International Standard

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Ships and marine technology — Human-occupied submersibles — Manoeuvring tests

Navires et technologie maritime — Submersibles habités — Essais de manœuvre

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Foreword

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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.

Introduction

As global marine technology continues to develop, human-occupied submersibles[1)] are being utilized in an increasing number of fields. A standardized manoeuvring test for human-occupied submersibles may be employed to provide a common approach to the analysis and assessment of the manoeuvrability performance of newly built submersibles. The output of such a common approach can provide useful information for the design, development and selection of navigation, power management and other ancillary systems used in the subsequent completion of the submersible's manufacture.

To meet the operating safety requirements, it is essential that the manoeuvring test is conducted within the designed safe operating envelope of the submersible including environmental, depth and endurance parameters. The measurement of manoeuvring performance is expected to be accurate and verifiable against an appropriately considered set of performance expectations. However, at the time of publication of this document, there is no International Standard that covers this element of submersible design and development in the industry. Therefore, the aim of this document is to provide standardized requirements for the submersible manufacturing and operating community.

1) This document uses the inclusive term "human-occupied submersible" in place of the term "manned submersible".

Ships and marine technology — Human-occupied submersibles — Manoeuvring tests

1 Scope

This document specifies the general requirements, test items and methods for conducting manoeuvring tests on human-occupied submersibles.

It is applicable to manoeuvring tests for all human-occupied submersibles operating in the sea and inland waterway areas.

It can also be used as a reference for manoeuvring tests on other types of submersibles operating in pools, lakes and seas.

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 terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
human-occupied submersible
submersible that encloses one or more persons within its pressure hull, fitted with one or more available surface accesses, or underwater pressurized or non-pressurized accesses

[SOURCE: ISO 5411:2024, 3.1.2, modified — the term has been modified from "manned submersible" to the inclusive term "human-occupied submersible".]

3.2
unpowered surfacing
free rising movement of a *human-occupied submersible* (3.1) which occurs without the use of propulsion or operation of the submersible's ballast system

3.3
unpowered submerging
free sinking movement of a *human-occupied submersible* (3.1) which occurs without the use of propulsion or operation of the submersible's ballast system

3.4
auto-depth keeping
computer-controlled mode to maintain the designated depth relative to the surface

[SOURCE: ISO 5411:2024, 3.9.6]

3.5
auto-heading control
computer-controlled mode to maintain the designated heading relative to the seabed

[SOURCE: ISO 5411:2024, 3.9.4]

3.6
auto-height keeping
computer-controlled mode to maintain the designated height above the seabed

[SOURCE: ISO 5411:2024, 3.9.7]

3.7
stopping distance
distance from slow down to stop with the use of propulsion, when a *human-occupied submersible* (3.1) travels at an initial speed

3.8
design maximum safe operating depth
maximum water depth at which the submersible is permitted to operate repeatedly and normally throughout its entire design life

4 General requirements and recommendations

4.1 Support vessel

For all submersible trial activities undertaken in open water such as the sea or an inland lake, a trial support surface vessel should be available to ensure the safe conduct of the trial programmes and meet any relevant requirements. If required, the support vessel should be capable of safely launching and recovering the submersible in the safe operating envelope of the submersible system. It can be necessary for the support vessel to be capable of dynamic positioning or mooring, thereby enabling the safe launch and recovery to be conducted in the environmental conditions in which the trials will take place. The vessel should be capable of dealing with any foreseeable emergency likely to be encountered during the trial programmes. The vessel should also have a robust communication capability such that the submersible's crew can communicate with the support vessel at all times during the trials and testing activities.

4.2 Test instruments

Test instruments include but are not limited to:

a) doppler velocity log;

b) depth gauge;

c) altimeter;

d) motion sensor;

e) conductivity, temperature and depth (CTD) sensor;

f) positioning system.

NOTE Test instruments can be subject to approval by national authorities for use in the testing process.

Test instruments should be valid for use in the testing regime and as required by the testing protocol.

Test instruments should be installed in a suitable location to achieve the objective of the test process and not adversely affected by movement, moisture, vibration or external environmental conditions during the test.

4.3 Test conditions

The test shall be conducted in a designated sea or inland waterway area where the water depth should be less than the design maximum safe operating depth of the human-occupied submersible. The specified test depth should not be affected by surface waves and appropriate safety precautions shall be implemented. This should include a suitably considered plan for recovery of a disabled submersible from the seabed or bottom of the inland waterway and establishing a safe depth which the submersible should not cross without approval.

The temperature, salinity, depth, seafloor topography and current of the seawater in the test area should be measured in advance, as a reference for whether a submersible can dive.

The submersible must successfully complete pre-dive checks and be fully serviceable throughout the test procedure. Any defects impacting on the safe conduct of the test or trial shall be rectified before continuing the test activity.

4.4 Emergency operating procedures

Emergency operating procedures must be established and tested, or drills must be conducted to ensure that they are adequate.

Any trial or test should be conducted in accordance with an authorized and defined set of specifications described in a formal trial order or similar auditable document. This should specify the aim, objectives, conditions, parameters, procedures to be used including the emergency procedures and the area where the trial is conducted. The person controlling the trial activity should formally sign the trial order or document.

At any time during the trial or test, the person responsible for conducting the activity should terminate the test or trial if there is any danger to the submersible crew or anyone else involved in the activity.

5 Test types

The following manoeuvring tests may be included in the trials and test programme:

a) unpowered submerging with releasable ballast response test;

b) powered submerging test;

c) unpowered surfacing with releasable ballast response test;

d) powered surfacing test;

e) auto-depth keeping test;

f) auto-heading control test;

g) triple-direction speed test;

h) braking sliding distance test;

i) turning test;

j) auto-height keeping test;

k) hovering test.

The listed tests should be chosen according to actual situation, which means some items can be removed depending on the capability of human-occupied submersibles.