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**Road vehicles — Liquefied natural gas  
(LNG) fuel system components —**

**Part 2:  
Performance and general test  
methods**

*Véhicules routiers — Équipements pour véhicules utilisant le gaz naturel liquéfié (GNL) comme combustible —*

*Partie 2: Performances et méthodes d'essai générales*

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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](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 41, *Specific aspects of gaseous fuels*.

This second edition cancels and replaces the first edition (ISO 12614-2:2014), which has been technically revised.

The main changes compared to the previous edition are as follows:

- editorial changes.

A list of all parts in the ISO 12614 series can be found on the ISO website.

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](http://www.iso.org/members.html).

# Road vehicles — Liquefied natural gas (LNG) fuel system components —

## Part 2: Performance and general test methods

### 1 Scope

This document specifies the performance and general test methods of liquefied natural gas fuel system components, intended for use on the types of motor vehicles as defined in ISO 3833. This document is also applicable to other LNG-fueled motor vehicles as far as appropriate, until any specific norm is worked out for such a type of vehicle. It also provides general design principles and specifies requirements for instructions and marking.

This document is not applicable to the following:

- a) fuel containers;
- b) stationary gas engines;
- c) container mounting hardware;
- d) electronic fuel management;
- e) refuelling receptacles.

It is recognized that miscellaneous components not specifically covered herein can be examined to meet the criteria of this document and tested according to the appropriate functional tests.

All references to pressure in this document are to be considered gauge pressures unless otherwise specified.

This document is based upon a working pressure for natural gas as fuel of 1,6 MPa (16 bar)<sup>1)</sup>. Other working pressures can be accommodated by adjusting the pressure by the appropriate factor (ratio). For example, a 2 MPa (20 bar) working pressure system will require pressures to be multiplied by 1,25.

### 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 188:2011, *Rubber, vulcanized or thermoplastic — Accelerated ageing and heat resistance tests*

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

ISO 12614-1:2021, *Road vehicles — Liquefied natural gas (LNG) fuel system components — Part 1: General requirements and definitions*

ISO 12614 (all parts), *Road vehicles — Liquefied natural gas (LNG) fuel system components*

ISO 15500 (all parts), *Road vehicles — Compressed natural gas (CNG) fuel system components*

1) 1 bar = 0,1 MPa = 105 Pa; 1 MPa = 1 N/mm<sup>2</sup>.

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12614-1 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 <https://www.electropedia.org/>

### 4 General

**4.1** Unless stated otherwise, the tests specified herein shall be conducted at room temperature, i.e.  $20\text{ °C} \pm 5\text{ °C}$ .

**4.2** Components shall comply with the tests outlined in ISO 12614-3 and subsequent parts of the ISO 12614 series and any other applicable tests specified in this document. Because of the peculiarities of some components, the list of tests described in this document from [Clauses 5 to 15](#) is not exhaustive. If additional tests are required, their requirements are provided in the respective part of the ISO 12614 series.

**4.3** Unless otherwise specified, all tests shall be conducted using inert gas. Qualified personnel can also test with natural gas providing that appropriate safety measures are fulfilled. The dewpoint of the test gas at the test pressure shall be at the temperature which ensures no icing, hydrate, or liquid formation. For testing at low temperatures, liquid nitrogen or LNG will be used, which will be specifically mentioned at the respective parts of the norm.

Unless otherwise specified, all pressures shall have a maximum tolerance of  $\pm 5\%$ .

Unless otherwise specified, all temperatures shall have a maximum tolerance of  $\pm 5\%$ .

Unless otherwise specified, all dimensions shall have a maximum tolerance of  $\pm 5\%$ .

### 5 Hydrostatic strength

A component shall not rupture when subjected to the following test method.

Outlet opening of the component shall be plugged. Valves or internal blocks shall be ensured in the open position. The hydrostatic pressure specified for each component in the ISO 12614 series shall be applied with a test fluid to the inlet of the component for a period of at least 3 min.

Test samples shall not be used for any other testing.

### 6 Leakage

#### 6.1 General

Prior to conditioning, the devices shall be purged with nitrogen and then sealed at 30 % of working pressure using nitrogen, dry air, or natural gas.

All tests shall be conducted while the devices are continuously exposed to the specified test temperatures. The device shall either be bubble free or have a leakage rate less than  $20\text{ Ncm}^3/\text{h}$  according to the following test method.

## 6.2 External leakage

Each device outlet shall be plugged with the appropriate mating connection and the test pressure applied to the inlet.

Pressurized air, nitrogen, or natural gas shall be applied to the test devices.

At all the test temperatures, immerse the components in a suitable test medium for 2 min or use a helium vacuum test (global accumulation method) or other equivalent methods.

If there are no bubbles for the specified time period, the sample passes the test. If bubbles are detected, then the leak rate shall be measured by an appropriate method.

## 6.3 Internal leakage

The internal leakage is applicable only to devices having a closed position. The aim of this test is to check the pressure tightness of the closed system.

The inlet or outlet of the device (as applicable) shall be connected with the appropriate mating connection while the opposite connection(s) shall be left open.

## 6.4 Test conditions

Test conditions for internal and external leakage:

- a) The device shall be conditioned at a low temperature of  $<-162$  °C and pressurized at 100 % and 25 % of working pressure.
- b) The device shall be conditioned at room temperature of 20 °C and pressurized at 25 % and 150 % of working pressure.
- c) The device shall be conditioned at a high temperature of 85 °C/120 °C and pressurized at 25 % and 150 % of working pressure.

## 7 Excess torque resistance

A component designed to be connected directly to threaded fittings shall be capable of withstanding without deformation, breakage, or leakage a torque effort of 150 % of the manufacturer's specified torque value.

The following test method shall apply.

- a) An unused component shall be used for this test. The torque shall be applied adjacent to the fitting.
- b) For a component having threaded connection(s), the turning effort shall be applied for 15 min, then released, and the component removed and examined for deformation and breakage.
- c) Subject the component to the leakage test specified in [Clause 6](#).
- d) Subject the component to the hydrostatic strength test specified in [Clause 5](#).

## 8 Bending moment

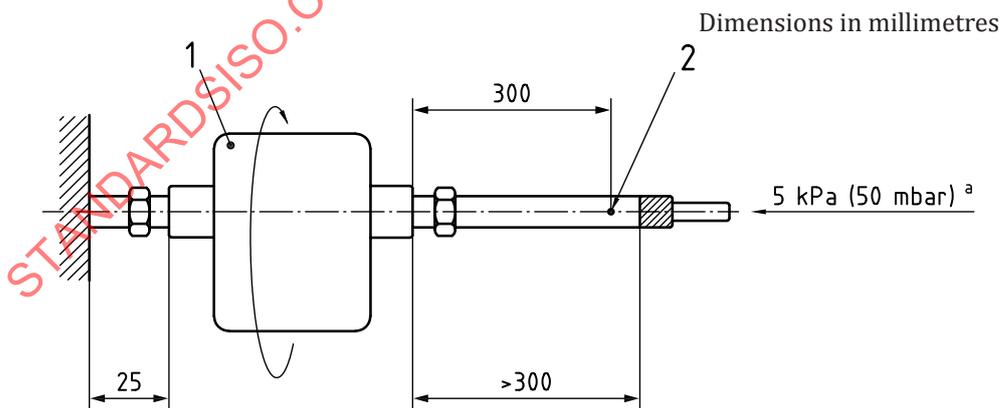
A component subject to bending moment tests shall be capable of operation without cracking, breaking, or leaking when subjected to the following test method.

- a) The connections of the component shall be assembled leak-tight to an appropriate mating connection(s), representative of design intent. After assembly, the length of the inlet tubing shall be greater than 300 mm (see [Figure 1](#)).

- b) The outlet connection shall be rigidly supported 25 mm from the component outlet, unless the following exceptions apply:
    - when the component has an integral mounting means independent of the inlet and outlet connections, the component shall be mounted using the integral mounting means as specified by the manufacturer;
    - when the component is intended to be mounted by either the integral mounting means or the component outlet, the mounting means which produces the most severe test condition shall be used.
  - c) This assembly above shall be checked for leaks prior to step d).
  - d) With the component in the closed position, the system shall be pressurized to 5 kPa and a force as specified in [Table 1](#) at 300 mm from the inlet shall be applied and maintained for 15 min. Without removing the force, the component shall be checked for leakage, in accordance with the test method in [Clause 6](#) at room temperature.
- NOTE Depending on how this is performed, raising the load to compensate buoyancy can be necessary.
- e) The test in step d) shall be conducted four times with the component being rotated 90° around the horizontal axis between each test. Between tests, the components shall be opened and closed (if applicable) three times with the bending moment removed.
  - f) At the completion of the above tests, the component shall be removed and examined for deformation and then subjected to the leakage test as specified in [Clause 6](#) and to the hydrostatic strength test according to [Clause 5](#).

**Table 1 — Bending test force**

Outside diameter of tubing (mm)	Force (N)
6	3,4
8	9,0
12	17,0
≥16	30,0



- Key**
- 1 component
  - 2 force point
  - <sup>a</sup> 4 × 90° rotation.

**Figure 1 — Bending moment**

## 9 Continued operation

### 9.1 General

Detailed test methods for each component can be found in the appropriate clauses of this document. The test method detailed below is general in nature and also applies to miscellaneous components.

Connect the component securely by a suitable fitting to a source of compressed dry air, nitrogen, or natural gas and subject it to the number of cycles specified in ISO 12614-3 and subsequent parts of the ISO 12614 series. A cycle shall consist of one opening and one closing (if applicable) of the component within a period of not less than  $10 \text{ s} \pm 2 \text{ s}$ . During the off cycle, the downstream pressure of the test fixture shall be lowered to a maximum of 50 % of the test pressure.

The test pressure shall be 100 % of the working pressure.

Unless otherwise specified, the following conditions apply.

### 9.2 Components, which are intended to be used at temperatures less than $-40 \text{ }^\circ\text{C}$

The component shall be operated through 96 % of the total cycles at  $< -162 \text{ }^\circ\text{C}$  temperature and working pressure, and shall comply with [Clause 6](#) at low temperature.

The component shall be operated through 4 % of the total cycles at the appropriate maximum temperature specified in ISO 12614-1:2021, 4.3 at working pressure.

The component shall comply with [Clause 6](#) at the appropriate maximum temperature specified in ISO 12614-1:2021, 4.3 at the completion of the low temperature cycles.

This test can be interrupted, if desired, at 20 % intervals for leakage testing.

### 9.3 Components, which are not intended to be used at temperatures less than $-40 \text{ }^\circ\text{C}$

The component shall be tested per the ISO 15500 series.

## 10 Corrosion resistance

**10.1** All components shall perform safely and in conformance with [Clause 6](#) following exposure to salt spray in accordance with the following test method. AISI series 300 austenitic stainless steels, or equivalent austenitic stainless steels, are exempt from corrosion resistance testing.

**10.2** With the component supported in its normal installed position, expose it for 144 h to a salt spray (fog) test, as specified in ISO 9227. If the component is expected to operate, unprotected, in vehicle underbody service conditions, then it shall be exposed for 500 h to the salt spray (fog) test.

**10.3** Maintain the temperature within the fog chamber between  $33 \text{ }^\circ\text{C}$  and  $36 \text{ }^\circ\text{C}$ .

**10.4** The saline solution shall consist of 5 % sodium chloride and 95 % distilled water, by weight.

**10.5** Immediately following the corrosion resistance test, rinse the sample and gently clean it of salt deposits; then subject it to the leakage test according to [Clause 6](#).

**10.6** Immediately following the corrosion resistance test and leakage test, subject the sample to the hydrostatic strength test according to [Clause 5](#).

## 11 Oxygen ageing

All synthetic or non-metallic parts of components which provide an LNG-containing seal, for which a satisfactory declaration of properties is not submitted by the applicant (see ISO 12614-1:2021, 4.4) shall, when tested, not crack or show visible evidence of deterioration after oxygen ageing in accordance with the following test method.

Representative samples shall be subjected to 96 h exposure to oxygen at a temperature of 70 °C at 2 MPa (20 bar) in accordance to ISO 188.

## 12 Electrical overvoltages

All electrical components or devices containing electrical subcomponents shall withstand application of the maximum voltage specified by the manufacturer or 1,5 times the nominal operating voltage  $\pm 5\%$ , whichever is higher, for periods of 3 min without failure.

## 13 Non-metallic material immersion

**13.1** Non-metallic material used in a component shall be subjected by the test agency to the tests described in [13.2](#), except where the applicant submits declarations of results of tests carried out on the material provided by the manufacturer.

**13.2** A part made of non-metallic material in contact with natural gas shall not show excessive change in volume or weight when tested according to the following procedure.

- a) Prepare, measure and weigh a representative sample or samples of each non-metallic material used in a component, then immerse the sample or samples at room temperature in natural gas at a pressure 3 MPa (30 bar) for a minimum of 70 h.
- b) Immediately following this period of immersion, rapidly reduce the test pressure to atmospheric pressure without causing shredding or disintegration.

No tested sample shall exhibit swelling greater than 25 % or shrinkage greater than 1 %. The weight change shall not exceed 10 %.

## 14 Vibration resistance

All components with moving parts shall remain undamaged and shall continue to operate and meet the requirements of their leakage tests and hydrostatic strength test after vibration, carried out according to the following test procedure.

Vibrate the component, pressurized to its working pressure with dry air, nitrogen, or natural gas and sealed at both ends, for 30 min along each of the three orthogonal axes at the most severe resonant frequency determined as follows:

- a) by an acceleration of 1,5g;
- b) within a sinusoidal frequency range of 10 Hz to 500 Hz;
- c) with a sweep time of 10 min.

If the resonance frequency is not found in this range, the test shall be conducted at 500 Hz.

At the completion of the test, the component shall not show any indication of fatigue or component damage and shall comply with the leakage test specified in [Clause 6](#) and the hydrostatic strength test specified in [Clause 5](#).

## 15 Brass material compatibility

All brass components or subcomponents which contain LNG for which a satisfactory declaration of properties is not submitted by the applicant shall be tested as described below.

Component manufacturers that can provide documentation attesting to the field worthiness of their products can be exempted from this requirement. Otherwise, the following test method is applied.

Each test sample shall be subjected to the physical stresses normally imposed on or within a part as a result of assembly with other components. Such stresses shall be applied to the sample prior to and maintained during the test. Samples with thread, intended to be used for installing the product in the field, shall have the threads engaged and tightened to the torque specified in the instruction manual of the sample. Polytetrafluorethylene (PTFE) tape or pipe compounds shall not be used on the threads.

Three samples shall be degreased and then continuously exposed to a set position for 10 d to a moist ammonia-air mixture maintained in a glass chamber of approximately 30 l having a glass cover.

Approximately 600 cm<sup>3</sup> aqueous ammonia having a specific gravity of 0,94 shall be maintained at the bottom of the glass chamber below the samples. The samples shall be positioned 40 mm above the aqueous ammonia solution and supported by an inert tray. The moist ammonia-air mixture in the chamber shall be maintained at atmospheric pressure and at a temperature of 34 °C ± 2 °C.

After being subjected to the conditions described above, the sample shall show no evidence of cracking when examined using a 25x magnification.

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