



**International
Standard**

ISO 11326

**Ships and marine technology — Test
procedures for liquid hydrogen
storage tank of hydrogen ships**

**First edition
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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 document 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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 3, *Piping and machinery*.

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

Hydrogen offers a reliable way to decarbonise a variety of sectors including the maritime industry, where it has been historically difficult to meaningfully reduce CO₂ emissions despite the commitments by governments and the implementation of regulatory measures.

There are technologies available that enable hydrogen to be produced, stored, transported and used as energy in different ways. Various materials can be produced by hydrogen, including renewable energy, natural gas, coal and oil. Hydrogen can be transported as a gas by pipelines or in liquid form by ship, much like liquid natural gas (LNG), and transformed into electric energy to provide homes or industry with power and also into fuels for cars, trucks, ships and planes.

However, the safe and wide use of hydrogen in marine industry faces several challenges, in particular the absence of applicable international standards on the safety testing of hydrogen systems. All system components should be designed and tested for the safety and reliability in handling liquid hydrogen and thereby the facilitation of decarbonisation with the transition into hydrogen-based clean energy.

In this regard, this document sets up a general test requirement for the liquid hydrogen cargo tank of hydrogen carrier ships. It is expected that useful information can be provided to the marine industry stakeholders including ship owners, classification societies and shipyards. Finally, this document aims to contribute to the growth of relevant industries and benefit all related stakeholders.

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Ships and marine technology — Test procedures for liquid hydrogen storage tank of hydrogen ships

1 Scope

This document specifies general inspection and test requirements for liquid hydrogen cargo tanks on board hydrogen carrier ships. In the cases of liquefied hydrogen containment systems, the testing activity depends strictly on the type of storage containment technology identified by the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code).^[1] This document is applicable to Type C independent metallic double wall type tanks with vacuum insulation having a capacity of not more than 1 000 cubic metres (m³). It is also applicable to liquid hydrogen cargo tanks which are designed to transport pure para-hydrogen (not less than 95 % content).

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 11114-4, *Transportable gas cylinders — Compatibility of cylinder and valve materials with gas contents — Part 4: Test methods for selecting steels resistant to hydrogen embrittlement*

ISO 17636-1, *Non-destructive testing of welds — Radiographic testing — Part 1: X- and gamma-ray techniques with film*

ISO 17636-2, *Non-destructive testing of welds — Radiographic testing — Part 2: X- and gamma-ray techniques with digital detectors*

ISO 3452-1, *Non-destructive testing — Penetrant testing — Part 1: General principles*

ISO 9934-1, *Non-destructive testing — Magnetic particle testing — Part 1: General principles*

ISO 23208, *Cryogenic vessels — Cleanliness for cryogenic service*

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 design pressure

pressure used to determine minimum scantlings of the *liquefied hydrogen (LH₂)* (3.3) storage tank

3.2 maximum allowable working pressure MAWP

maximum pressure of a storage tank determined by the tank design code

Note 1 to entry: MAWP should not be less than the *design pressure* (3.1).

3.3
liquefied hydrogen

LH₂
hydrogen that has been cooled and condensed into liquid form

Note 1 to entry: LH₂ is a cryogenic liquid having a temperature typically around -253 ° Celsius under normal atmospheric pressure.

3.4
para-hydrogen

one of the two isomers of the hydrogen molecule where the nuclear spins of the two atoms are opposed

3.5
independent tank

self-supporting tank that does not form part of the ship's hull and is not essential to the hull strength

Note 1 to entry: The design basis for type C independent tanks is based on pressure vessel criteria modified to include fracture mechanics and crack propagation criteria.

3.6
cold spot

part of the hull or thermal insulation surface where a localized temperature decrease occurs with respect to the allowable minimum temperature of the hull or its adjacent hull structure, or design capabilities of cargo pressure and temperature control systems

4 Abbreviated terms

For the purpose of this document, the following abbreviated terms apply

| | |
|----------|---|
| IMO | International Maritime Organization |
| MSC | Maritime Safety Committee |
| IGC Code | International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk |
| IACS | International Association of Classification Societies |
| ASME | American Society of Mechanical Engineers |

5 Inspection and tests

5.1 General

Tests shall be conducted on new design Type C independent tanks for liquid hydrogen storage on hydrogen carrier ships. All tanks subjected to type tests shall be made unusable after the tests are completed.

The LH₂ storage tank provider shall preserve the type test results for the intended life of the storage tank design. The test result shall also document the tank specification.

[Annex B](#) gives an example of general inspection and test procedures. The liquid hydrogen storage tank may be subjected to inspection and tests specified in [Annex B](#), under mutual agreement between owner and the LH₂ storage tank provider.

[Annex E](#) provides an example figure of the design and installation arrangements of a vacuum-insulated LH₂ cargo tank, with various piping and instrumentation normally attached to the tank.

[Annex A](#) provides information regarding other potential hazards and safety considerations associated with the storage and containment of liquefied hydrogen.

5.2 Design appraisal

Liquid hydrogen storage tank drawings and material specifications shall be submitted to the owner or classification society for written approval before test implementation. The owner or classification society shall approve of the drawings.

An example of the drawings which can be submitted are listed in [Annex C](#).

5.3 Material inspection

Material property testing of liquid hydrogen storage tanks, which are required for the acceptance of use by the classification society or ship owner where the minimum design temperature is less than -196 °C , shall be carried out with the appropriate medium within the range between the maximum design temperature in service (normally taken as 45 °C) and the temperature lower than the minimum design temperature by at least 5 °C .

The hydrogen embrittlement test shall be carried out and materials shall be selected to ensure the safety of liquid hydrogen cargo tanks. Reference should also be made to the “Guide to Safety of Hydrogen and Hydrogen systems” published by the American Institute of Aeronautics and Astronautics (AIAA),^[3] as referenced in IMO Resolution MSC. 420(97).^[22]

The hydrogen embrittlement test shall be carried out to provide evidence that the metallic double wall type hydrogen storage tank is not susceptible to hydrogen embrittlement. In hydrogen storage tanks that are subject to frequent evaporated gaseous form, conditions can lead to local fatigue, and the initiation and propagation of fatigue cracks induced by ship motion in the liquid hydrogen cargo tanks. The hydrogen compatibility shall be tested in accordance with ISO 11114-4.

Test results should show that the selected materials for liquid hydrogen storage tanks are suitable for their specific operating conditions and environment, taking into account factors such as design temperature, pressure, working stress and other environmental conditions.

5.4 Welding inspection

All welded joints of the shells and domes to shell of liquid hydrogen storage tanks shall be of the butt weld full penetration type to prevent leakage of hydrogen. For nozzle or other penetration connections, either fillet welds or the full penetration type may be used depending on the results of the tests carried out, after getting approval of the welding procedure. Otherwise, if the nozzle or other penetration is made of forgings with an integral forged ring to match the contour of the dome or shell, the joint shall use full penetration butt welds.

All welded points of the liquid hydrogen storage tank between the inner tank and outer tank shall be subjected to non-destructive test inspection. All butt welds of liquid hydrogen storage tanks shall be subjected to radiographic testing in accordance with ISO 17636-1 and ISO 17636-2. Where welding points of the liquid hydrogen storage tank cannot be radiographed, these welds shall be subjected to penetrant testing in accordance with ISO 3452-1, magnetic particle testing in accordance with ISO 9934-1, and approved ultrasonic testing.

5.5 Hydrostatic test

A hydrostatic test shall be carried out at a pressure measured at the top of tank.

The test pressure shall be at least 1,5 times the design pressure. At no point during the pressure test shall the calculated primary membrane stress exceed 90 % of the yield stress of the material. To ensure that this condition is satisfied where calculations indicate that this stress will exceed 0,75 times the yield strength, the type test shall be monitored using strain gauges or other suitable equipment in pressure vessels, other than simple cylindrical and spherical pressure vessels.

The temperature of the water used for the test shall be at least 30 °C above the nil-ductility transition temperature of the material, as fabricated. The pressure shall be held for 2 h per 25 mm of thickness, but in no case less than 2 h.

Where necessary, a pneumatic test may be carried out in cases where the liquid hydrogen storage tank is produced or supported such that it cannot be safely filled with water. The pneumatic test procedures may be specially considered by the relevant testing authority, and the test pressure for a pneumatic test shall be 1,25 times the maximum allowable working pressure (MAWP). Special considerations shall be given to the stored energy involved with a pneumatic test, and it shall be carried out where adequate facilities and procedures are employed to ensure the safety of inspectors and the public.

Upon completion of the hydrostatic test, the inner tank shall be cleaned and dried in accordance with ISO 23208.

5.6 Tightness test

For the liquid hydrogen cargo tank tightness test, helium or a mixture of 5 % hydrogen and 95 % nitrogen should be used as the test medium instead of air, with dedicated detectors employed since the permeability of hydrogen is high.

The tightness check for the inner vessel can be completed after the hydrostatic test by reducing the pressure to the design pressure with an appropriate tracer gas. The helium leak test can be completed by a sniffer method with appropriate calibration at every 10 m of weld. When the LH₂ tank design includes wear plates or support plates covering the inner vessel weld, then appropriate leak testing to test these welds shall be done before the completion of the inner vessel.

The outer vessel vacuum integrity should be confirmed by injecting helium into the space between the inner and annular outer vessel weld/sealing surfaces and placing a detector appropriately on the vacuum port. The standard leak calibrator shall be connected to the vacuum port to establish the delay time and set the speed of the helium spray on the outer vessel welds. During the operation of this test, the inner vessel can be maintained at design pressure with helium tracer gas and nitrogen mixture to complete the test.

The helium leak testing procedure should be confirmed according to ISO 20485 and ISO 20486, ASME Section VIII Div 2, JIS Z 2331 or other suitable standards. Tests shall confirm that there are no leaks larger than the limit acceptable criteria.

Consideration should be given to using oxygen-free nitrogen with a small molecule tracer gas, such as helium, as the test medium and an electronic leak detector for identifying leaks.

If the above test medium is not practical, test mediums other than helium or a mixture of 5 % hydrogen and 95 % nitrogen can be used to conduct the test, upon mutual agreement between the owner and the LH₂ storage tank provider.

5.7 Insulation and testing

The insulation performance testing should be conducted in accordance with ISO 21014. The test can be confirmed in the fully loaded condition at the proper vacuum level.

5.8 Cold spot test

Cold spot tests aim to verify:

- the results of thermal calculation for the adjacent structures of storage tanks such as fixed supports, saddle, nozzle, gauge points or tank holding space bulkheads;
- the possible failure of vacuum insulation system of storage tank.

A cold spot test failure occurs if icing is detected at the cold spot test area. The loading of LH₂ generally improves the vacuum, thereby enhancing the insulation performance. However, there can be cold spots from support structures between the outer and inner walls of the tank.

5.9 Visual inspection

The outer surfaces of the inner and outer tanks shall be visually inspected. The liquid hydrogen storage tank surfaces shall not show any damage or defects.

6 Marking

The test result shall be stencilled or otherwise marked with the date of testing, tank specified maximum working pressure and storage capacity. If used in services other than ambient temperature services, its maximum and minimum service temperature shall also be marked.

See [Tables D.1](#) to [D.3](#) for examples of a marked name plating test report for the liquid hydrogen storage tank.

7 Test report

The test report shall include at least the following details:

- a) the size and type of the test tank;
- b) the name of the manufacturer;
- c) the serial number;
- d) the test number;
- e) test items;
- f) test data including the test results and date of the test;
- g) reference to this document (e.g. ISO 11326:2024);
- h) any deviations from the procedure;
- i) any unusual features observed;

A sample format of a test report is shown in [Annex D](#).

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Annex A (informative)

General considerations for liquefied hydrogen storage tank

A.1 Potential hazards

A.1.1 General

This annex provides general considerations for the liquid hydrogen storage system. Liquefied hydrogen has dangerous characteristics such as low ignition energy, a wide range of flammability limits, low visibility of flame in case of fire, and high flame velocity, which can potentially lead to a detonation explosion with shockwave. It is also characterized by extremely low temperature, which can result in liquefaction or solidification of inert gas and constituents of air, which can result in an oxygen-enriched atmosphere. Furthermore, high permeability, low viscosity, and hydrogen embrittlement of weld metals are other risk factors.

The LH₂ storage tank provider should consider the potential hazards related to liquid hydrogen storage systems, allowing for control of the potentially hazardous environments and chemical properties associated with hydrogen. Any event involving hydrogen that can result in one or more of the following is considered a hazard:

- a) injury to people;
- b) damage to property or equipment;
- c) delay or malfunction of ship operation;
- d) indirect global warming potential/environmental pollution.

Liquefied natural gas (LNG) is widely used in marine industry, and relevant technology for its safe application is relatively mature. In this regard, the difference of physical properties between hydrogen and methane should be considered. Based on the comparison of physical properties with methane, major hazards of hydrogen can be clearly identified. [Table A.1](#) shows a comparison of the physical properties of hydrogen and methane (the primary component of LNG).

Table A.1 — Comparison of physical properties in hydrogen and methane

| Item | Hydrogen | Methane |
|--|----------|---------|
| Boiling temperature (K) | 20,3 | 111,6 |
| Liquid density (kg/m ³) | 70,8 | 422,5 |
| Gas density (kg/m ³) (Air: 1,198) | 0,084 | 0,668 |
| Lower flammable limit (%) | 4,0 | 5,3 |
| Higher flammable limit (%) | 75,0 | 17,0 |
| Lower detonation limit (%) | 18,3 | 6,3 |
| Higher detonation limit (%) | 59,0 | 13,5 |
| Minimum ignition energy (mJ) | 0,017 | 0,274 |
| Auto ignition temperature (°C) | 560 | 600 |
| Viscosity (g/cm·s×10 ⁻⁶) (liquid) | 13,49 | 116,79 |
| Flame temperature in air (°C) | 2 396 | 2 230 |
| Maximum burning velocity (m/s) | 3,15 | 0,385 |
| Maximum experimental safe gap (MESG), mm | 0,29 | 1,12 |

NOTE For further explanation of auto ignition temperature and MESG, see IMO Resolution MSC.420(97)^[22] and ISO/IEC 80079-20-1.

A.1.2 Combustion hazard

Combustion hazards can potentially result in fire. The LH₂ storage tank provider and ship system designer should therefore consider the following scenarios:

- Hydrogen is released, mixes with an oxidizer, and forms a combustible mixture. The mixture contacts an ignition source and fire occurs.
- The hydrogen system is contaminated with an oxidizer as a result of improper operation, which can be either purging or leakage, or leakage of an oxidizer such as air. The hydrogen and the oxidizer form a combustible mixture, which contacts an ignition source, and ignition occurs.
- Hydrogen or an oxidizer leaks from one part of a system into another part of the system, where a combustible mixture is formed and subsequently ignited.

A.1.3 Pressure hazard

Overpressure hazards which result in a subsequent release of hydrogen should be considered, since hydrogen has a significant expansion ratio in its conversion from a liquid at normal boiling point to a gas at normal temperature and pressure.

Liquid hydrogen has a higher volumetric energy density than gaseous hydrogen. This means that more liquid hydrogen can be stored in a tank or cylinder than gaseous hydrogen. Hence, when boil-off gas occurs, the pressure in the tank infrastructure increases.

A minor increase in pressure is not necessarily a problem, but if the pressure increases significantly, dangers can arise. For example, when the gas accumulates in one place or when the infrastructure comes under too much pressure, the risk of fire and explosion becomes imminent.

A.1.4 Leakage and dispersion hazard

Hydrogen permeability is relatively higher than methane, which makes it easier to leak since hydrogen is the lightest element in nature with the smallest molecular size and atomic mass. Especially, when hydrogen is transported by ship, the high storage pressure and large storage capacity greatly increase the risk of hydrogen leakage.

If hydrogen leaks in confined spaces in ships such as machinery space or hydrogen refuelling stations, hydrogen can easily accumulate on the top of the confined space, forming an explosive mixed gas cloud, leading to fire or explosion hazard. Therefore, it is important to consider the hazards of hydrogen leakage and the removal of leaked hydrogen from confined spaces.

A.1.5 Rapid boiling temperature increase hazard

Due to the demand for high hydrogen storage density, hydrogen storage tanks mostly adopt a structure with a composite fibre winding and aluminium inner liner structure.

The temperature of the hydrogen storage tank rises during filling operations, which affects the resin binder of the composite material, reducing its load-bearing capacity and lowering the overall safety of the storage tank. In this regard, the LH₂ storage tank provider should pay attention to rapid temperature increases which can lead to certain safety hazards.

NOTE The term BLEVE stands for “boiling liquid expending vapor explosion”. It describes a hazard for flammable liquids which occurs when the pressure containment system for the liquid is lost, such as a tank rupture, and the liquid rapidly expands and converts to a flammable vapour.

A.1.6 Fire and explosion hazard

[Table A.1](#) explains that hydrogen has a wider combustion range and smaller minimum ignition energy, which makes it easier to be ignited after leakage in confined spaces of hydrogen ships. Without mitigation, hydrogen gas accumulates in confined spaces and mixes with air to form an explosive gas cloud, which can cause a fire or explosion hazard after encountering an ignition source. A hydrogen fire is hard to detect and observe in the daytime since the flame of hydrogen is colourless.

The downstream vent mast piping of the LH₂ storage tank should ensure that:

- the released cryogenic hydrogen vapour does not ignite in the confined pipe when in contact with air. Sufficient purging means should be provided to keep the pipe inert.
- the length/diameter (L/D) ratio of the vent line piping is appropriate to prevent a deflagration to detonation transition.
- the vent mast outlet prevents the collection of static and falling droplets of liquid oxygen which can ignite the released H₂ vapour;
- means to detect vent mast fire are provided and tested.

One of the important and special property features of hydrogen is that it can spontaneously ignite after leakage without a clearly identified ignition source. Hydrogen leakage and spontaneous combustion can lead to fire or explosion accidents in ships. In this regard, the LH₂ storage tank provider and ship designer should consider fire and explosion hazards.

A.1.7 Embrittlement hazard

Hydrogen embrittlement can lead to leakage or catastrophic failures in metal and non-metallic storage tanks. Therefore, choices of suitable materials and manufacturing processes for the hydrogen system in marine applications are key to resisting hydrogen embrittlement. The mechanisms that cause hydrogen embrittlement effects are not well defined. Factors known to influence the rate and severity of hydrogen embrittlement include hydrogen concentration, pressure, temperature, purity, type of impurity, stress level, stress rate, metal composition, metal tensile strength, grain size, microstructure, and heat treatment history.

Considering the above-described hydrogen properties and hazards, ship design and risk assessment should at least focus on the following issues:

- keeping the H₂ concentration to less than lower explosive limit (LEL);
- high flammability;
- chemical reaction with oxidant agents;
- asphyxiation at high H₂ concentrations;
- hydrogen accumulation on the upper part of spaces;
- invisible and high temperature flame;
- H₂ embrittlement of metals at high pressure;
- H₂ cryogenic temperatures causing thermal fractures.

A.1.8 Human contact hazard

Since all cryogenic liquids and their boil-off vapours are extremely cold, they can rapidly freeze human tissue and cause frostbite. Even a brief contact with a cryogenic liquid is capable of causing tissue damage similar to that of thermal burns.

Cryogenic liquids are typically odourless and colourless when vaporized to the gaseous state.

Wearing personal protective equipment when handling cryogenic material is necessary.

A.2 Accessories

A.2.1 General

Tank accessories should have a minimum working pressure equal to at least the MAWP of the inner tank.

A.2.2 Pressure relief valves for the inner tank

The inner tank should be protected with a primary pressure relief valve that limits the pressure inside the inner tank to not more than 120 % of the MAWP of the inner tank. This pressure relief valve should be connected directly to the highest part of the inner tank in its design position under normal operating conditions.

The inner tank pressure relief valves should close at a pressure higher than 90 % of the set pressure of the pressure relief valve and remain closed at all lower pressures.

The sizing of the inner tank pressure relief valves should be done according to ISO 21013-3.

The rating (set pressure) of the inner tank pressure relief valves should be based on the consideration of the containment structural strength and clearly marked. A lead seal or equivalent system should be installed on these pressure relief valves in order to provide a physical impediment to tampering. Fitting of pressure monitoring measures such as pressure sensors and alarms should be activated for early detection of high pressure.

Pressure relief valves should function under cryogenic conditions, given the exposure to ambient moisture that can be prone to icing.

A.2.3 Vacuum isolation connection on outer vessel

Vacuum plates, gauges, and O-ring based isolation valve seats should be tested to meet sealing requirements against the vacuum to atmospheric pressure ratio in the loaded state. O-ring based seals are known to fail (i.e. they allow air ingress beyond acceptable) when the vacuum improves beyond 1×10^{-6} Pa.

A.2.4 Lines incorporating pressure relief valves

The piping lines in front of and behind the pressure relief valves should not impede their function.

A.2.5 Automatic shut-off valves and non-return valves

The cargo tank should be provided with shut-off valves for the purpose of securing the bunkering lines. These valves should be mounted directly on or within the cargo tank.

A.2.6 Overfill protection gauge

The cargo tank should be equipped with a measuring gauge that measures the level of liquid in the inner tank as it approaches the maximum filling level with an accuracy of ± 2 % of the inner tank capacity.

A.2.7 Maximum filling level

A system should be provided for preventing the cargo tank from being overfilled. This system may work in conjunction with the bunkering station. During the filling process, the pressure relief valve should not operate. The filling process should not lead to operating conditions that the boil-off management system is not designed for, and therefore cannot handle. Under all circumstances and regardless of the cargo condition and the maximum operating pressure of the inner tank, the filling volume of liquid hydrogen should not exceed the maximum filling level of the inner tank specified by the cargo tank manufacturer.

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Annex B
(informative)

Inspection and test procedures

[Table B.1](#) provides an example of the tests and inspections that can be required for the acceptance of an LH₂ storage tank, under mutual agreement between the owner and the LH₂ storage tank provider.

Quality assurance representatives of the liquid hydrogen storage tank manufacturer should attend all inspections and review documentation for accuracy.

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Table B.1 — Sample inspection and test procedures

| No. | Inspection activity | Inspection specification | Document contents |
|-----|---------------------|---|--|
| 1 | Design approval | Material application review of design conditions | MTR/Datasheet/Equipment drawing |
| | | DWG, design, calculation document review | Datasheet / Equipment drawing |
| 2 | Material Inspection | Material application review of design conditions | MTR / Datasheet / Equipment drawing |
| | | Visual inspection and marking check | Cutting plan |
| | | Mill certificate check (shell plate, cap) | MCR |
| 3 | Welding inspection | Ultrasonic test material and test activity check | MTR or USTR |
| | | Visual check of welding part (crack, overlap, undercut etc) | Dimension check record |
| | | Butt fit-up inspection | WPS/PQR |
| | | Welder qualification certificates | WPS/PQR |
| | | UT, PT, MT test review | NDE test |
| | | RT test and film review | NDE test |
| 4 | Hydrostatic test | Hydrostatic test | Hydrostatic test procedure/Hydrostatic test report |
| 5 | Tightness test | Tightness test | Tightness test report |
| | | Helium leak test (if necessary) | Helium leak test report |
| 6 | Cold spot test | Cold spot evaluation | Cold spot evaluation procedure |
| | | Test document review | Datasheet / Equipment drawing / Cold spot evaluation procedure |

Key

- MTR Material test report
- DWG Drawing
- MCR Material certificate report
- USTR Ultrasonic test report
- WPS Welding procedure specification
- PQR Procedure qualification record
- UT Ultrasonic testing
- PT Penetrant testing
- MT Magnetic testing
- RT Radiography testing
- NDE Non-destructive examination
- MLI Multi-layer insulation

Table B.1 (continued)

| No. | Inspection activity | Inspection specification | Document contents |
|-----|---------------------|---|--|
| 7 | Visual Inspection | Visual inspection of plate and cap after assembly and thickness check of main parts | Dimension check record |
| | | Plate and head forming and dimension check | Formed head inspection report |
| | | Head forming heat treatment check | Formed head inspection report/ Heat treatment record |
| | | Multi-layer film winding preparation check | Datasheet / MLI inspection report |
| | | Visual inspection and marking check | Cutting plan |
| | | Check of name plate | Nameplate report |
| | | Final visual and dimensional check | As-built drawing |

Key

- MTR Material test report
- DWG Drawing
- MCR Material certificate report
- USTR Ultrasonic test report
- WPS Welding procedure specification
- PQR Procedure qualification record
- UT Ultrasonic testing
- PT Penetrant testing
- MT Magnetic testing
- RT Radiography testing
- NDE Non-destructive examination
- MLI Multi-layer insulation

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Annex C (informative)

Example of drawing list applicable to design appraisal

[Table C.1](#) provides an example of the drawings which can be submitted for design appraisal.

Table C.1 — List of drawings for design appraisal

| No. | Drawing and description |
|-----|---|
| 1 | Arrangement of liquefied hydrogen storage tank |
| 2 | Detail of tank structure including tank connection space; welding details shall be included |
| 3 | Supporting structure of liquefied hydrogen storage tank |
| 4 | Specification of materials in liquefied hydrogen storage tanks |
| 5 | Arrangement and specification of insulation |
| 6 | Information on non-destructive testing (NDT) for welds, and strength and tightness testing of tanks |
| 7 | Specification of welding procedures for liquefied hydrogen storage tanks |
| 8 | Specification of stress-relieving procedure for independent tank (thermal or mechanical) |
| 9 | Specification of cooling-down procedure for liquefied hydrogen storage tank |
| 10 | Marking plate for liquefied hydrogen storage tanks |
| 11 | Other plans and documents deemed necessary by the classification society |

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Annex D
(informative)

Examples of test report form

Table D.1 — Example of visual and dimension inspection test report

| Visual and Dimension Inspection Report | | | | | | | | | | Page | of | |
|---|---|---|---|---------------|---|--|---|---------------------------|---|------|----|---|
| | | | | | | | | | | Date | | |
| Customer | | | | | | Project Name | | | | | | |
| Owner | | | | | | Drawing (DWG) No. | | | | | | |
| Serial No. | | | | | | Report No. | | | | | | |
| | | | | | | | | | | | | |
| MARK | A | B | C | D | E | F | G | H | I | J | K | L |
| DWG. | | | | | | | | | | | | |
| Tolerance (Tol.) | | | | | | | | | | | | |
| Actual(Act.) | | | | | | | | | | | | |
| MARK | A | B | C | D | E | F | G | H | I | J | K | L |
| DWG. | | | | | | | | | | | | |
| TOL. | | | | | | | | | | | | |
| ACT. | | | | | | | | | | | | |
| Result of Inspection | | | | | | | | | | | | |
| Dimension | | | | Visual | | | | Nozzle Orientation | | | | |
| | | | | | | | | | | | | |
| <input type="checkbox"/> WITNESSED <input type="checkbox"/> REVIEWED BY CUSTOMER: _____ | | | | | | APPROVED BY: _____ CHECKED BY: _____ INSPECTED BY: _____ | | | | | | |

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Table D.2 — Hydrostatic test report

| REPORT OF HYDROSTATIC TEST | | | | Page | of |
|----------------------------|--|------------------------|--|--------------|----|
| | | | | Date | |
| Customer | | Project name | | | |
| Owner | | Drawing (DWG) No. | | | |
| Serial No. | | Report No. | | | |
| Test part | | Test item | | | |
| Test pressure (DWG) | | Test pressure (Actual) | | | |
| Design Pressure | | Fluid name | | | |
| Humidity | | Holding time | | | |
| Temperature | | Result | | | |
| | | | | | |
| TESTED BY | | APPROVED BY | | WITNESSED BY | |
| | | | | | |

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