SLOVENSKI STANDARD
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Oprema za dihanje - Potapljaški dihalni aparat z odprtim krogom in sredinskim dovodom stisnjenega plina - 1. del: Zahteve za aparat

Respiratory equipment - Open-circuit umbilical supplied compressed gas diving apparatus - Part 1: Demand apparatus

Atemgeräte - Schlauchversorgte Leichttauchgeräte mit Druckgas - Teil 1: Lungenautomatisch gesteuerte Geräte

Equipements respiratoires - Appareil de plongée en narguilé à gaz comprimé et à circuit ouvert - Partie 1: Appareil à la demande

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Respiratory equipment - Open-circuit umbilical supplied compressed gas diving apparatus - Part 1: Demand apparatus

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Foreword

This document (EN 15333-1:2008) 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of an identical text or by endorsement, at the latest by July 2008, and conflicting national standards shall be withdrawn at the latest by July 2008.

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.

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Introduction

A given open-circuit umbilical supplied compressed gas diving apparatus can only be approved when the apparatus or apparatus sub-assemblies satisfy the requirements of the tests specified in this European Standard, and practical performance tests have been carried out successfully on complete apparatus where specified in this European Standard.

The production of this European Standard has identified varying methods of surface supply and has separated them into two parts; equipment that supplies demand type facepieces and equipment that supplies free flow type facepieces.

1 Scope

This European Standard specifies minimum requirements for demand surface supplied and demand surface oriented diving apparatus to ensure a minimum level of safe operation of the apparatus. It applies to the following:

— depths between 0 m and 50 m for apparatus using air, oxygen or oxygen in nitrogen mixtures;

— depths between 0 m and 60 m for apparatus using oxygen, oxygen and helium or oxygen, nitrogen and helium gas mixtures;

— water temperatures between 4 °C and 34 °C or outside these temperatures as specified by the manufacturer.

The requirements of this European Standard are intended to take account of the interaction between the wearer, the apparatus, and where possible the environment in which the apparatus is likely to be used.

This European Standard does not cover saturation diving systems, mini bell systems or apparatus used for oxygen decompression only.

2 Normative references

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

EN 132:1998, *Respiratory protective devices — Definitions of terms and pictograms*

EN 134:1998, *Respiratory protective devices — Nomenclature of components*

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

EN 144-3, *Respiratory protective devices — Gas cylinder valves — Part 3: Outlet connections for diving gases Nitrox and oxygen*

EN 397, *Industrial safety helmets*

EN 812 *Industrial bump caps*

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

EN 14593-1:2005, *Respiratory protective devices — Compressed air line breathing apparatus with demand valve — Part 1: Apparatus with a full face mask — Requirements, testing marking*

EN ISO 12209-1, *Gas cylinders - Outlet connections for gas cylinder valves for compressed breathable air - Part 1: Yoke type connections (ISO 12209-1:2000)*

EN ISO 12209-2, *Gas cylinders - Outlet connections for gas cylinder valves for compressed breathable air - Part 2: Threaded connections (ISO 12209-2:2000)*

EN ISO 12209-3, *Gas cylinders - Outlet connections for gas cylinder valves for compressed breathable air - Part 3: Adaptor for 230 bar valves (ISO 12209-3:2000)*

EN 61508-1, *Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 1: General requirements (IEC 61508-1:1998 + Corrigendum 1999)*

EN 61508-2, *Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 2: Requirements for electrical/electronic/programmable electronic safety- related systems (IEC 61508-2:2000)*

EN 61508-3, *Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 3: Software requirements (IEC 61508-3:1998 + Corrigendum 1999)*

EN 61508-4, *Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 4: Definitions and abbreviations (IEC 61508-4:1998 + Corrigendum 1999)*

EN 61508-5, *Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 5: Examples of methods for the determination of safety integrity levels (IEC 61508-5:1998 + Corrigendum 1999)*

EN 61508-6, *Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 6: Guidelines on the application of IEC 61508-2 and IEC 61508-3 (IEC 61508-6:2000)*

EN 61508-7, *Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 7: Overview of techniques and measures (IEC 61508-7:2000)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 132:1998 and the nomenclature given in EN 134:1998 apply together with the following:

3.1
auxiliary gas supply system (bail out)
auxiliary and independent gas supply or breathing apparatus for use in case of a failure of the umbilical supply

3.2
body harness
component of the system to attach the breathing apparatus, umbilical and any pressure vessels to the body of the diver

3.3
breathing frequency
number of breathing cycles per minute

3.4
displaced (tidal) volume
volume of respirable gas displaced by a breathing simulator during one half cycle (inhalation or exhalation) measured in litres

3.5
full face mask
facepiece covering mouth, nose, eyes and chin which may be fitted with either a mouthpiece or an inner mask

3.6
helmet
facepiece covering the whole head, which may be fitted with either a mouthpiece or an inner mask

3.7
high pressure
any pressure greater than medium pressure

3.8
hydrostatic imbalance
difference at both end exhalation no flow and end inhalation no flow between the pressure within the facepiece (see Figure 1) and that at the reference point, which could be either the suprasternal notch or the lung centroid of the diver (see Figure 2)

3.9
life line
component of the system which connects the diver to the surface and may be used to help a diver in distress

3.10
lifting harness
component of the system attached to the diver for lifting the diver from the water

3.11
low pressure
pressure within the facepiece, i.e. approximately ambient pressure

3.12
medium pressure
internal pressure between a pressure reducer and a demand valve

NOTE This is sometimes referred to as intermediate pressure.

3.13
neck connector
device that provides a sealed connection between the helmet and a wearers drysuit. It is normally worn with some form of retaining device that prevents the helmet from floating off the wearers head

3.14
neckdam
device that connects to the helmet and seals at the wearers neck. It is normally worn with some form of retaining device that prevents the helmet from floating off the wearers head

3.15
pressure volume diagram
diagram generated during one breathing cycle by plotting the respiratory pressure against the displaced volume (see Figure 1)

3.16
rated working pressure
maximum allowable pressure for which the apparatus is designed

3.17
respiratory minute volume (RMV)
product of the tidal volume and breathing frequency measured in litres per minute

3.18
respiratory pressure
differential pressure at the mouth relative to the no flow pressures at the mouth at the end of inhalation and exhalation (see Figure 1)

3.19
surface control system
system that controls the supply from (a) gas source(s) to the diver(s) via the umbilical. It may also have a separate independent controlled supply for a stand by diver

3.20
surface supplied diving apparatus (demand)
diving apparatus that has gas supplied from the surface through a surface control system or system via an umbilical, allowing the diver to breathe under water from a facepiece. The apparatus is designed and constructed to enable the diver to inspire gas from a facepiece on demand and to pass exhaled gas into the water

3.21
umbilical
connection to the diver from the surface control system. It may consist of a single hose or multiple lines, comprising life line, gas supply and if fitted voice communication and depth measuring system together with other services such as heating or cooling for suits, power for lighting and camera video signals

3.22
work of breathing
work expended during one breathing cycle measured in Joule per litre

NOTE This work is proportional to the area bounded by the pressure volume diagram (see Figure 1).

4 Minimum equipment

The apparatus may consist of subassemblies.

The apparatus shall comprise, at least the following components:

- surface gas supply:
  - gas supply;
  - surface control system;
  - gas monitoring;

- breathing system:
  - facepiece, demand valve and exhalation valve;
  - body harness;
  - umbilical;
  - safety device(s).

It shall also be delivered with information supplied by the manufacturer.

The apparatus may also include the following components:

- auxiliary gas supply;
- lifting harness;
- depth measuring device;
- voice communication system.

5 Requirements

5.1 Design

5.1.1 The manufacturer shall support the apparatus design by the provision of a failure mode effect and criticality analysis.

Testing shall be done in accordance with 6.2.

5.1.2 The apparatus shall be designed and its components and parts located to provide protection against mechanical damage caused by external influence and to ensure that it is possible to perform all pre-dive functional checks specified by the manufacturer.

Testing shall be done in accordance with 6.2 and 6.13.

5.1.3 The combination of components and parts shall not adversely affect the safe operation and use of the apparatus.

Testing shall be done in accordance with 6.2 and 6.13.

5.1.4 The apparatus shall not have any sharp edges or protrusions that can injure the diver or surface operator.

Testing shall be done in accordance with 6.2 and 6.13.

5.1.5 All parts, which have to be actuated by the diver or the surface operator 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.

Testing shall be done in accordance with 6.13.

5.1.6 The apparatus shall function satisfactorily out of the water and in all orientations in the water.

Testing shall be done in accordance with 6.2 and 6.13.

5.1.7 The apparatus may have an auxiliary independent gas supply (bail out) to allow the diver to return safely to the surface or a point of safety. If fitted, the design shall prevent inadvertent use of the auxiliary supply and to prevent the supply from exhausting into the water in the event of a main umbilical failure.

Testing shall be done in accordance with 6.2 and 6.13.

5.1.8 The design shall prevent negative facepiece pressure in the event of any gas supply failure.

Testing shall be done in accordance with 6.2.

5.1.9 The apparatus shall include a means to expel water from the facepiece.

Testing shall be done in accordance with 6.2 and 6.13.

5.1.10 The apparatus shall be designed to prevent any saliva, condensation or ingress of water from adversely affecting the operation of the apparatus or causing harmful effect to the diver when used according to the information supplied by the manufacturer.

Testing shall be done in accordance with 6.2 and 6.13.

5.1.11 If the apparatus is intended for use in water temperatures less than 4 °C the manufacturer shall state the minimum temperature and its performance shall be tested at that temperature.

Testing shall be done in accordance with 6.5.2 and 6.5.3.

5.1.12 The apparatus shall allow the use of a suitable auxiliary gas supply.

Testing shall be done in accordance with 6.2 and 6.13.

5.2 Materials

5.2.1 The parts used shall have adequate mechanical strength, durability and resistance to wear and feature sufficient resistance to changes caused by the effect of temperature individually and when assembled.

Testing shall be done in accordance with 6.2, 6.3, 6.4, 6.8, 6.9, 6.10, 6.11 and 6.13.

5.2.2 Any materials that may come into contact with pressurized gas above 25 bar, other than air in accordance with EN 12021, and with an oxygen content greater than 21 %, shall be compatible for use with high pressure oxygen. All components and assemblies shall be supplied clean to meet the intended service.

Testing shall be done in accordance with 6.2 and 6.12.

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

Testing shall be done in accordance with 6.2 and 6.13.

5.2.4 Any material that may come into contact with sea water shall be sea water resistant. After conditioning in accordance with 6.9 the apparatus shall still be fully functional.

Testing shall be done in accordance with 6.2, 6.9 and 6.13.

5.3 Diver worn pressure vessel(s) (if fitted)

The pressure vessel(s) shall be designed in accordance with appropriate regulations and shall be approved and tested with respect to the rated working pressure and the use of elevated oxygen content if appropriate.

The pressure vessel(s) shall be marked with the appropriate neck thread designation according to EN 144-1 where the preferred versions are M 18 x 1,5 and M 25 x 2.

Testing shall be done in accordance with 6.2.

5.4 Diver worn pressure vessel valve(s) (if fitted)

5.4.1 Pressure vessel valve(s) shall comply with appropriate specifications and shall be approved and tested for use at the rated working pressure and gas.

Testing shall be done in accordance with 6.2 and 6.12 if applicable.

5.4.2 The connections between the pressure vessel valve(s) and the diver worn gas control or supply system shall be constructed according to:

— EN ISO 12209 Parts 1, 2 and 3 for pressure vessels intended for compressed air;

— EN 144-3 for pressure vessels intended for compressed Nitrox and compressed oxygen.

If no specific standards for other respirable gases are available connections according to EN 144-3 shall be used.

Testing shall be done in accordance with 6.2.

5.4.3 The opening of the valve orifice shall be progressive. Complete opening shall require more than one rotation of the operating mechanism. For valves, in which it is technically difficult to limit opening in this way (e.g. diaphragm valves) other means shall be provided to delay full gas flow. The valve(s) shall be designed and located so that it cannot be closed inadvertently, e.g. by requiring at least two full turns from fully open to fully closed position.

Testing shall be done in accordance with 6.2 and 6.13.

5.4.4 The function of a pressure vessel valve shall not be impaired by the ingress of water.

Testing shall be done in accordance with 6.2.

5.4.5 The pressure vessel valve(s) shall be protected against the entrainment of dirt, solid particles and water from inside the pressure vessel e.g. by means of a protective tube with a length of at least 30 mm and an inside diameter of at least 2,5 mm.

Testing shall be done in accordance with 6.2.

5.4.6 The pressure drop measured across the complete pressure vessel valve(s) assembly with a pressure vessel pressure of 50 bar shall not exceed 10 bar.

Testing shall be done in accordance with 6.14.

5.5 High and medium pressure parts and connections

5.5.1 General

All metallic high and medium pressure tubes, valves and couplings shall be capable of withstanding a pressure 50 % above the rated working pressure.

Non-metallic high and medium pressure tubes, valves and couplings shall be tested to prove that they are capable of withstanding a pressure of twice the rated working pressure.

It shall not be possible to connect a pressure component to a system with a pressure greater than the rated working pressure of that component.

Testing shall be done in accordance with 6.2 and 6.3 and 6.13.

5.5.2 Pressure reducer(s)

Any pre-set pressure reducer 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 6.2 and 6.13.

5.5.3 Pressure relief system(s)

5.5.3.1 General

Each section of a given high pressure system shall be either capable of operating up to the maximum rated working pressure of the system or shall be provided with an adequate pressure relief valve.

All medium pressure supplies shall be fitted with a pressure relief system.

In the event of a pressure reducer failure the relief system shall maintain the pressure within the rated working pressure of the system.