INTERNATIONAL STANDARD

ISO 15738

First edition
2002-02-01

Ships and marine technology — Gas inflation systems for inflatable life-saving appliances

Navires et technologie maritime — Systèmes de gonflage au gaz pour dispositifs de sauvetage

Reference number
ISO 15738:2002(E)

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Printed 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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 15738 was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 1, *Lifesaving and fire protection*.

It is intended to supplement International Maritime Organization (IMO) requirements for inflatable lifesaving appliances.

Ships and marine technology — Gas inflation systems for inflatable life-saving appliances

1 Scope

This International Standard specifies performance and testing requirements for the gas inflation systems for inflatable life-saving appliances complying with the requirements of the 1974 Safety of Life at Sea Convention (SOLAS 74), as amended, and the IMO International Life-Saving Appliance Code (LSA Code), adopted by IMO Resolution MSC.48(66).

For the purposes of this International Standard, the gas inflation system consists of inflation gas, cylinder valve, cylinder operating head, high-pressure hoses, and pressure-relief, inflate/deflate, non-return and transfer valves. This International Standard addresses only systems in which compressed inflation gas in cylinders is used as the inflation medium.

Because national requirements for qualification, use, and testing of gas-cylinders vary widely, requirements for gas-cylinders are not addressed in this International Standard, but should meet the requirements of the applicable regulatory bodies. The systems addressed in this International Standard are of the type generally used in primary life-saving appliances such as survival craft, marine evacuation systems, and means of rescue; systems used in personal life-saving appliances, such as inflatable lifejackets, are addressed elsewhere.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

International Convention for the Safety of Life at Sea, 1974 (SOLAS 1974), as amended in 1996

International Life-Saving Appliance Code (LSA Code), adopted by IMO Resolution MSC.48(66)

IMO Resolution A.689(17) (as amended), *Recommendation on Testing and Evaluation of Life-Saving Appliances*

3 Term and definition

For the purposes of this International Standard, the following term and definition applies.

3.1

approved cylinder

cylinder which has been approved by a competent authority as complying with an appropriate recognized national or international standard

4 Inflation gas

4.1 Type and quantity

The gas used for inflation shall be non-toxic, for example carbon dioxide. The type and quantity shall provide a sufficient rate of inflation to allow the complete system to meet the specified inflation performance requirements for the equipment in which it is installed.

4.2 Dryness

If the gas used is carbon dioxide, its moisture content shall be no more than 150 parts water per 1 million parts of gas by mass.

5 Gas-cylinder valve

5.1 General

5.1.1 The cylinder valve shall be fitted with a safety relief device which will vent gas prior to damage to the cylinder from overpressurization.

5.1.2 Means shall be provided to protect the threads on the cylinder valve for attachment of the high-pressure hoses and operating head from damage during storage and transit.

5.1.3 A cylinder valve constructed from aluminium alloy shall be anodized and may only be used with an aluminium cylinder, unless it is galvanically isolated from the cylinder.

5.1.4 Each combination of cylinder valve and cylinder which are of differing materials, or any aluminium alloy cylinder valve used with an aluminium cylinder, shall be subjected to the salt water exposure test as described in 5.2.9.

5.1.5 If the cylinder valve is for use with carbon dioxide, a syphon tube shall be used. It shall be ensured that, in all operational positions of the cylinder, the syphon tube's open end remains submerged in the liquid gas.

5.2 Testing

5.2.1 Safety relief test

It shall be demonstrated that the safety relief device on the gas-cylinder valve, when fitted to an approved cylinder in accordance with the instructions of the cylinder valve manufacturer, will operate at a pressure not greater than the highest cylinder test pressure for which it is rated.

5.2.2 Proof-load test

The bodies of six cylinder valves shall be subjected to an internal hydraulic pressure of the greater of 28 MPa, or the highest cylinder test pressure for which the valve is rated, for a period of 60 s.

On completion, there shall not be any signs of leakage or damage.

5.2.3 Temperature cycling test

5.2.3.1 Test procedure

Two gas-cylinder valves fitted to approved cylinders, with a gas capacity of not less than 5 litres, shall be charged with CO_2/N_2 gas in the ratio 96 %/4 % by mass, weighed and then alternately subjected to surrounding temperatures of $-$ 30 °C and $+$ 65 °C. These alternating exposures need not follow immediately after each other and the following procedure is acceptable.

Complete an 8 h half-cycle exposure at $+$ 65 °C in one day.

Remove specimens from the hot chamber and leave them exposed to ordinary room temperature until the following day.

Complete an 8 h half-cycle exposure at $-$ 30 °C the next day.

Remove specimens from the cold chamber and leave them exposed to ordinary room temperature until the following day.

Repeat the above procedure a further nine times.

5.2.3.2 Acceptance criterion

On completion, the cylinders shall be allowed to return to room temperature before being reweighed. The loss of mass, if any, shall not be greater than 2 % of the original mass of the gas.

5.2.4 Cold inflation test

Gas-cylinder valves fitted to two approved cylinders, with a gas capacity of not less than 5 litres, one charged with 3,17 kg of CO_2 and the other charged with 3,17 kg of CO_2/N_2 in the ratio 96 %/4 % by mass, shall be placed in a cold chamber at a temperature of $-$ 30 °C for 3 h.

On completion, the gas shall be capable of being completely and continuously discharged through a nozzle containing four holes of diameter 3,3 mm within the following times:

— CO_2: 20 s;
— CO_2/N_2: 14 s.

NOTE The cylinder may be rotated during the test to demonstrate the efficacy of the syphon in various operational positions.

5.2.5 Fatigue test

Two valve bodies shall be hydraulically pressure-cycled internally in a laboratory from 0 MPa to 20 MPa for 33 000 cycles.

On completion, the two valve bodies shall be subjected to a hydraulic pressure of the greater of 28 MPa, or the highest cylinder test pressure for which the valve is rated, for a period of 60 s. There shall be no damage to the valve bodies as a result of this test.

5.2.6 Long-term leak test

Cylinder valves shall be fitted to two approved cylinders, with a gas capacity of not less than 5 litres, charged with not less than 3,17 kg of CO_2/N_2 gas in the ratio 96 %/4 % by mass.

The two units shall be weighed carefully and then stowed in a secure stowage place for a period of 18 months at an ambient temperature of 18 °C to 20 °C.

On completion of the 18 month period, the two units shall be reweighed and the loss of gas charge on each cylinder shall not exceed 2 % of the original mass of the gas.

5.2.7 Impact test

One of the gas-cylinders and valves used in the long-term leak test, after being fully discharged of gas, shall be dropped 9 times from a height of 300 mm at an angle of 45° onto a concrete floor covered with hardboard so that the valve receives the full force of the impact.

The test shall be repeated with the cylinder angled in a plane at 90° to the original test.

On completion of the above tests, the cylinder shall be stood vertically on its base, and pushed over so that, as it falls, the cylinder valve strikes a steel stop secured to the floor. The height of the steel stop shall be not less than half the diameter of the cylinder used for the test. The test shall be repeated 12 times.

On completion, the valve shall be carefully examined, if necessary using a flaw detector. There shall not be any signs of flaw or fracture other than superficial surface damage.

An approved gas-cylinder, with a mass of at least 8,165 kg, fitted with the cylinder valve shall be dropped three times from a height of 1,5 m onto an aluminium sheet so that the valve takes the full force of the impact at an angle of 60° to the sheet.

The aluminium sheet shall be removed and the test repeated with a single drop onto a concrete floor.

On completion, the valve shall be removed from the cylinder and carefully examined. There shall not be any signs of flaw or fracture other than superficial surface damage.

5.2.8 Torque test

An approved CO_2 gas-cylinder shall be valved and devalved in accordance with the instructions of the valve manufacturer. Repeat for a total of six cycles.

On completion, carefully examine the valve threads. There shall not be any signs of stripping or damage.

5.2.9 Salt water exposure test

This test is applicable to combinations of cylinder valve and approved cylinder which are of differing materials, or any aluminium-alloy cylinder valve used with an approved aluminium cylinder.

The complete assembly shall be assembled in accordance with the instructions of the cylinder valve manufacturer, and partially immersed in a 3 % sodium chloride solution for a period of 18 months, or alternatively be exposed to a salt water spray (5 % sodium chloride solution) at a temperature of 35 °C ± 3 °C for 160 h without interruption.

On completion of either of these tests, the mass of the gas charge shall not have been reduced by more than 2 %, and both the valve and operating head shall function in a satisfactory manner.

NOTE This test may be performed simultaneously with the test specified in 6.2.4.

6 Gas-cylinder operating head

6.1 General

The connection between the operating head and the painter or operating cable shall be so arranged that the load is wholly taken by the operating mechanism until the valve has operated. For an operating head intended for use in an inflatable survival craft, means shall be provided so that, when the valve has been opened, the load on the painter is transferred to the towing patch or bridle of the survival craft.

The operating head of an approved cylinder, with a gas capacity of not less than 5 litres, charged with 3,17 kg of CO_2, shall fully open with an actuating force not exceeding 150 N and a travel of not more than 200 mm at an ambient temperature of 18 °C to 20 °C.

The operating head shall be made from corrosion-resistant materials.

An operating head constructed from aluminium alloy shall be anodized and shall comply with 5.1.4.

Means shall be provided, as necessary, to prevent kinking of the cable and abrasive damage to the fabric of an inflatable survival craft.

The operating head shall be sealed against the ingress of water.

The operating head shall be of a design that prevents any chafing of the fabric of an inflatable survival craft.

6.2 Testing

6.2.1 Hot actuation-force test

Two operating heads fitted to approved cylinders, with a gas capacity of not less than 5 litres, charged with 3,17 kg of CO_2, shall be placed in a hot chamber at a temperature of $+ 65$ °C for a period of 2 h. On removal from the hot chamber, the force required to activate the heads shall be measured.

The force shall not be greater than 150 N.

6.2.2 Cold actuation-force test

Two operating heads fitted to approved cylinders, with a gas capacity of not less than 5 litres, charged with 3,17 kg of CO_2, shall be placed in a cold chamber at a temperature of $- 30$ °C for a period of 2 h. On removal from the chamber, the force required to activate the heads shall be measured.

The force shall not be greater than 150 N.

6.2.3 Ambient actuation-force test

Two operating heads fitted to approved cylinders, with a gas capacity of not less than 5 litres, charged with 3,17 kg of CO_2, shall be placed at a temperature of 20 °C $\pm$ 3 °C for a period of 2 h. After this period, the force required to activate the heads shall be measured.

The force shall not be greater than 150 N.

6.2.4 Salt water exposure test

Two operating head assemblies, each fitted to an approved type of cylinder valve and cylinder, shall be partially submerged for a period of 18 months in a 3 % salt water solution at an ambient temperature of 18 °C to 20 °C, or alternatively be exposed to a salt water spray (5 % sodium chloride solution) at a temperature of 35 °C $\pm$ 3 °C for 160 h without interruption. On completion of either of these tests, the heads shall be carefully examined, then the operating mechanism shall be activated.

There shall not be any signs of excessive pitting or corrosion, and the operating heads shall continue to function in a satisfactory manner.

6.2.5 Impact test

An operating head assembly shall be fitted to an approved type of cylinder valve and placed in a cold chamber for 2 h at − 30 °C. On completion, drop the complete assembly from a height of 2 m onto a solid floor covered with a sheet of hardboard in such a way that the operating head receives the full impact on

— the top of the head, and

— the side of the head.

The test shall be repeated three times, replacing the assembly in the cold chamber between each test to ensure that a temperature of − 30 °C is maintained.

There shall be no visible signs of damage to the operating head and, on being activated, it shall continue to function in a satisfactory manner.

6.2.6 Water ingress test

Two operating head assemblies, each fitted to an approved type of cylinder valve and cylinder, shall be weighed and then submerged in water to a depth of 4 m for a period of 30 min.

Upon removal from the water, each assembly shall be weighed. There shall be no increase in mass due to water ingress.

Each operating head shall then be activated, and the contents of the cylinder shall be completely discharged. The actuation force shall not exceed 150 N.

After discharge, each operating head shall then be disassembled for inspection. There shall be no ingress of water into the system.

7 High-pressure hose assembly

7.1 General

A high-pressure hose shall be used to connect the gas-cylinder to the inlet manifold on the inflatable chambers.

It shall be constructed of natural or synthetic rubber or another suitable material having a smooth bore and some form of corrosion-resistant reinforcement.

It shall be fitted with end connectors of sufficient strength to withstand moderate overtightening.

NOTE Brass end connectors with a mass fraction of zinc of more than 33 %, if cold pressed without annealing, may be subject to “season cracking” and should be avoided.

Where nipples are inserted into the ends of the hose, they shall be suitably shaped to prevent damage or abrasion to the inner lining and to provide a smooth gas flow.

The outer casing of the hose shall be suitably protected against damage or abrasion.

The hose shall have a minimum bursting pressure of 21 MPa at an ambient temperature of 18 °C to 20 °C, and 4,2 MPa at a temperature of − 45 °C.

The hose shall operate in a satisfactory manner throughout an air temperature range of − 45 °C to + 65 °C.

The hose shall be capable of being bent through 180° over a former of 50 mm radius, at a temperature of − 45 °C, without cracking or damage.

The hose shall not distort or be damaged when subjected to a hydraulic pressure of 12,5 MPa.

Every hose shall be carefully inspected and marked by the manufacturer's quality inspector.

To enable traceability, the hose shall be marked externally with

— the name of the manufacturer, and

— the lot or batch number.

7.2 Testing

7.2.1 Hoses used for CO_2/N_2 gas systems

7.2.1.1 Three hoses, at an ambient temperature of 18 °C to 20 °C, shall be subjected to an internal pressure until destruction. The pressure at which the hose bursts shall not be less than 21 MPa.

7.2.1.2 Three hoses, after being placed in a cold chamber at a temperature of − 45 °C for a period of 72 h, shall immediately be subjected to an internal pressure until destruction. The pressure at which the hose bursts shall not be less than 4,5 MPa.

7.2.1.3 Three hoses shall be subjected to an internal hydraulic pressure of 12,5 MPa for a period of 60 s. During the test, the hose and end fittings shall be carefully examined and there shall not be any signs of leakage, damage or distortion.

7.2.1.4 The three hoses used in the hydraulic pressure test, after being thoroughly dried out, shall be placed in a cold chamber for 2 h at a temperature of − 45 °C. Immediately upon removal from the cold chamber, the hoses shall be bent through 180° around a former 50 mm in diameter, without any signs of cracking or damage. On completion of this test, the hoses shall be allowed to warm up to room temperature before being subjected again to the hydraulic test outlined in 7.2.1.3 to confirm that the hoses are still in a serviceable condition.

7.2.1.5 The joint between the hose and the end connections shall be subjected to an in-line loading of 180 kg for a period of 60 s, at an ambient temperature of 18 °C to 20 °C. On completion, the hose shall be carefully examined and shall not show any signs of damage or detachment from the end connections.

7.2.1.6 A hose placed on a solid base shall be subjected to a load of 45 kg, applied on a bar 25 mm wide resting on the hose at right angles to the bore, for a period of 60 s. Using a flow meter, flow rates shall be taken before and after the test to confirm that there has been no loss of cross-sectional area in the bore of the hose.

7.2.2 Hoses used for compressed air/nitrogen systems

7.2.2.1 The hoses shall be subjected to the tests outlined in 7.2.1.1 to 7.2.1.6 inclusive.

7.2.2.2 Three hoses shall be subjected to an internal pressure of 2,5 times the working pressure of the air/nitrogen in the storage cylinder, at an ambient temperature of 18 °C to 20 °C for a period of 60 s. The hoses shall not show any signs of leakage, distortion or damage.

8 Valves — pressure-relief, inflate/deflate, non-return/transfer

8.1 Pressure-relief valve

8.1.1 Pressure test

A minimum of six valves shall be subjected to this test. A valve shall be placed in a suitable test rig and air pressure applied slowly until the valve opens. The pressure shall then be gradually reduced until the valve re-seats. The valve shall be considered to have re-seated when its leak rate is less than 0,01 l/h.

The pressures at which the valve opens and re-seats shall be recorded and shall fall within the design parameters specified by the manufacturer.

NOTE The pressure at which a pressure-relief valve opens is commonly referred to as the “blow-off” pressure for the valve.

8.1.2 Drop test

A minimum of six valves shall be subjected to this test. A valve shall be dropped 12 times from a height of 2 m onto a solid concrete floor. On completion of the drops, the valve shall be carefully examined and then activated on a suitable test rig. There shall be no signs of any damage other than superficial surface damage, and the valve shall continue to function in a satisfactory manner.

8.1.3 Valve securing test (where applicable)

A minimum of six valves shall be subjected to this test. A valve shall be placed in a suitable test rig and subjected for a period of 3 min to a tensile test force of 1 800 N across the flange in an attempt to separate it from the valve. The valve shall be turned through 90° and the test repeated.

On completion of the test, the valve shall be examined and shall not show any signs of distortion or detachment of the flange from the valve.

8.1.4 Pulsating load test

A minimum of six valves shall be subjected to this test. A valve shall be fitted to a single inflatable buoyancy tube of an approved six-person liferaft. The tube shall be inflated until the valve opens, and the pressures at which the valve opens and re-seats shall be recorded. A person weighing not less than 75 kg shall then step up onto the tube 25 times and, on completion, the pressure in the tube shall be recorded. The pressure drop in the tube shall not be greater than 10 % of the pressure at which the valve re-seated.

8.1.5 Overpressure test

A minimum of six valves shall be subjected to this test. The valve, fitted to the tube used in 8.1.4, shall be plugged, and the tube inflated to a pressure at least three times the pressure at which the valve opens (blow-off pressure). This pressure shall be maintained for a period of 5 min and the valve shall be carefully examined.

There shall be no damage to the valve or any signs of it being detached from the tube.

8.1.6 Flow test

A minimum of six valves shall be subjected to this test. Using a flow meter and a suitable test rig, it shall be demonstrated at an ambient temperature of 18 °C to 20 °C that the valve, when fully open, is capable of discharging gas at least at the following rates:

Table 1 — Required flow rates

Pressure	Flow rate
0,014 MPa (14 kN/m^2)	1,30 m^3/min
0,021 MPa (21 kN/m^2)	1,85 m^3/min
0,028 MPa (28 kN/m^2)	2,45 m^3/min
0,042 MPa (42 kN/m^2)	3,40 m^3/min

8.2 Inflate/deflate valve

8.2.1 Leak test

A minimum of six valves shall be subjected to this test. A valve shall be placed in a suitable test rig and air pressure slowly applied until the valve opens. The valve shall be allowed to re-seat and an air pressure of 0,014 MPa shall be applied to the back of the valve. The leak rate through the valve shall be less than 0,01 l/h.

8.2.2 Valve-securing test

A minimum of six valves shall be subjected to this test. A valve shall be placed in a suitable test rig and be subjected to a tensile force of 1 800 N across the flange in an attempt to separate it from the valve. The force shall be applied for not less than 3 min, then the valve turned through 90° and the test repeated.

The valve shall not be distorted and there shall not be any signs of detachment of the flange from the valve.

8.2.3 Drop test

A minimum of six valves shall be subjected to this test. A valve shall be dropped 12 times from a height of 2 m onto a solid concrete floor. On completion of the drops, the valve shall be carefully examined and then activated on a suitable test rig. There shall be no signs of any damage other than superficial surface damage, and the valve shall continue to function in a satisfactory manner.

8.2.4 Flow test

A minimum of six valves shall be subjected to this test. Using a flow meter and a suitable test rig, it shall be demonstrated, at an ambient temperature of 18 °C to 20 °C, that the air flow through the valve when fully open at a range of pressures between 0,014 MPa and 0,028 MPa complies with the design parameters specified by the manufacturer.

8.3 Non-return/transfer valve

8.3.1 Leakage test

A minimum of six valves shall be subjected to this test. A valve shall be placed in a suitable test rig and air pressure slowly applied until the valve opens. The valve shall be allowed to re-seat and an air pressure of 0,007 MPa applied to the back of the valve. The leak rate shall be less than 0,01 l/h. This test shall then be repeated using a pressure of 0,014 MPa.

8.3.2 Valve-securing test

A minimum of six valves shall be subjected to this test. A valve shall be placed in a suitable test rig and be subjected to a tensile force of 1 800 N across the flange in an attempt to separate it from the valve. The force shall be applied for not less than 3 min, then the valve turned through 90° and the test repeated.

The valve shall not be distorted and there shall not be any signs of detachment of the flange from the valve.

8.3.3 Drop test

A minimum of six valves shall be subjected to this test. A valve shall be dropped 12 times from a height of 2 m onto a solid concrete floor. On completion of the drops, the valve shall be carefully examined and then activated on a suitable test rig. There shall be no signs of any damage other than superficial surface damage and the valve shall continue to function in a satisfactory manner.

9 Final determination of suitability of a system

It shall be emphasized that the final determination of suitability of a system evaluated in accordance with this International Standard shall be made on the basis of testing the end product in which the system is used in accordance with IMO resolution A.689(17), as amended through IMO Resolution MSC.81(70). The suitability of any component of the system is generally dependent upon its relationship to the size, number, and arrangement of the other components of the system in the end product. In addition to the specific requirements of this International Standard, it is expected that approval authorities will also evaluate inflation systems against the general material requirements in paragraph 1.2 of the IMO LSA Code.

ICS 47.020.99

Price based on 10 pages