SLOVENSKI STANDARD
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Oprema za dihala – Samoreševalni dihalni potapljaški aparati

Respiratory equipment - Self-contained re-breathing diving apparatus

Atemgeräte - Autonome Regenerationstauchgeräte

Appareils de protection respiratoire - Appareils de plongée autonomes a circuit fermé

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Respiratory equipment - Self-contained re-breathing diving apparatus

Apareils respiratoires - Appareils de plongée autonomes à circuit fermé

Atemgeräte - Autonome Regenerationstauchgeräte

This European Standard was approved by CEN on 7 August 2003.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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Foreword

This document (EN 14143:2003) 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of an identical text or by endorsement, at the latest by March 2004, and conflicting national standards shall be withdrawn at the latest by March 2004.

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.

In this European Standard the annex A is informative.

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

Introduction

A given self-contained re-breathing diving apparatus can only be approved when the apparatus or apparatus sub-assemblies satisfy the requirements of the tests specified in this standard, and practical performance tests have been carried out successfully on complete apparatus where specified in the standard.

The production of the standard has raised new questions regarding the interpretation of the physiological and equipment acceptance limits for the diving application which have not been fully answered. However, this standard has been published to provide a level of safety for re-breathing diving apparatus.

1 Scope

This European Standard specifies minimum requirements for self-contained re-breathing diving apparatus to ensure a minimum level of safe operation of the apparatus. It applies to the following:

— a maximum depth of 6 m for apparatus using pure oxygen;

— a maximum depth of 40 m for apparatus using oxygen in nitrogen gas mixtures;

— a maximum depth of 100 m for apparatus using oxygen and helium or oxygen, nitrogen and helium gas mixtures;

— water temperatures between 4 °C and 34 °C.

The requirements of this 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. See annex ZA.

2 Normative references

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

EN 132:1998, *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 250, *Respiratory equipment - Open circuit self contained compressed air diving apparatus - Requirements, testing and marking*

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

EN 61000-6-1, *Electromagnetic compatibility - Part 6-1:Generic standards; Immunity for residential, commercial and light industrial environments*

ISO/IEC 12207, *Information technology – Software life cycle process*

IEC 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems*

IEC 60300-3-6, *Dependability management - Part 3: Application guide - Section 6: Software aspects of dependability*

3 Terms and definitions

For the purpose of this European Standard the terms and definitions given in EN 132:1998 and the nomenclature given in EN 134:1998 apply together with the following:

3.1 self-contained re-breathing diving apparatus
apparatus that has a supply of gas carried by the diver, allowing the diver to breathe under water

The apparatus is designed and constructed to enable the diver to inspire gas from a facepiece connected to a counterlung and to pass exhaled gas through a carbon dioxide absorption material before it is re-breathed from the counterlung. The inspired partial pressure of the gases within the apparatus remain within acceptable physiological limits. The gas is thus re-circulated within the apparatus.

A self-contained re-breathing diving apparatus may also be called a diving Re-breather.

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

3.3 medium pressure
the pressure between the pressure reducer and a gas control system

NOTE This is sometimes referred to as intermediate pressure.

3.4 low pressure
the pressure within the facepiece, breathing hoses, counterlung and absorbent canister, i.e. approximately ambient pressure

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

3.6 rated working pressure
the maximum working pressure of the respective components

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

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

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

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

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

3.12 work of breathing
the work expended during one breathing cycle measured in Joule per litre. This work is proportional to the area bounded by the pressure volume diagram (see Figure 1)

3.13 breathing hose
flexible low pressure hose(s) connecting the facepiece to either the counterlung(s) or absorbent canister

3.14 counterlung
variable volume container for the diver to inhale from and exhale to

3.15 absorbent canister
container of absorbent materials which will remove carbon dioxide from the gas passing through them

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

3.17 body harness
component of the re-breather to attach the apparatus to the body of the diver

3.18 facepiece
device for connecting the apparatus to the wearer. It may be a mouthpiece assembly, a diving half mask or a full face mask

4 Minimum equipment

The apparatus shall comprise at least the following components:

— breathing circuit comprising e.g. facepiece, breathing hose(s), counterlung(s), exhaust valve, absorbent canister;

— gas control or supply system;

— gas supply pressure vessel(s);

— safety device(s);

— body harness.

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

5 Requirements

5.1 Design

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

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 the required pre-dive functional checks.

The combination of components and parts shall not adversely affect the safe operation and use of the apparatus, e.g. by incorrect connection of the hoses to the breathing circuit.

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

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

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

The apparatus shall be designed to prevent any chemicals used within the apparatus, 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.

Any part of the equipment intended for high pressure gas with an oxygen content greater than air as specified in EN 12021 shall be designed and selected for use with high pressure oxygen.

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 6.2, 6.15 and 6.16.

5.2 Materials

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.

Any materials that may come into contact with a high pressure gas with an oxygen content greater than air as specified in EN 12021 shall be compatible for use with high pressure oxygen.

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.

Any material that may come into contact with sea water shall be sea water resistant.

After testing in accordance with 6.17 the apparatus shall still be fully functional.

Testing shall be done in accordance with 6.2, 6.8, 6.9, 6.13, 6.14, 6.15, 6.16 and 6.17.

5.3 Pressure vessel(s)

The pressure vessel(s) shall comply with regulations appropriate to the country of use 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 Pressure vessel valve(s)

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

The threads for connecting the pressure vessel(s) and the valve(s) shall be as described in EN 144-1 where the preferred versions are M 18 x 1,5 or M 25 x 2.

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

— EN 250 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 are recommended.

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 (for example 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.

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

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, 6.15 and 6.16.

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 working pressure of the pressure vessel.

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 of the pressure vessel.

It shall not be possible to connect a low or medium pressure hose assembly to a high pressure outlet or connection.

Testing shall be done in accordance with 6.2 and 6.9.

5.5.2 Pressure reducer (if fitted)

On the pressure reducer any adjustable medium pressure setting shall be reliably secured against accidental alteration and adequately sealed so that any unauthorised adjustment can be detected.

If fitted, any pressure reducer which may be used with a respirable gas having an oxygen content greater than that of air as specified in EN 12021, shall withstand the oxygen pressure surge test.

Testing shall be done in accordance with 6.2, 6.15 and 6.16.

5.5.3 Pressure relief system(s)

All medium pressure supplies shall be fitted with a pressure relief system. The manufacturer shall specify the relief pressure and flow based on the failure mode effect and criticality analysis (FMECA). In any case the maximum relief pressure shall not exceed 50 % of the burst pressure as specified by the manufacturer.

Testing shall be done in accordance with 6.10.5.

5.6 Breathing circuit

5.6.1 Performance requirements

5.6.1.1 General

The breathing performance shall be measured using a sinusoidal waveform from a breathing machine with simulated RMVs up to 75 l min^{-1} (BTPS; Body Temperature and Pressure Saturated (see Table 4)). The