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

## Part 20: Flexible fuel or vent lines

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

*Partie 20: Conduites de carburant ou d'aération flexibles*



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# Foreword

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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).

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

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.

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

# Part 20: Flexible fuel or vent lines

## 1 Scope

This document specifies tests and requirements for the flexible fuel lines, a liquefied natural gas fuel system component intended for use on the types of motor vehicles defined in ISO 3833. 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.

NOTE 1 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.

NOTE 2 All references to pressure in this document are considered gauge pressures unless otherwise specified.

NOTE 3 This document is based upon a working pressure for natural gas as a fuel of 1,6 MPa (16 bar). (1 bar = 0,1 MPa = 105 Pa; 1 MPa = 1 $N/mm^2$.) 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 12614-1, *Road vehicles — Liquefied natural gas (LNG) fuel system components — Part 1: General requirements and definitions*

ISO 12614-2:2021, *Road vehicles — Liquefied natural gas (LNG) fuel system components — Part 2: Performance and general test methods*

ISO 12614-11, *Road vehicles — Liquefied natural gas (LNG) fuel system components — Part 11: Fittings*

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

ANSI/ASME B31.3, *Process Piping*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12614-1 and the following 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**
**braid**
layer, or layers, of woven wires covering the *hose* (3.2) and permanently attached to the flexible *hose assembly* (3.3) and end fittings, serving the function of restraining the flexible hose against elongation

**3.2**
**hose**
flexible conduit of either corrugated metal or composite material or *hose assembly* (3.3)

**3.3**
**hose assembly**
*hose* (3.2) with end fittings attached, complete with *braid* (3.1) and/or other covering

**3.4**
**live length**
flexible section of the *hose assembly* (3.3)

**3.5**
**protection sheath**
outer cover fitted to protect the main hose and *braid* (3.1) against damage and abrasion

## 4 Marking

Marking of the component shall provide sufficient information to allow the following to be traced:

a) the manufacturer's or agent's name, trademark, or symbol;

b) the model designation (part number);

c) the working pressure or pressure and temperature range;

d) the serial number or date code.

The following additional markings are recommended:

— the direction of flow (when necessary for correct installation);

— the type of fuel;

— electrical ratings (if applicable);

— the symbol of the certification agency;

— the type approval number;

— a reference to this document.

NOTE This information can be provided by a suitable identification code on at least one part of the component when it consists of more than one part.

## 5 Construction and assembly – Hose assembly

**5.1** The hose assembly shall comply with the applicable provisions of ISO 12614-1 and ISO 12614-2, and with the tests specified in Clause 7.

**5.2** Metallic hose assemblies shall comply with the hose construction in accordance with this document and with the tests specified in Clause 7.

**5.3** A component or material used in a hose assembly shall comply with an applicable standard or shall be evaluated for the intended application as part of the evaluation of the hose assembly.

**5.4** The construction of all parts of a hose assembly, whether specifically covered in this document or not, shall be in accordance with good engineering practice for safety, durability and maintainability.

NOTE All specifications as to construction set forth herein can be satisfied by the construction prescribed or such construction as will provide at least equivalent performance.

**5.5** The hose nominal size designation shall be based on the inner diameter of the hose. The measured internal diameter of a corrugated metal hose shall not be less than 98 % of its nominal size designation.

**5.6** A hose assembly is typically made up of:

a) a corrugated flexible hose made from seamless or welded tube. The corrugations may be parallel or helical and be of single or multiple ply;

b) a stainless-steel braid fitted over the hose which generally consists of woven wire in one or two layers;

c) end fittings that are welded to the hose and braid; and

d) an insulation/protection sheath fitted over the hose and braid or sandwiched between the hose and the braid.

**5.7** The corrugation shall be of regular form, continuous and concentric along the length of the hose, and shall be free of defects, such as scores, dents, cuts, or weld variations, which can cause premature failure. Longitudinal weld joints shall be butt welded. Where required, a hose may be heat treated after forming. The product shall have identical heat treatment as the hose tested.

Heat treatment influences flexibility, fatigue life, and pressure-bearing capacity. Therefore, the manufacturer shall provide heat treatment details of the hose to be tested.

**5.8** Braids shall be uniformly covered by wire, either machine-woven around the hose or tightly fitted by hand, as a stocking.

**5.9** Braid irregularities, such as wire crossings and wire loops, shall be limited and the wires of a strand should all have a similar tension.

**5.10** Where a braid is connected to end fittings, care shall be taken to ensure that all the braid wires are securely bonded to the end fittings.

**5.11** The design shall ensure that pressurization and corrosion between the hose and the outer braid or sheath is prevented.

**5.12** Hose, braid and end fittings of the hose assembly shall be rated for use at a service temperature range.

**5.13** Sheaths, if provided, shall be rated for the expected material temperature during service.

**5.14** The working pressure (WP) of the hose assembly established by the manufacturer shall be the lowest of any component of a hose assembly.

**5.15** Hose assemblies and their materials shall be designed, fabricated, welded, examined and tested in accordance with ANSI/ASME B31.3 normal fluid service. Welding and brazing shall be carried out according to approved weld procedure specifications.

**5.16** Hose assemblies shall be protected to minimize corrosion and pitting from corrosive atmospheric and industrial substances during storage, construction, fabrication, testing, and service. These substances shall include, but not be limited to:

a) chlorides and compounds of sulfur or nitrogen;

b) compounds in tapes or other packaging materials; and

c) compounds in insulation and sheath materials.

**5.17** A hose assembly shall be made of a single continuous hose without circumferential weld joints.

**5.18** An area for marking shall be provided on one of the end fittings of the hose assembly or on a permanent attachment.

**5.19** Compounds, if used on threaded joints, shall be specified by the manufacturer, be suitable for use with LNG at the maximum rated working pressure and over the service temperature range, and shall be applied to the threads during testing.

**5.20** Hose assemblies shall be electrically conductive from one end fitting to the other. The electric resistance of a hose assembly shall not exceed 1 Ω/m.

## 6 Construction and assembly – General

### 6.1 Materials

**6.1.1** Materials for the manufacture of corrugated metal hoses and metal hose component assemblies shall be selected based on their suitability for fabrication (cold forming, welding, etc.) and for the conditions under which they shall be used, and shall be limited to the austenitic stainless steel or nickel alloy group of materials.

**6.1.2** All materials should be selected to be compatible and suitable for the intended use and the minimization of corrosion and should be installed to minimize corrosion and protect from corrosion as required. Stainless steels that do not resist chloride-induced pitting/corrosion cracking and sensitization-induced corrosion should not be used. The use of dissimilar metal junctions should be minimized. Junctions should provide good corrosion protection to reduce corrosion effects of such a materials combination on long- term corrosion.

**6.1.3** Pitting resistance equivalent numbers (PREN) are widely used to compare the pitting corrosion resistance of stainless steels, represented by the formula: PREN = Cr + 3,3 Mo + 16 N. A PREN of 23,1 is considered the minimum acceptable for materials used for hose construction.

### 6.2 Joining

**6.2.1** Brazing filler material shall have a melting point exceeding 538 °C.

**6.2.2** Oxy-fuel gas welding shall not be permitted.

**6.2.3** A furnace butt-welding process shall not be used for hose joints.

## 6.3 Fittings

**6.3.1** End fittings shall comply with ISO 12614-11.

**6.3.2** End fittings shall be joined permanently to the hose and braid. End fitting shall provide a leak-tight joint between the hose and end fitting.

**6.3.3** End fittings shall be made of materials in compliance with 6.1 and be compatible with the other materials of the hose assembly.

## 6.4 Cleaning

Hose assemblies shall be cleaned in accordance with ISO 23208, CGA G-4.1, or equivalent manufacturer specification to remove hydrocarbons, moisture, particles, or other contaminations from inside the hose assembly.

## 6.5 Installation instructions

**6.5.1** An instruction's label covering proper installation and usage shall be attached to each hose assembly.

**6.5.2** The instructions shall include, as a minimum, the following information:

a) the hose or hose assembly shall not be kinked, twisted or torqued;

b) the working pressure (WP) which is marked on the hose shall not be exceeded;

c) contact with foreign objects or substances shall be avoided;

d) the manufacturer's specified minimum bend radius shall be noted and not be exceeded;

e) the manufacturer shall provide appropriate installation instructions with cautionary notes for leak testing; and

f) the hose assembly shall be inspected prior to installation in accordance with the manufacturer's instructions. The manufacturer's instructions shall address such items as:

   i) leakage;

   ii) damage to the hose protection cover;

   iii) damage to the hose, i.e. dents, kinks, deformation, cuts, abrasion;

   iv) damage to the braid:

      1) kinked, flattened, abraded or permanently deformed wire braid;

      2) bulging under pressure; and

      3) loose braid when not under pressure;

   v) end fitting, damage to threads, flange bolts, deformation, fitting movement, slipping, wear; and

   vi) deteriorated legibility or absence of markings.

**6.5.3** The instruction tag does not need to be permanent in nature but shall be durable and attached in a manner that it is expected to reach the person who will install the hose assembly.

## 6.6 Packaging

**6.6.1** Packaging shall prevent kinking or excessive bending of the hose.

**6.6.2** Hose assemblies shall be protected against ingress of any foreign matter.

## 6.7 Hose assembly type

**6.7.1** A hose assembly is of the same type when the design and its characteristics are similar to the tested hose; similarity is defined as having the same:

a) materials;

b) welding method and weld penetration;

c) heat-treatment process;

d) type of corrugation (geometry, shape, dimensions, and method of manufacturing);

e) method of joining (hose and end fitting); and

f) braid (type of braiding, i.e. calculated according to diameter to obtain the same maximum tensile stress in each wire, the same materials and the same welding method).

**6.7.2** The end fitting type does not change the hose assembly type provided the connection to the hose and braid and braid connector is of identical type. If welded, it shall be to the same weld procedure, geometry, penetration and weld size. Fittings shall have a working pressure (WP) equal to or higher than that of the hose.

**6.7.3** Sample testing the smallest and largest nominal size of the product size range of a hose assembly type qualifies the complete size range of the hose assembly type except each hose assembly nominal size shall be hydraulic burst tested.

# 7 Tests

## 7.1 Applicability

The tests required to be carried out are indicated in Table 1.

**Table 1 — Tests applicable**

| Test | Applicable | Test procedure as required by ISO 12614-2 | Specific test requirements of this document |
|---|---|---|---|
| Hydrostatic strength | X | X | X (see 7.2) |
| Leakage | X | X | |
| Excess torque resistance | X | X | |
| Bending moment | X | X | |
| Continued operation | X | | X (see 7.3) |
| Corrosion resistance | X | X | |
| Oxygen ageing | | | |
| Electrical overvoltages | | | |
| Non-metallic material immersion | | | |
| Vibration resistance | X | X | X (see 7.4) |

**Table 1** *(continued)*

| Test | Applicable | Test procedure as required by ISO 12614-2 | Specific test requirements of this document |
|---|---|---|---|
| Brass material compatibility | | | |
| Bending | X | | X (see 7.5) |

## 7.2 Hydrostatic strength

The flexible fuel line shall be tested according to the procedure for testing hydrostatic strength specified in ISO 12614-2. The test pressure shall be four times the specified working pressure.

In addition to the test specified in ISO 12614-2, the tested samples shall be pressurized up to rupture as follows.

a) Subject a straight, unconstrained sample assembly of minimum length 1 m to a hydraulic pressure applied gradually in increments over a minimum period of 1 min until the assembly fails by visible leakage or rupture of any of the components.

b) Bursting is to occur only in the body of the hose assembly and may in no case affect the end fittings and their connections.

c) After the test, hoses shall be discarded and are not to be used.

NOTE The higher hydrostatic test pressure for the flexible fuel line than the other ISO 12614 series components is due to the necessary provisions to cope for eventual damage or abrasions under normal operation.

## 7.3 Continued operation

### 7.3.1 General

The hose assembly shall be subjected to pressure cycling from 0,1 MPa (1 bar) to working pressure (WP), at room temperature and at a frequency of approximately four cycles per minute for 100 000 pressure cycles.

### 7.3.2 Method of test

For test purposes, the live length of the hose (mm) to be used shall be computed as follows:

$$= \pi \times R + 2 \times D$$

where

$R$ is the hose minimum static bend radius specified by the manufacturer, in mm;

$D$ is the outside diameter of the hose bellows.

The hose assembly shall be bent 180° with the minimum radius specified by the manufacturer and rigidly attached to a fixture in that position. One end of the hose shall be plugged, and the other end shall be attached to a hydraulic supply. A liquid, which is compatible with the hose materials, shall be used as the pressure medium. Cycling shall be between 0,1 MPa (1 bar) and the specified working pressure (WP) ±0,2 MPa (2 bar). The pressure shall be applied within 1 s by means of a quick opening solenoid valve at a rate of approximately four cycles per minute. The maximum pressure shall be held for 10 ± 1 s and then reduced to 0,1 MPa (1 bar) for 5 ± 0,5 s.

The temperature of the hose assembly during the test shall be as specified in ISO 12614-2:2021, 9.2.