
**Submersibles — Hydrostatic pressure
test — Pressure hull and buoyancy
materials**

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Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 13, *Marine technology*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

The document provides a unified specification for the hydrostatic pressure test method applicable to the pressure hull and buoyancy materials of submersibles to confirm that their pressure resistance performance is normal prior to assembly.

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Submersibles — Hydrostatic pressure test — Pressure hull and buoyancy materials

1 Scope

This document specifies a test method for the hydrostatic pressure test for pressure hull and buoyancy materials of submersibles. The test sequence comprises a tightness test and the hydrostatic pressure test itself. It can also include continuous pressurization and depressurization tests, long-term static load and cycling external pressure tests.

This document is applicable to the pressure structure of manned submersibles and unmanned submersibles, including the pressure hull, its accessories (such as viewports, hatches and connectors) and buoyancy materials. The long-term static load and cycling external pressure tests are only applicable to buoyancy material.

This document is not applicable to submarines and other submersibles parking or operating underwater for more than one week.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1

submersible

vehicle operating underwater

3.2

manned submersible

submersible (3.1) occupied by persons

3.3

unmanned submersible

submersible (3.1) not occupied by persons

3.4

maximum working depth

maximum operating depth at which a *submersible* (3.1) can operate safely

Note 1 to entry: It is expressed in meters (m).

3.5

maximum working pressure

p

maximum pressure in which a system (pressure vessel, supporting controls and instrumentation) can be operated

3.6
test pressure

p_t
water pressure endured by the pressure structure during the pressurization test or tightness test

Note 1 to entry: It is expressed in megapascals (MPa).

3.7
pressure hull

shell capable of withstanding the internal and/or an external pressure, in which occupants and the required equipment are housed

3.8
viewport

penetration in the pressure vessel including a window, flange, retaining rings and seals

3.9
buoyancy material

material for a *submersible* (3.1), whose density is lower than that of the ambient medium

3.10
structural change

position which has a change in cross sectional area, structural configuration or other physical characteristic

3.11
stress raiser

area where, due to the characteristics of the hull such as *structural change* (3.10), internal mounting, reduced thickness due to constructional tolerances, additional loads, etc., a change in stress is likely to occur

3.12
continuous pressurization and depressurization test

test in which the pressurization rate and depressurization rate keep the same values without any pause for strain measurement

4 General

4.1 Test program

Prior to the test, the test program shall be prepared, including the test organization, test objective, test equipment, inspection content, loading and unloading procedures, support conditions and test result processing.

4.2 Manufacturing requirements

Tests shall be carried out on completion of assembly, welding of components and accessories, and completion of heat treatment/post weld heat treatment, if applicable. The components and accessories shall be assembled in place, provided with quality certificates for materials, manufacturing and assembly.

4.3 Test equipment and instruments

- a) The test equipment shall pass the certification, obtaining the qualifications of carrying out hydrostatic pressure test within the validity period.
- b) The test equipment and instruments shall pass the verification, which evaluates the metrological performance of measuring instruments and determines whether they are certified or not. The

equipment and instruments shall be within the specified period of validity and be checked and calibrated, and then remain in good condition before the test.

- c) The test equipment and instruments shall be installed in the appropriate positions according to the requirements of the test and to the relevant operating instructions, to prevent the test results from being affected by the external environment during the test.
- d) Two thirds of the range of the test pressure gauge shall not be less than the maximum test pressure.

4.4 Requirements for the test environment:

- a) During the hydrostatic pressure test, the pressure medium temperature may be set as the room temperature (10 °C to 30 °C). For viewports, the temperature of the pressurizing medium during the test shall be the design temperature for which the viewport is rated, with a tolerance of +0/-2,5 °C (+0/-5 °F). Brief deviations from these temperature tolerances are allowed, provided that the deviation does not exceed 5,5 °C (10 °F) and lasts less than 10 min.
- b) Atmospheric pressure: 0,084 MPa to 0,106 MPa.
- c) Relative humidity: 30 % to 95 %.
- d) Pressure medium: fresh water or seawater.

4.5 Test sequence

The hydrostatic pressure test of the submersible pressure structure consists of at least the following:

- a) a prior tightness test;
- b) the hydrostatic pressure test itself.

Optional testing includes strain measurement tests, and continuous pressurization and depressurization tests.

4.6 Test record

All test checks shall be recorded, and relevant reports shall be filled in.

4.7 Specification

The factors and terms in this document should be used when the design is not specific. When a design specifies other factors and terms, these should be considered, and the final decisions agreed with the designer and the recorded for use.

5 Detailed requirements

5.1 Preparation before the tests

Prior to testing, the integrity and appearance of the pressure structure shall be checked, and parameters such as dimensions and weights of the pressure structure shall be measured.

5.2 Hydrostatic pressure test

5.2.1 General

The test shall be carried out by steps and in two stages, namely a prior tightness test and the hydrostatic pressure test itself. The test pressure during the hydrostatic pressure test may exceed the maximum working pressure within a short period of time; the pressure test shall be carried out repeatedly to

check the consistency and stability of the test. For the selection of the test pressure, since manned submersibles with occupants are concerned with personnel safety, the test pressure requirements for pressure hull and buoyancy materials of manned submersibles are higher than those for pressure hull and buoyancy materials of unmanned submersibles. For the sake of safety, the maximum test pressure during the hydrostatic pressure test shall be higher than the maximum working pressure of submersibles, with the specific settings and test processes as given in 5.2.2 to 5.2.4. Prior to conducting the hydrostatic pressure test, the user shall verify that the testing object has adequate design safety margins.

5.2.2 Test pressurization and depressurization rates and holding time

The process of the hydrostatic pressure test is to simulate the hydrostatic external pressure applied to the pressure structure during diving, operating at the maximum working depth, and surfacing of the submersible. The test pressurization rate shall not be less than the pressure change rate caused by the diving speed of the submersible. The holding time at the maximum working pressure shall not be less than the design operation time at the maximum working pressure. The depressurization rate shall not be less than the pressure change rate caused by the surfacing speed of the submersible. The holding time at a pressure higher than the maximum working pressure during the test may be adjusted according to actual conditions.

5.2.3 Hydrostatic pressure test of the pressure hull and its accessories including viewports, hatches and connectors

5.2.3.1 Test pressure of the pressure hull and its accessories

5.2.3.1.1 Test pressure of the pressure hull of a manned submersible and its accessories.

- 1) For manned submersibles whose maximum working depth is not more than 6 000 m, the test pressure is set as 1,25 times the maximum working pressure.
- 2) For manned submersibles whose maximum working depth is more than 6 000 m, the test pressure is set as 1,1 times to 1,25 times the maximum working pressure.

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5.2.3.1.2 Test pressure of the pressure structure of an unmanned submersible and its accessories.

For the pressure hull and buoyancy materials of unmanned submersibles, the test pressure is set as 1,1 times to 1,25 times the maximum working pressure.

5.2.3.2 Test procedure for the pressure hull and its accessories

Prior to the hydrostatic pressure test, the maximum working pressure is applied to the pressure structure to check for leakage. Only by passing the tightness test, can the next hydrostatic pressure test proceed.

For a newly built pressure hull, it is generally recommended to conduct a pre-test before the formal hydrostatic pressure test. The pre-test procedure consists in pressurizing the pressure hull to the maximum working pressure and then releasing to zero, so as to eliminate the welding residual stress, machining stress and assembly stress, making the pressure hull to tend to a stable state.

The requirements for the hydrostatic pressure test are shown in [Figure 1](#).