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Ships and marine technology — Inflatable buoyancy support systems against flooding of ships —

Part 2: Buoyancy chamber

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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 8, *Ship design.*

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

This document is intended to support the development and technical implementation of various types of buoyancy support systems.

In case of marine accidents, such as collisions and groundings, excessive damage and flooding can cause the ship to sink, capsize or impede the use of its essential navigation equipment. As a ship has watertight bulkheads, doors, hatches and other equipment, the consequences of flooding accidents can usually be mitigated at the early phases of the accident. Subsequently, the progressive flooding after an important accident can cause the sinking or capsizing of the ship.

To counter these problems, inflatable buoyancy support systems can be used, which are composed of a gas supply system and a buoyancy chamber, where the gas supply system provides the medium for the inflation of the buoyancy chamber. A fixed fire extinguisher can be used as a gas inlet when the ship is at risk of sinking or overturning. When fire extinguishers are used to supply the media into the buoyancy chamber, additional means must be available not to impair fire-fighting, following SOLAS, Chapter II-2A, Regulation 4. Buoyancy chambers have various shapes and capacities to aid a damaged ship's buoyancy.

Ships and marine technology — Inflatable buoyancy support systems against flooding of ships —

Part 2: Buoyancy chamber

1 Scope

This document specifies general requirements, the materials and test methods for the buoyancy chamber of inflatable buoyancy support systems, which serve residual buoyancy for damaged ships not to sink or capsize, and which can be installed in machinery spaces and/or cargo holds.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 1402, *Rubber and plastics hoses and hose assemblies — Hydrostatic testing*

ISO 1419:2019, *Rubber- or plastics-coated fabrics — Accelerated-ageing tests*

ISO 1421:2016, *Rubber- or plastics-coated fabrics — Determination of tensile strength and elongation at break*

ISO 2231:1989, *Rubber- or plastics-coated fabrics — Standard atmospheres for conditioning and testing*

ISO 2411, *Rubber- or plastics-coated fabrics — Determination of coating adhesion*

ISO 4674-1:2016, *Rubber- or plastics-coated fabrics — Determination of tear resistance — Part 1: Constant rate of tear methods*

ISO 4675, *Rubber- or plastics-coated fabrics — Low-temperature bend test*

ISO 5978, *Rubber- or plastics-coated fabrics — Determination of blocking resistance*

ISO 9227, *Corrosion tests in artificial atmospheres — Salt spray tests*

ISO 9650-3, *Small craft — Inflatable liferafts — Part 3: Materials*

IMO Resolution MSC 81(70):1998, *Revised recommendation on testing of life-saving appliances*

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
inflatable buoyancy support system
system composed of a gas supply system and an inflatable *buoyancy chamber* (3.3) against flooding of ships

3.2
operating pressure
pressure determined by the designed pressure of the relief valves, except that, if the actual pressure of the relief valves, determined by testing, exceeds the designed pressure by more than 15 %, the higher figure is used

3.3
buoyancy chamber
chamber contributing to the buoyancy of a damaged ship

4 General requirements

4.1 General

The buoyancy chamber shall inflate within an air temperature range between –15 °C and 65 °C.

A schematic diagram of the inflatable buoyancy support system is shown in Figure 1 of ISO 23121-1:2019.

4.2 Valves

4.2.1 Topping-up inflation valve

All inflatable compartments shall be provided with a topping-up non-return valve allowing the compartments to be inflated by a bellows or a pump.

4.2.2 Non-return valve

Sufficient non-return valves shall be provided to the gas supply system.

4.2.3 Relief valve

The number and location of relief valves shall be such that the pressure is limited in all the inflatable compartments.

The relief valves shall be able to be sealed off temporarily according to the manufacturer's instructions. The relevant outlet shall not discharge inside the buoyancy chamber.

If the gas medium is carbon dioxide, the released medium shall be ventilated before entering the buoyancy chamber.

4.3 Indicator

Pressure and temperature indicators shall be provided to monitor the inflation of the buoyancy chamber.

4.4 High pressure hose assembly (if fitted)

Where a high-pressure hose assembly, if fitted, is used to convey the gas from the cylinder to the buoyancy chamber, it shall meet the following requirements (see also ISO 9650-1):

a) it shall show no leaks or any sign of deterioration after having been subjected, during at least 1 min, to a hydraulic test in accordance with ISO 1402, under a pressure of 12,5 MPa for liquefied gases and of 20 MPa for non-liquefied gases;

b) it shall operate within a temperature range of:

   1) between –45 °C and +65 °C inclusive, for liquefied gases;

   2) between –20 °C and +65 °C inclusive, for non-liquefied gases;

c) at the lowest temperature of each of the ranges defined in b) above, the hose shall be bent through 180° over a mandrel of radius 5 cm and shall meet the requirements of a);

d) the hose assembly shall not be in contact with any sharp edges and shall not show any sign of corrosion when tested;

e) the bursting pressure of the hose assembly shall not be less than 168 % of the hydraulic test pressure.

NOTE A new hose can be used for each operating test.

5 Materials

5.1 Metallic parts

All exposed metallic parts shall be tested in accordance with ISO 9227 for two periods of 24 h with a 2 h drying period in between (i.e. a total test time of 50 h).

After this test, there shall be no corrosion that might impair the function of the component.

5.2 Fabrics

The materials shall comply with the requirements specified in Table 1.

Table 1 — Performance requirements

Property	Performance requirements for buoyancy chambers	Subclause number
Tensile strength	not less than 1 500 N/50 mm warp, 1 300 N/50 mm weft	5.3.3
Tear strength, constant rate of traverse method A	not less than 80 N for both warp and weft	5.3.4
Coating adhesion, ply separation and surface receptiveness test	not less than 15 N/10 mm	5.3.5
Low-temperature bend test	Buoyancy chamber material[a] cracking when tested at – 50 °C is permissible only if an internal insulation and protection system are used. No cracking or other visible deterioration when tested at –30 °C is allowed.	5.3.6
Porosity	no bubbles visible within 5 min of the start of the test [a]	5.3.7
Ageing test	no cracking, blistering or stickiness	5.3.8
Hydrolysis test	after 14 days at 70 °C, 95 % relative humidity, following ISO 1419:2019, method C: 1) coating adhesion test: not less than 10 N/10 mm 2) folding test: no cracks	5.3.9
Resistance to blocking test	rating between one and two	5.3.10
Oil resistance test	2 h at 20 °C no tackiness test with ASTM no.1 oil	5.3.11

[a] For buoyancy chambers using an internal bladder construction, these tests (low-temperature bend test and porosity test) are applicable only to the inner bladder material. The outer support material shall meet a –15 °C low-temperature bend test.

[b] For buoyancy chambers using internal bladders, the specified value is 1 000 N/50 mm.

Table 1 *(continued)*

Property	Performance requirements for buoyancy chambers	Subclause number
Seam strength test	1) on new samples: tensile strength not less than 90 % of the value specified[b] in warp and weft 2) after ageing: tensile strength not less than 70 % of the value obtained on new samples in warp and weft	5.3.12

[a] For buoyancy chambers using an internal bladder construction, these tests (low-temperature bend test and porosity test) are applicable only to the inner bladder material. The outer support material shall meet a −15 °C low-temperature bend test.

[b] For buoyancy chambers using internal bladders, the specified value is 1 000 N/50 mm.

5.3 Test methods

5.3.1 General conditions

Unless otherwise specified, the standard environmental conditions for the tests shall be in conformance with ISO 2231:1989; atmosphere B shall be used. The temperature, humidity and atmospheric pressure at the time of test shall be recorded.

5.3.2 Test specimens

The required number of test specimens shall be taken from the effective width of a coated fabric, well away from the selvages and the ends, and in a direction parallel with the warp or parallel with the weft, as required. This does not apply to the ozone test or the porosity test.

5.3.3 Tensile strength

This test shall be carried out to determine the breaking strength under a tensile load.

The test shall be performed in accordance with ISO 1421:2016, method 1, using dry test strips.

5.3.4 Tear test (constant rate of traverse method)

This test shall be carried out in accordance with ISO 4674-1:2016, method A, using dry test specimens.

5.3.5 Coating adhesion, ply separation and surface receptiveness test

Adhesion between coating and fabric shall be tested in accordance with the method specified in ISO 2411. All coated surfaces shall be tested.

The adhesion strength is expressed as the arithmetic mean of the strengths of the specimens.

5.3.6 Low temperature bend test

This test shall be carried out in accordance with ISO 4675 on each coated surface of the material.

Test specimens for all materials shall be exposed at the test temperature for 1 h before the tests are carried out.

5.3.7 Porosity test

This test shall be carried out in accordance with ISO 9650-3.

5.3.8 Ageing test

This test shall be carried out in accordance with ISO 1419:2019, method B, for 7 days at a temperature of (70 ± 1) °C.

There shall be no visible cracking in accordance with ISO 4675.

5.3.9 Hydrolysis test

5.3.9.1 Method

This test shall be carried out in accordance with ISO 1419:2019, method C, for 14 days at 70 °C, 95 % relative humidity.

5.3.9.2 Folding test

Refer to material tests in IMO Resolution MSC 81(70).

After 15 min at room temperature, fold the specimens consecutively in two directions parallel to the edges at right angles to each other so as to reduce the exposed area of each specimen to one quarter of its original size. Unfold and refold along the same creases but with each fold reversed in direction. After each folding, press the fold by rubbing fingers and thumb along it, and inspect the specimens for cracks, separation of plies, stickiness or brittleness.

There shall be no visible cracking in accordance with ISO 4675.

5.3.10 Resistance to blocking test

This test shall be carried out in accordance with ISO 5978 [5 kg for 3 h at (70 ± 2) °C].

5.3.11 Oil resistance test

This test shall be carried out with reference to the material tests in IMO Resolution MSC 81(70), as follows.

When tested, after exposing the outer surface to oil ASTM No. 1 for 2 h at (20 ± 2) °C, there shall be no separation of coating from textile and no residual tackiness when two exposed faces are pressed together. The coating shall not smear when rubbed with a single pass of the finger.

The test shall be carried out not less than 16 h after vulcanization or curing.

5.3.12 Seam strength test

This test shall be carried out in accordance with ISO 1421.

6 Inflation tests

6.1 General

These tests shall be carried out for each packaging type according to the procedures described in 6.2, 6.3 and 6.4.

Each type of buoyancy chamber shall be tested according to the procedure described in 6.2 to 6.5.

6.2 Ambient temperature test

Let the buoyancy chamber, packaged in its valise or canister, stand for 24 h at an ambient temperature of (20 ± 2) °C.

Inflate the buoyancy chamber by pulling on the painter line.

The buoyancy chamber shall be inflated to its final shape within 120 s of actuating the inflation device, enabling persons to board.

The operating pressure shall be achieved within 2 min of actuating the inflation device.

6.3 High temperature test

Place the buoyancy chamber, packaged in its valise or canister, in a preheated chamber set at +65 °C and leave it for at least 7 h at +65 °C.

Inflate the buoyancy chamber by pulling on the painter line to trigger the firing mechanism.

Inspect the buoyancy chamber for any defects that could give problems with the intended use of the buoyancy support system.

There shall be no evidence of seam slippage, constructional defects, valve dysfunction or material deterioration as a result of the tests.

The maximum pressure shall be recorded and shall not exceed that required for the pressure test described in 6.5.

6.4 Low temperature test

Place the buoyancy chamber, packaged in its valise or canister, in a precooled chamber set at 0 °C and leave it for at least 24 h.

Keep the buoyancy chamber in this room at the temperature of 0 °C, and inflate it.

Inspect the buoyancy chamber for any defects that could give problems with the intended use of the buoyancy support system.

There shall be no evidence of seam slippage, constructional defects, valve dysfunction or material deterioration as a result of the tests.

6.5 Pressure test

6.5.1 Test for air pressure conservation

Inflate the buoyancy chamber to a pressure equal to the operating pressure, then leave it to stand for 30 min.

Readjust, if necessary, the design operating pressure, note the ambient temperature, wait 1 h and record the measured final pressure and the ambient temperature.

Apply, if necessary, a correction taking account of the variation in temperature at the rate of 0,4 kPa/ °C.

The final pressure, corrected if necessary, shall not be less than 95 % of the initial pressure.

The test is only valid if the temperature variation within the chamber is less than or equal to 3 °C.

The pressure relief valves shall remain operative during the test.

6.5.2 Excess pressure test

Each inflatable compartment in the buoyancy chamber shall be tested to a pressure equal to 3 times the operating pressure.

Each pressure relief valve shall be made operative, and compressed air shall be used to inflate the inflatable buoyancy chamber.