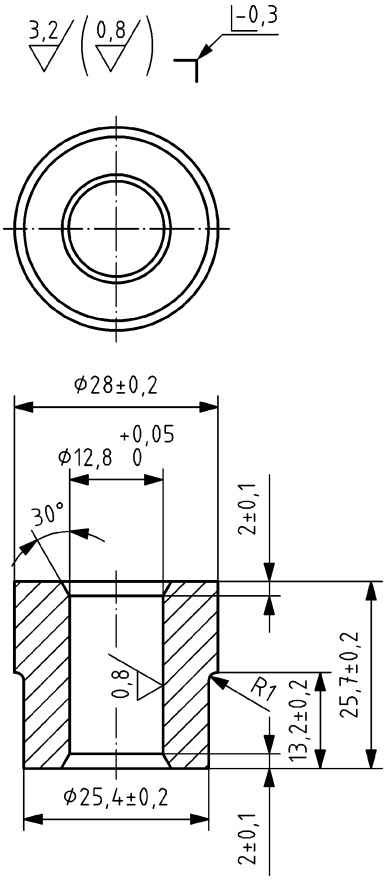


Figure 3 — Calibration test orifice

6.3 Visual inspection

Visual inspection shall be conducted at normal visual acuity by the responsible expert(s) to test the apparatus.

The visual inspection shall include the assessment of the device marking, information supplied by the manufacturer, any safety data sheets related to materials (if applicable), and relevant declarations applicable to its construction.

6.4 High and medium pressure parts and connections

The high and medium pressure parts and connections shall be subjected internally to the required hydrostatic pressure for a period of at least 20 s.

6.5 Hose assemblies

6.5.1 General

Any high and medium pressure hose assemblies of the apparatus shall be subjected to the following tests.

6.5.2 Tensile strength of high and medium pressure hose assemblies that may be subjected to external tensile force

Attach the end fittings to appropriate anchorage points and apply the tensile load of 1 000 N to the hose assembly for a test period of 10 s to 15 s.

6.5.3 Flexibility of high and medium pressure hoses

Bend the hose through an angle of 180° for 8 h around a cylinder with a diameter of (65 ± 2,5) mm.

6.5.4 Leakage of high pressure hose assembly

Submerge the high pressure hose assembly in water and apply the rated working pressure for at least 5 min with compressed air as test medium.

6.5.5 Leakage of medium pressure hose assembly

Submerge the medium pressure hose assembly in freshwater and apply twice the operating pressure of a safety valve or at least 30 bar, whichever is the greater, for at least 5 min with the compressed air as test medium.

6.5.6 Burst pressure of high pressure hose assembly

Apply four times the rated working pressure for at least 20 s with water as test medium.

6.5.7 Burst pressure of medium pressure hose assembly

Apply four times the rated working pressure or at least 100 bar, whichever is greater, for at least 20 s with water as test medium.

6.5.8 Kinking of medium pressure hoses

Test in accordance with EN 14593-1:2005, 6.11.

6.5.9 Tensile load of breathing hose connections

Apply a tensile load of 250 N for 10 s to the hose assembly by attaching the end fittings into appropriate anchorage points.

6.6 Pressure relief system

6.6.1 Upstream demand valve

With the breathing machine not operating, a suitable flow measuring device is connected to the outlet of the relief valve and air is supplied to the medium pressure side of the reducer. The air supply pressure is gradually increased. While under these conditions, the breathing machine is brought into operation and the respiratory pressure is measured.

6.6.2 Downstream demand valve

If a demand regulator incorporates adjustable sensitivity controls then the demand valve shall be tested at both the maximum and minimum performance positions. Demand valves which incorporate a dive/pre-dive control shall be tested with the control set to dive position. Air is supplied to the medium pressure side of the reducer and the air supply pressure is gradually increased; the medium pressure required to create a continuous flow of 400 l/min through the demand valve. Under these conditions, a breathing simulator test is conducted on the complete apparatus including the facepiece and the respiratory pressure is measured at the appropriate pressure sample point.

6.7 Demand regulator

6.7.1 General

The dynamic performance of the apparatus shall be determined from the pressure-volume diagram, generated by plotting the respiratory pressure against the displaced volume. It shall be measured at a pressure of 6 bar absolute using a breathing simulator set to provide a sinusoidal minute volume of 62,5 l/min (25 cycles/min, 2,5 l/stroke). The variation in frequency and amplitude shall not deviate from the set value by more than ± 3 %. The test duration shall be such as to obtain steady-state performance.

Throughout these tests, with the exception of the test relating to low temperature, the demand regulator shall be immersed in water at a temperature of $10^{\ 0}_{-1}$ °C and the demand valve shall be rigged as though the diver's head is in the upright position to a depth of at least 0,2 m to preclude surface effects.

Testing shall be carried out with the apparatus supplied with high pressure air at the rated working pressure of the regulator as specified by the manufacturer and repeated at 50 bar.

This test shall be performed in water, at 1 bar pressure by checking while breathing at 62,5 l/min (25 cycles/min, 2,5 l/stroke) for 5 min. The test shall be conducted with a $14^{+1}_{\ 0}$ l cylinder and shall commence at the rated working pressure of the regulator.

Where the demand regulator is tested separately it shall be supplied by a device (which may be a cylinder valve) which causes a pressure drop of 9 bar to 10 bar when tested in accordance with 6.9.

6.7.2 Cold water performance

Apparatus and sub-assemblies intended for use in water temperatures below 10 °C shall be immersed and tested as ready-for-use apparatus in fresh water at a water temperature of $4^{\ 0}_{-2}$ °C at a depth of at least 0,2 m for 5 min at 6 bar absolute pressure. The demand valve shall be rigged as though the diver's head were in both the upright and the horizontal face down (swimming) position respectively.

The air exhaled by the breathing simulator shall be heated and humidified. The air temperature shall be (28 ± 2) °C and the relative humidity greater than 90 % throughout the test when measured at the interface with the demand valve.

The cylinder(s) used for the test of the demand regulator shall have an internal volume of $14^{+1}_{\ 0}$ l. They shall be charged to the maximum rated working pressure of the regulator.

If the rated working pressure of the regulator is less than 200 bar, the cylinder(s) when charged to the rated working pressure of the pressure reducer shall contain sufficient air to complete the test and shall not be discharged to less than 50 bar.

The complete self-contained apparatus with any external gas supply isolated shall be immersed in the cold water for a period of 10 min prior to starting the test. The complete self-contained apparatus shall stay immersed during the test.

6.8 Exhalation valve

The following tests shall be carried out in the following sequence:

a) The exhalation valve shall be subjected to a constant flow of 300 l/min for a period of 1 min.

b) The test shall be carried out using a demand valve with wetted exhalation valve and with the medium pressure supply port blanked: A static negative pressure of 80 mbar is applied at the demand valve without the facepiece for a period of 10 s.

c) The exalation valve shall then be tested to verify the leakage at a negative pressure of 7 mbar.

6.9 Cylinder valve

The cylinder with its valve and demand regulator is connected to a breathing machine. The breathing machine is adjusted to 62,5 l/min (25 cycles/min, 2,5 l/stroke). The test shall be performed at 6 bar absolute and the pressure measured at the cylinder valve outlet or an unrestricted high pressure port, while the cylinder pressure is maintained at 50 bar. Cylinder valves fitted with reserve valves shall be tested with the reserve valve in the fully open position.

6.10 Facepiece

6.10.1Mouthpiece

Attachment to the demand valve shall be tested by pulling the mouthpiece with an axial force of 80 N for 10 s.

6.10.2Full face mask or oro-nasal half mask

6.10.2.1 Carbon dioxide content of the inhalation air

The CO_2 content of the inhalation air of the apparatus (facepiece and demand regulator fed with constant supply pressure of 50 bar) shall be measured at a pressure of 1,0 bar and 6,0 bar absolute using a breathing simulator set to a ventilation rate of 10 l/min (10 cycles/min and 1 l tidal volume) and 62,5 l/min (25 cycles/min, 2,5 l/stroke) at each test pressure with the equipment fitted on a dummy head and immersed in water at a temperature of 10 °C.

The demand regulator shall be rigged as though it were carried by the diver's head in the upright position.

Measure the inspired carbon dioxide at the mouth with an analyser having a response time of less than 150 ms to 95 % of the step change. The breathing simulator shall be set to provide an end tidal CO_2 level of (50 ± 2) mbar.

Demand regulators which incorporate adjustable sensitivity controls shall be tested with the settings at minimum. Demand regulators which incorporate a dive/pre-dive control shall be tested with the control set to dive position.

The monitored carbon dioxide level shall then be integrated with respect to the volume of gas inspired rather than the time of inspiration. Determine the volume weighted average inspired carbon dioxide.

6.10.2.2 Mechanical strength of the facepiece connector

Support the facepiece on a dummy head which can be adjusted so that the force can be applied axially to the connection. Additionally, fit a system of restraining straps or bands over the faceblank around the connection so that the force is applied as directly as possible to the fitting of the connection in the faceblank and the restraining force is not applied wholly to the head harness (see Figure 4).

Apply the force in accordance with Figure 4 for a period of 10 s.

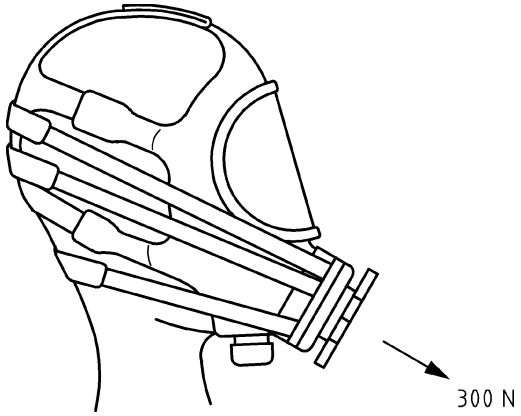


Figure 4 — Test arrangement for tensile force

6.10.2.3 Field of vision

Measure the field of vision using a Stoll apertometer (see Figure 5). A diagram as shown in Figure 6 shall be used for the evaluation:

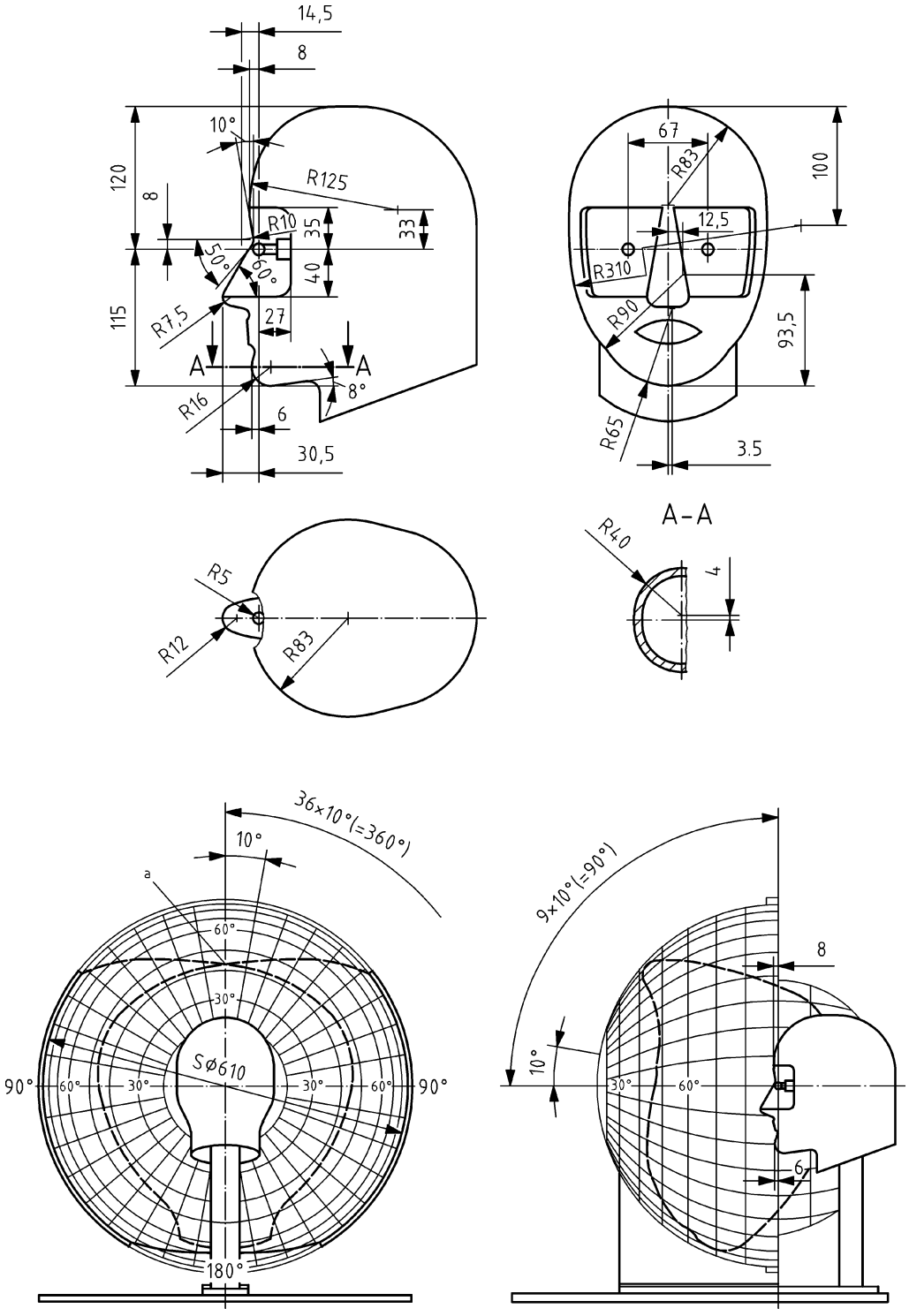
a) fit the full face mask to the dummy head and with both eyes lit, adjust the facepiece until the outline of the visor is symmetrical on the hemi-spherical shell and the field of vision is a maximum. Adjust the tensions of the straps to obtain a reasonable secure fit;

b) map the positions of the field of vision of each eye individually on to the printed diagram, using the grid lines as a guide;

c) measure the areas of the total field of vision and the overlapped field of vision with a planimeter. The field of vision is the innermost line at any point of either the field of vision of the full face mask or the natural field of vision according to Stoll as shown on the printed diagram (see Figure 6).

Express the results as a percentage of the area of the natural field of vision in accordance with Figure 6.

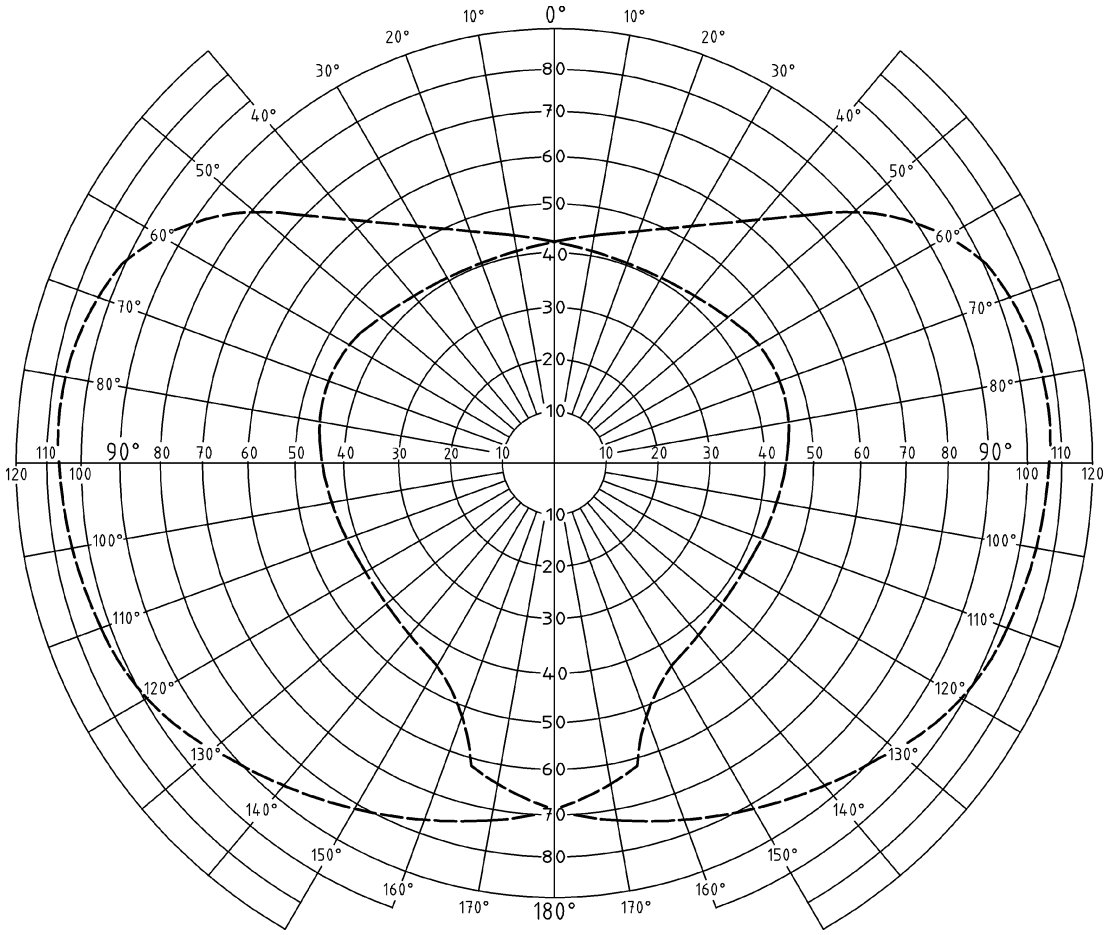
Dimensions in millimetres



Key

A transfer the natural field of vision with the natural overlapped field of visions to the diagram

Figure 5 — Stoll Apertometer



Key

..... natural field of vision with natural overlapped field of vision

The areas enclosed by circular lines of the diagram are proportional to the corresponding areas marked on the spherical shell of the apertometer.

Semi-circular surface represented inside of the 90° circle	= 126,9 cm^2
Natural field of vision inside of the 90° circle (78,8 %)	= 100,0 cm^2
Natural field of vision outside of the 90° circle	= 12,0 cm^2
Natural field of vision totally	= 112,0 cm^2 = 100 %
Natural overlapped field of vision	= 39,0 cm^2 = 100 %

Shape of lenses: _____ Facepiece model: _____

(Dimensions) _____ _____

Where measurements of the field of vision are taken, the effective field of vision as observed by the apertometer shall be transferred to the diagram. Only the effective field of vision within the natural field of vision respectively the effective overlapped field of vision shall be planimetered and noted in cm^2.

Planimetered area of effective field of vision (totally)	..... cm^2
Planimetered area of effective overlapped field of vision	..... cm^2
Effective field of vision (totally)	..... %
Effective overlapped field of vision	..... %

Figure 6 — Apertometer diagram (not to scale)

6.10.2.4 Impact resistance of the visor(s)

For tightness, the full face mask shall be fitted to a dummy head.

A pressure of −10 mbar is created in the cavity of the full face mask. After 1 min the pressure is measured.

When this test is carried out the inhalation valves shall be sealed and the disk of the exhalation valve shall be wetted. It can be also necessary to seal the area of contact of the mask with the face.

Impact resistance shall be tested using a completely assembled full face mask mounted on a dummy head such that a steel ball (22 mm diameter, 43,8 g approximately) falls normally from a height of 130 cm on the centre of the lens. Once the visor has been impacted, the inhalation valves shall be sealed and the disk of the exhalation valve shall be wetted. It can be also necessary to seal the area of contact of the mask with the face. Then a pressure of –10 mbar is created in the cavity of the full face mask. After 1 min the pressure is measured.

Five visors shall be tested.

6.10.3Head harness

Test three samples; all in the state as received.

The force shall be applied to the free end of the straps.

Each strap of the head harness shall withstand a pull of 150 N applied for 10 s in the direction of pulling when the facepiece is donned.

Apply a force of 30 N for 10 s to the free end of the straps and measure the permanent deformation 4 h after the pull test.

6.11 Safety devices

6.11.1Pressure indicator

6.11.1.1 Pressure indicator connector

Connect a 100 bar gas supply to the inlet of the connector. Connect a suitable flow device to the outlet of the connector.

Check the flow.

6.11.1.2 Pressure relief facility

A pressure flow test shall be carried out to demonstrate that when the case is subjected to the opening pressure of the pressure relief facility feature there is no damage.

The manufacturer shall provide documented evidence that the window material does not splinter when broken.

Any mechanical pressure indicator shall be subjected to an internal hydraulic test pressure to determine the burst pressure of the case.

6.11.1.3 Water leak test

The pressure indicator shall be immersed in water and pressurized at a rate of 3 bar/min. After 15 min no ingress of water shall be observed.

6.11.2Reserve valve

If fitted, the operating characteristics of the reserve valve shall be measured at ambient pressure of 1,0 bar using a breathing simulator set to provide ventilations of 20 l/min (20 cycles/min and 1 l tidal volume) and at 6,0 bar absolute 62,5 l/min (25 cycles/min and 2,5 l/stroke).

First warning is defined as when the inhalation pressure raises 5 mbar over the average maximum inhalation pressure.

During the test of the apparatus, the reserve valve shall allow at least three breaths between 5 mbar over the average maximum inhalation pressure and 60 mbar when tested with an air cylinder of 10 l water capacity.

During a practical performance test, the pressure increase shall be clearly noticed by the test subject and the diver shall be able to breathe at least 5 breaths.

After actuation of the release control, the breathing resistance (respiratory pressure during inhalation and exhalation) shall not exceed the limits specified in 5.7.

After actuation, the safety device shall not reduce the air supply available to the diver.

The reserve valve shall perform as described above when the cylinder pressure has fallen to not below 50 bar.

6.11.3Other active warning device

If fitted, the operating characteristics of the active warning device shall be measured at ambient pressures of 1,0 bar and 6,0 bar absolute using a breathing simulator set to provide ventilations of 15 l/min (15 cycles/min and 1 l tidal volume) and 62,5 l/min (25 cycles/min and 2,5 l/stroke) at each test pressure.

6.12 Resistance to specific temperatures

6.12.1Testing after storage at +70 °C

The apparatus and/or sub-assemblies shall be tested as ready-for-use apparatus pressurized to 50 % of the rated working pressure and shall be placed in an environmental test chamber at standard laboratory conditions. The chamber temperature shall be raised to 70 °C with a relative humidity of 80 % to 95 % and shall be maintained at this temperature and humidity for not less than 3 h.

On completion of the above procedure the equipment temperature shall be allowed to return to standard laboratory conditions. The equipment shall then be immersed to a depth of 0,2 m and tested at a pressure of 1,0 bar using a breathing simulator set to a ventilation rate of 62,5 l/min (25 cycles/min, 2,5 l/stroke) for a period of not less than 5 min during which time the performance shall remain within the limits specified in 5.7.

6.12.2Testing after storage at −30 °C

The apparatus and/or sub-assemblies shall be tested as ready-for-use apparatus pressurized to 50 % of the rated working pressure and shall be placed in an environmental test chamber at standard laboratory conditions. The chamber temperature shall be lowered to −30 °C and shall be maintained at this temperature for not less than 3 h.

On completion of the above procedure the equipment temperature shall be allowed to return to standard laboratory conditions. The equipment shall then be immersed to a depth of 0,2 m and tested at a pressure of 1,0 bar at a ventilation rate of 62,5 l/min (25 cycles/min, 2,5 l/stroke) for a period of not less than 5 min during which time the performance shall remain within the limits specified in 5.7.

6.12.3Testing at +55 °C

The apparatus and/or sub-assemblies shall be tested as ready-for-use apparatus with cylinder valve in the closed position and pressurized to 50 % of the rated working pressure and shall be placed in an environmental test chamber and heated to 55 °C for a period not less than 3 h.

The cylinder valve shall then be opened while the equipment is still at a temperature of 55 °C.

6.12.4Testing at −20 °C

The apparatus and/or sub-assemblies shall be tested as ready-for-use apparatus with cylinder valve in the closed position and pressurized to 50 % of the rated working pressure and shall be placed in an environmental test chamber and cooled to −20 °C for a period not less than 3 h.

The cylinder valve shall then be opened while the equipment is still at a temperature of −20 °C.

If a leak is detected, immerse the equipment immediately in water with maximum temperature of $4^{\ 0}_{-2}$ °C for 2 min. The equipment should no longer leak on completion of this 2 min submersion.

6.13 Seawater resistance

The complete apparatus with the gas supply in the “turned off” position shall be submerged for 8 h ± 5 min in natural seawater or artificial seawater (see Annex C) of between 15 °C and 25 °C. Without cleaning in fresh water the apparatus shall stay in air for 16 h ± 30 min at 15 °C to 25 °C and a relative humidity of not more than 75 %.

Apply four complete cycles.

6.14 Practical performance

6.14.1General

For reasons of safety, practical performance tests shall be carried out only after all laboratory tests have been satisfactorily completed.

The practical performance test shall assess the apparatus with regard to the requirements specified in Clause 5 where practical testing is to be performed. For each relevant requirement a qualified statement from the test subject shall be given.

6.14.2Test subjects

The apparatus shall be tested by five test subjects practicing regularly and familiar with the type of apparatus under test. Their medical history shall be known to be satisfactorily. They shall be medically examined and certified fit to undertake the test procedures.

The necessity of a medical examination immediately before tests and a medical supervision during the tests shall be decided by the testing authority.

6.14.3Basic testing

Each test subject shall make at least two dives. Each subject shall wear protective gloves (mitten, with 6 mm to 7 mm padding on either side) in order to check whether all parts, which have to be actuated by the test subject or the surface operator (e.g. supervisor or attendant) during use, are accessible and controllable under that condition.

The test subjects shall read the information supplied by the manufacturer. They shall set up and operate the apparatus in accordance with the information supplied by the manufacturer.

During the test (pre-dive, dive and post dive) the apparatus will be subjectively assessed by the test subject and the test subject's comments on the following points shall be recorded after the test and all comments shall be used to assess the overall performance:

a) harness comfort;

b) security of fastenings and couplings, including the harness;

c) accessibility and operation of controls and pressure gauge;

d) clarity and field of vision;

e) impeding of the vision by emerging air bubbles;

f) performance of the apparatus when conducting full range of head and arm movement;

g) where there is an adjustable valve the test subject shall assess the performance of the apparatus over the full range of adjustment;

h) facepiece comfort and security of air supply. In the case of a facepiece incorporating multiple straps, each one is disconnected in turn for a period of five breaths. During this test, the test subject should be ready to hold the device to the face to maintain security of the air supply;

i) if an automatic reserve valve is fitted than the test shall include charging the cylinder to ensure that the reserve valve has automatically reset;

j) any other comments reported by the test subject on request.

6.14.4Functional testing when diving

a) Demand regulators which incorporate a dive/pre-dive control shall be switched to the dive position;

b) donning and doffing of the apparatus as well as adjustment of all straps of the apparatus without help on land;

c) jumping test (feet first) from the height of 1,5 m;

d) of the two dives to be conducted by each diver at least one dive to be completed deeper than 5 m;

e) donning and doffing of apparatus under water without stopping breathing through the apparatus;

f) swimming in all positions;

g) testing all sensitivity controls over their full range;

h) checking of all monitors and indicators;

i) swimming at maximum speed;

j) changing to and from emergency breathing apparatus;

k) performance of the apparatus in all orientations when conducting full range of head and arm movements;

l) all diver operated controls shall be tested;

m) back roll entry test from a height of between 0,2 m to 1,0 m as specified by the manufacturer;

n) checking and/or actuation, if applicable, of safety device.

6.14.5Pass/fail criteria

Where practical performance tests show the apparatus has imperfections related to wearer's acceptance, the device shall be deemed to have failed.

The following examples are obvious reasons for concluding that an apparatus is unacceptable and not fit for use:

a) subjects that it should fit cannot wear it;

b) it will not stay in place;

c) it compromises a function, e.g. like sight or breathing;

d) simple tasks to be performed wearing it are impossible;

e) the subject refuses to continue the assessment due to difficulties;

f) the subject reports high levels of discomfort;

g) it prevents the wearing or use of other essential PPE.

6.14.6Report

A record with a final report of the tests performed by the test subjects shall be kept. This record shall contain an assessment of the apparatus by the test subjects with regard to the requirements in Clause 5 and give details of the test conditions and all equipment worn.

7 Marking

7.1 General

Parts with considerable bearing on safety shall be marked so that they can be identified. If parts with considerable bearing on safety are too small to be marked, the information shall be given in the information supplied by the manufacturer;

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

Each sub-assembly as specified in Clause 4 shall be marked as indicated below:

NOTE The required marking can also be relevant to the components.

a) the manufacturer shall be identified by name, trade mark or other means of identification;

b) type-identifying mark;

c) the number of this European Standard;

d) the rated working pressure of pressure reducers and pressure indicators ;

e) the date (at least the year) of manufacture, where the reliable performance of components can be affected by ageing;

f) sub-assemblies, which are not intended for cold water performance shall be marked with “> 10 °C”.

7.2 Demand regulator

The pressure reducer and the demand valve shall be durably marked with a serial number. The marking shall be such that the month and the year of production can be ascertained. In addition, provision shall be made for test marks.

Both the pressure reducer and the demand valve shall be marked.

The demand regulators which are not designed for cold water performance shall be marked with “> 10 °C”.

The demand regulator may be marked with a lower temperature if specified by the manufacturer and successfully tested at that temperature.

The demand regulator for the auxiliary emergency breathing system shall be marked with “A”.

Examples for performance markings on the pressure reducer:

EXAMPLE 1 EN 250 A > X °C or EN 250 A > 10 °C.

Examples for performance markings on the demand valve:

EXAMPLE 2 EN 250 A > X °C or EN 250 A > 10 °C.

8 Information supplied by the manufacturer

8.1 Information supplied by the manufacturer in the official language(s) of the country of destination shall accompany every apparatus and/or sub-assembly enabling trained and qualified persons to assemble and use it in a safe way.

8.2 The name and address of the manufacturer and/or his representative established in the EU.

8.3 The information supplied by the manufacturer shall include a statement that the depth of equipment certification is 50 m.

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

a) application:

   1) use in water temperatures below 10 °C;

   2) intended use, compressed air only;

b) assembly:

   1) permissible and compatible components and sub-assemblies;

   2) permissible connections;

   3) required safety devices with reference to risk;

4) possible incompatibility of safety devices when used together;

c) assessment of risk:

1) temperature conditions;

2) visibility;

3) type of work;

d) checks prior to use;

e) donning, adjustments;

f) use;

g) removal;

h) user maintenance (preferably separately printed instructions);

i) storage:

1) shelf life (where applicable);

2) inspection intervals of the equipment.

8.5 The information supplied by the manufacturer shall include that the air supply shall meet the requirements for breathable air in accordance with EN 12021.

8.6 The information supplied by the manufacturer shall be precise and comprehensible. If helpful, illustrations, part numbers, marking, etc. shall be added.

8.7 Number and year of this European Standard.

8.8 The information supplied by the manufacturer shall contain a warning, that only SCUBA complying with this standard and marked in accordance with 7.2 may be used as an escape device by more than one user at the same time.

8.9 The information supplied by the manufacturer shall contain a warning, that if SCUBA is configured for and used by more than one diver at the same time, then it shall not be used at depths greater than 30 m and in water temperatures less than 10 °C. A lower water temperature may be specified by the manufacturer, in which case this shall be the temperature shown in the warning.

Annex A
(informative)

Requirement clauses and corresponding test clauses of this European Standard

Table A.1 — Comparison of requirement clauses and test clauses

Requirement Clause		Test Clause(s)
5.1	Design	6.3, 6.14
5.2	Auxiliary emerging breathing system	Annex B
5.3	Materials	6.3, 6.5, 6.12, 6.14
5.4	Air cylinder(s)	6.3
5.5	Cylinder valve(s)	6.3, 6.9, 6.14
5.6	High pressure parts and connections	6.3, 6.4
5.7	Demand regulator	No specific test
5.7.1	General	6.7
5.7.2	Cold water	6.7.2
5.7.3	Pressure reducer	6.3
5.7.4	Pressure relief system	No specific test
5.7.4.1	Upstream demand valve	6.6.1
5.7.4.2	Downstream demand valve	6.6.2
5.7.5	Demand valve	6.14
5.7.6	Exhalation valve	6.8. a), 6.8 b) and 6.8 c)
5.8	Hose assemblies	No specific test
5.8.1	Tensile strength of high and medium pressure hose assemblies that may be subjected to external tensile force	6.5.2
5.8.2	Flexibility of high and medium pressure hoses	6.5.3
5.8.3	Leakage of high pressure hose assembly	6.5.4
5.8.4	Leakage of medium pressure hose assembly	6.5.5
5.8.5	Burst pressure of high pressure hose assembly	6.5.6
5.8.6	Burst pressure of medium pressure hose assembly	6.5.7
5.8.7	Kinking of medium pressure hoses	6.5.8
5.8.8	Breathing hose	6.5.9, 6.14
5.8.9	Length and arrangement of medium pressure hose assembly	6.14
5.9	Safety devices	No specific test
5.9.1	General	6.3, 6.11, 6.14
5.9.2	Pressure indicator	6.3, 6.11.1.1, 6.11.1.2, 6.11.1.3, 6.14

Requirement Clause		Test Clause(s)
5.9.3	Reserve valve (if fitted)	6.3, 6.11.2, 6.14
5.9.4	Other active warning devices	6.3, 6.11.3, 6.14
5.10	Facepiece	No specific test
5.10.1	General	6.3, 6.14
5.10.2	Inspired carbon dioxide	6.10.2.1
5.10.3	Mouthpiece assembly	6.3, 6.10.1, 6.14
5.10.4	Head harness	6.10.3, 6.14
5.10.5	Full face mask or oro-nasal half mask	6.3, 6.12.1
5.10.5.1	General	6.3, 6.10.2.2, 6.14
5.10.5.2	Visor(s)	6.3, 6.10.2.3, 6.10.2.4, 6.14
5.11	Body harness	6.3, 6.14
5.12	Resistance to temperature	No specific test
5.12.1	Storage	6.12.1, 6.12.2
5.12.2	Performance	6.12.3, 6.12.4
5.12.3	Cold water performance	6.7.2
5.13	Cleaning and disinfection	6.3
5.14	Seawater resistance	6.3, 6.13
5.15	Practical performance	6.14

Annex B
(normative)

Auxiliary emergency breathing system

B.1 General

This annex applies to demand regulators with an auxiliary emergency breathing system attached to one pressure reducer.

The purpose of this annex is to ensure a minimum level of safe operation for such an apparatus down to a maximum depth of 30 m and an operating temperature down to 10 °C or less if specified by the manufacturer. Practical performance tests are defined for the assessment of compliance with this European Standard and this annex.

The use of an auxiliary emergency breathing system in temperature less than 10 °C is not a preferred configuration and alternative fully independent systems are advised.

The use of an auxiliary emergency breathing system (octopus) in water temperature less than 10 °C carries a significant risk of accidents.

B.2 Requirements

As the auxiliary emergency breathing system is attached to one pressure reducer (two demand valves connected to one pressure reducer) additional requirements shall be observed that the safe operation and the use of the apparatus according to this standard is not adversely affected.

The auxiliary emergency breathing system, when tested alone at 6 bar (50 m) shall meet the requirements as specified in 5.7, 5.10 and 5.12.2. When simulated in conjunction, the primary regulator and the auxiliary emergency breathing system shall meet the requirements as specified in 5.7, 5.10 and 5.12.2 at 4 bar (30 m). Where a manufacturer claims performance at less than 10 °C then the auxiliary emergency breathing system shall meet the requirements specified in 5.12.3.

Where the auxiliary emergency breathing system is integral to a buoyancy jacket inflation system it shall be tested alone at 6 bar (50 m) and tested in conjunction with the primary regulator at 4 bar (30 m) it shall meet the requirements as specified in 5.7 except that the WOB shall be less than 3,0 J/l.

B.3 Testing

All applicable requirements and testing of this standard shall be applied to a demand regulator with the auxiliary emergency breathing system attached. Maximum testing pressure for a demand regulator including auxiliary emergency breathing system shall be 4 bar (30 m) and the water temperature shall be 10 °C or at a lower temperature if specified by the manufacturer.

The demand regulator shall be immersed in water at a temperature of $10^{\ 0}_{-1}$ °C and the demand valve shall be rigged as though the diver's head is in the upright position to a depth of at least 0,2 m to preclude surface effects.

Each demand valve (the primary and the auxiliary emergency breathing system) shall be subjected to test.

An intermediate pressure outlet on the first stage regulator shall be connected to a flowmeter on the outside of the test chamber. The volume of the intermediate pressure system pipe work shall be minimised and not exceed 200 ml.

The first stage regulator shall be supplied with a constant pressure of 50 bar.

After the chamber is pressurized to the test pressure, the test sequence shall be as follows:

a) set a constant flow rate of 560 l/min STP on the flowmeter;

b) start the breathing simulator attached to the demand valve under test;

c) during the simulated breathing the flow rate will fall and shall not be re-adjusted;

d) record the inhale and exhale respiratory pressures and calculate the work of breathing;

e) stop the breathing simulator after a period of 2 min;

f) stop the constant flow.

No free-flow shall be observed during the test.

B.4 Practical performance test

In addition to factors for basic testing as described in 6.14.3, the divers shall perform a share air exercise at minimum depth of 5 m and maximum depth of 10 m. Both divers breathe from the same apparatus, one from the main demand valve, the other from the auxiliary demand valve simultaneously for 1 min. The apparatus shall not free-flow during this time period.

Annex C
(informative)

Artificial seawater

28,0 g NaCl

5,0 g $MgCl_2 \cdot 6\ H_2O$

2,4 g $CaCl_2 \cdot 6\ H_2O$

are completely dissolved in 885 ml of desalinated water (solution A).

7,0 g $MgSO_4$ and 0,2 g $NaHCO_3$

are completely dissolved in 100 ml of desalinated water (solution B).

Solution B is poured into solution A as a thin jet.

After 24 h, the mixture is filtered and adjusted to $7 \leq pH \leq 8$ by adding NaOH-solution.

Annex D
(informative)

Details of significant technical changes between this European Standard and the previous edition

The significant technical changes between this European Standard and the previous edition are the following:

a) inclusion of requirements concerning the auxiliary breathing system;

b) change of requirements on the demand regulator;

c) upper limit of test temperatures increased to 55 °C;

d) functional testing aligned with EN 14143;

e) marking on the demand regulator specified;

f) clear separation of requirements and testing.

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 89/686/EEC

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive 89/686/EEC on Personal Protective Equipment

Once this standard is cited in the Official Journal of the European Union under that Directive and has been implemented as a national standard in at least one Member State, compliance with the clauses of this standard given in Table ZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations.

Table ZA.1 — Correspondence between this European Standard and Directive 89/686/EEC on Personal Protective Equipment

Clause(s)/subclause(s) of this EN	Basic Requirement (EU Directive 89/686/EEC, Annex II)	Qualifying remarks/Notes
5.1, 5.5, 5.6, 5.7.1, 5.7.4.1, 5.7.4.2, 5.7.5, 5.7.6, 5.8.2, 5.8.7, 5.8.8, 5.8.9, 5.9.1, 5.9.2, 5.9.4, 5.10.2, 5.10.3, 5.11, 5.12.1	1.2.1 Absence of risks and other inherent nuisance factors	
5.3	1.2.1.1 Suitable constituent materials	
5.1	1.2.1.2 Satisfactory surface condition of all PPE parts in contact with the user	
5.10.4, 5.11	1.3.1 Adaption of PPE to user morphology	
5.3, 5.6, 5.8.1, 5.8.3, 5.8.4, 5.8.5, 5.8.6, 5.10.4, 5.10.5.1, 5.10.5.2, 5.12.2, 5.14	1.3.2 Lightness and design strength	
5.2	1.3.3 Compatibility of different types of PPE designed for simultaneous use	
5.13	1.4 Information supplied by the manufacturer	
5.1, 5.7.3	2.1 PPE incorporating adjustment systems	
5.10.5.2	2.3 PPE for the face, eyes and respiratory tracts	
5.10.5.1	2.9 PPE with components that can be adjusted or removed by the user	
Clause 7	2.12 PPE bearing identification marks related to health and safety	
5.7.1, 5.7.2, 5.9.3, 5.12.3	3.11 Safety devices for diving equipment	

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

This page deliberately left blank

This page deliberately left blank

British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards -based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member**.

PLUS is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email bsmusales@bsigroup.com.

BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK

Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

Copyright

Useful Contacts:

Customer Services
Tel: +44 845 086 9001
Email (orders): orders@bsigroup.com
Email (enquiries): cservices@bsigroup.com

Subscriptions
Tel: +44 845 086 9001
Email: subscriptions@bsigroup.com

Knowledge Centre
Tel: +44 20 8996 7004
Email: knowledgecentre@bsigroup.com

Copyright & Licensing
Tel: +44 20 8996 7070
Email: copyright@bsigroup.com

bsi.

...making excellence a habit.™