
Diving respiratory equipment

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NORSOK Standard

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Diving respiratory equipment

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Foreword

The NORSOK standards are developed by the Norwegian petroleum industry to ensure adequate safety, value adding and cost effectiveness for petroleum industry developments and operations. Furthermore, NORSOK standards are, as far as possible, intended to replace oil company specifications and serve as references in the authorities' regulations.

The NORSOK standards are normally based on recognised international standards, adding the provisions deemed necessary to fill the broad needs of the Norwegian petroleum industry. Where relevant, NORSOK standards will be used to provide the Norwegian industry input to the international standardisation process. Subject to development and publication of international standards, the relevant NORSOK standard will be withdrawn.

The NORSOK standards are developed according to the consensus principle generally applicable for most standards work and according to established procedures defined in NORSOK A-001.

The NORSOK standards are prepared and published with support by the Norwegian Oil and Gas Association, the Federation of Norwegian Industries, Norwegian Shipowners' Association and The Petroleum Safety Authority Norway.

NORSOK standards are administered and published by Standards Norway.

Introduction

The first edition of this NORSOK standard was published in 1999. It was based on the "Guidelines for evaluation of breathing apparatus for use in manned underwater operations (MUO) in the petroleum activities" which was published jointly by the Norwegian Petroleum Directorate and the Department of Energy (UK) 1991.01.22.

This NORSOK standard supports essential requirements of EU Council Directive of 1989.12.21 relating to personal protective equipment (PPE) (89/686/EEC).

A given BA may only be approved when the individual components satisfy the requirements of this NORSOK standard, and practical performance tests have been satisfactory carried out on a complete apparatus. If, for any reason, a complete apparatus is not tested, then simulation of the missing element(s) of the apparatus is permitted, provided the respiratory characteristics are similar to those of the complete apparatus.

Since the first edition of this NORSOK standard was published, some European Standards (EN 250, EN 13949, EN 14143, EN 15333-1 and EN 15333-2) have been prepared under mandate by the European Commission and the European Free Trade Association to provide the means of conforming to essential requirements of the New Approach Directive 89/686/EEC on the approximation of the laws of the Member States relating to Personal Protective Equipment. None of these explicitly have a scope that includes saturation or bell diving and the maximal depth is, because of this, significantly limited in comparison to this NORSOK standard.

1 Scope

This NORSOK standard applies to design and testing of BA for use in MUO down to a maximal depth as specified by the manufacturer and limited to 400 msw.

This NORSOK standard may be applied for testing and assessment of any BA intended for use in MUO.

NOTE This NORSOK standard does not apply to BA intended for use only within the scope of one of the European Standards (EN) mentioned in Introduction.

2 Normative and informative references

The following standards include provisions and guidelines which, through reference in this text, constitute provisions and guidelines of this NORSOK standard. Latest issue of the references shall be used unless otherwise agreed. Other recognized standards may be used provided it can be shown that they meet the requirements of the referenced standards.

2.1 Normative references

ISO 16972, *Respiratory protective devices – Terms, definitions, graphical symbols and units of measurement*

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

93/42/EEC, *Medical Devices Directive (2007/47/EC)*

2.2 Informative references

EN 250, *Respiratory equipment – Open-circuit self-contained compressed air diving apparatus – Requirements, testing, marking*

EN 13949, *Respiratory equipment – Open-circuit self-contained diving apparatus for use with compressed Nitrox and oxygen – Requirements, testing, marking*

EN 14143, *Respiratory equipment – Self-contained re-breathing diving apparatus*

EN 13921, *Personal protective equipment – Ergonomic principles*

EN 15333-1, *Respiratory equipment – Open-circuit umbilical supplied compressed gas diving apparatus - Part 1: Demand apparatus*

EN 15333-2, *Respiratory equipment – Open-circuit umbilical supplied compressed gas diving apparatus – Part 2: Free flow apparatus*

ISO 16976-1, *Respiratory protective devices – Human factors – Part 1: Metabolic rates and respiratory flow rates*

ISO 16976-2, *Respiratory protective devices – Human factors – Part 2: Anthropometrics*

ISO 16976-3, *Respiratory protective devices – Human factors – Part 3: Physiological responses and limitations of oxygen and limitations of carbon dioxide in the breathing environment*

ISO 16900-2, *Respiratory protective devices – Methods of test and test equipment – Part 2: Determination of breathing resistance*

3 Terms, definitions, abbreviations, symbols and units

For the purposes of this NORSOK standard, the terms, definitions, abbreviations, symbols and units given in ISO 16972, EN 132 and the following apply.

3.1 Terms and definitions

3.1.1 ambient pressure

P_A

pressure in the surrounding environment at the level of the diver's mouth (measured in kPa)

NOTE For test purposes the P_A is equal to the test pressure.

3.1.2

can

verbal form used for statements of possibility and capability, whether material, physical or casual

3.1.3

built in breathing system

BIBS

BA intended for use only in the dry inside closed compartment, and with moderate work rates, corresponding RMVs equal to 40 l/min or less

3.1.4

breathing gas

gas mixture (or O₂) suitable for breathing at P_A

3.1.5

hydrostatic imbalance

HI

pressure difference between the P_r and the P_{lc}, $HI = P_r - P_{lc}$ (measured in kPa)

NOTE The HI may be positive, negative or zero, depending on the position of the demand valve (or equivalent device) and the orientation of the diver. The HI can only be measured when there is no respiratory gas flow.

3.1.6

lung centroid pressure

P_A

pressure in the surrounding environment at the level of the diver's mouth (measured in kPa)

NOTE The P_{lc} may be measured at a point 1,24 kPa inferior to and 0,7 kPa posterior to the suprasternal notch or 2,84 kPa inferior to and 1,4 kPa posterior to the mouth.

3.1.7

manned underwater operation

MUO

activity where humans stay below surface and/or are exposed to increased P_A

3.1.8

may

verbal form used to indicate a course of action permissible within the limits of this NORSOK standard

3.1.9

over/under-pressure

maximum and minimum pressure to which the diver may be exposed in the event of failure of the apparatus (measured in kPa)

NOTE The pressure is related to the reference pressure and will provide design parameters for emergency relief valves, shutoff valves and flow fuses. This pressure is not working pressure for normal operations.

3.1.10

primary BA

BA in the mode which is normally used by a diver in water

3.1.11

respiratory minute volume

RMV_A

volume of breathing gas exhaled by the diver in the course of one minute (measured in l BTPS·min⁻¹)

3.1.12

shall

verbal form used to indicate requirements strictly to be followed in order to conform to this NORSOK standard and from which no deviation is permitted, unless accepted by all involved parties

3.1.13

should

verbal form used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required

3.1.14

supply pressure

overpressure of the breathing gas at the end of the umbilical where it is connected to the BA on the diver's body, related to the PA (measured in kPa)

3.1.15

respiratory pressure

P

differential pressure measure in the diver's mouth during inhalation and exhalation, in relation to the reference pressure (measured in kPa)

3.1.16

reference pressure

P_r

pressure in the diver's mouth with relaxed muscles of respiration and no breathing gas flow (measured in kPa)

3.1.17

return pressure

under-pressure of the breathing gas in the return hose at the end of the umbilical where it is connected to the BA on the diver's body, related to the PA (measured in kPa)

3.1.18

temperature of inspired gas

temperature of the breathing gas inhaled by the diver (measured at the diver's mouth in °C)

3.1.19

test depth

depth measured at the level of the diver's mouth (measured in msw)

3.1.20

test pressure

pressure at test depth (measured in kPa or MPa)

NOTE For test purposes set equal to the P_A.

3.1.21

tidal volume

volume of breathing gas exhaled by the diver in each breath (measured in l BTPS)

3.1.22

work of breathing

WOB

additional external work required in order to use the BA (measured in J·l⁻¹)

NOTE See 5.2.1.

3.2 Abbreviations, symbols and units

CO ₂	carbon dioxide
BA	breathing apparatus
BIBS	built in breathing system
BTPS	body temperature (37 °C), P _A , saturated with water vapour
HI	hydrostatic imbalance
k	constant used in equation in 5.2.2
kPa	kilopascal
l	litre
MPa	megapascal
msw	meters of sea water, relative density equal to 1,01972
ms	milliseconds
min	minute
O ₂	oxygen
PA	ambient pressure
P	respiratory pressure
Plc	lung centroid pressure
Pr	reference pressure
RMV	respiratory minute volume
STPD	standard temperature and pressure dry gas (0 °C, 101,3 kPa and 0 kPa water vapour)
WOB	work of breathing