



**International
Standard**

ISO 16904-2

**Installation and equipment for
liquefied natural gas — Design
and testing of marine transfer
systems —**

**Part 2:
Design and testing of transfer hoses**

*Installations et équipements de gaz naturel liquéfié —
Conception et essais des systèmes de transfert marins —*

Partie 2: Conception et essais des flexibles de transfert

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Contents

Page

Foreword	v
1 Scope	1
2 Normative references	1
3 Terms, definitions and abbreviations	1
3.1 Terms and definitions	1
3.2 Abbreviations	5
4 Applications and qualification categories	5
4.1 Applications	5
4.2 Qualification categories	6
5 Description of typical LNG transfer hose assembly designs and accessories	6
5.1 General	6
5.2 Mandatory components	7
5.3 Optional components	7
5.4 Typical construction of LNG transfer hose assemblies	7
5.4.1 Main hose categories	7
5.4.2 Corrugated metal hose assemblies	8
5.4.3 Thermoplastic multi-layer (non-vulcanized) hose assemblies (Composite hose assemblies)	10
5.4.4 Hose-in-hose with annular space	11
6 Design features of the LNG transfer hoses assemblies	12
6.1 General	12
6.2 Transfer hose assembly technology design parameters	12
6.3 Project specific design parameters	13
6.3.1 Selection of hose assembly length	13
6.3.2 Service life	13
6.3.3 Selection of buoyancy and submersion	13
6.3.4 Selection of insulation	13
6.3.5 Selection of external protection	13
6.3.6 Selection of leak detection	13
6.4 Component details – End fitting	14
6.4.1 General	14
6.4.2 Termination	14
6.4.3 Connector	14
6.4.4 Bending stiffener/restrictor (optional)	15
6.5 Hose assembly handling / lifting device	15
6.6 Safety systems	15
6.6.1 Leak detection (optional)	15
6.6.2 Fire safety requirements	16
6.6.3 Electrical safety requirements	16
6.7 Connection to the ship	16
6.8 Hydraulic and electric control systems	16
7 Qualification requirements	16
7.1 Foreword	16
7.2 Qualification process	16
7.2.1 General principle	16
7.2.2 Qualification levels specific requirements	17
7.2.3 Certification range definition from a tested hose assembly	18
7.2.4 Certification extension and update	19
7.3 Hose assembly tests	19
7.3.1 General	19
7.3.2 Hose assembly property characterization tests	20
7.3.3 Qualification tests with acceptance criteria	28

ISO 16904-2:2024(en)

8	Quality assurance and control	37
8.1	General	37
8.2	Material selection	37
8.3	Manufacturing	37
8.3.1	Manufacturing basics	37
8.3.2	Traceability	38
8.3.3	Marking	38
8.3.4	Packing and preservation	38
8.4	Factory acceptance tests	38
8.4.1	General	38
8.4.2	Tests to be performed on every hose assembly	39
9	Documentation	39
9.1	Purchasing guidelines	39
9.2	Design, qualification and manufacturing documentation	39
9.3	As-built documentation/manufacturing Data Book	39
9.4	Operation manual	40
	Annex A (informative) Purchasing guidelines table	41
	Annex B (informative) Guidelines for additional testing program	43
	Annex C (informative) Guidelines for Hose Qualification Categories (HQC) selection	50
	Annex D (informative) Surge pressure considerations for LNG hose assemblies	52
	Annex E (informative) Pressure leak tests - justification about maximum allowed permeability rate and leak detection value	53
	Bibliography	55

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Foreword

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This document was prepared by the European Committee for Standardization (CEN) (as EN 1474-2:2020+AC:2023) and drafted in accordance with its editorial rules. It was assigned to Technical Committee ISO/TC 67, *Oil and gas industries including lower carbon energy*, Subcommittee SC 9, *Production, transport and storage facilities for cryogenic liquefied gases* and adopted without modification.

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.

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Installation and equipment for liquefied natural gas — Design and testing of marine transfer systems —

Part 2: Design and testing of transfer hoses

1 Scope

This document gives general guidelines for the design, material selection, qualification, certification, and testing details of hose assemblies for Liquefied Natural Gas (LNG) marine transfer applications.

The transfer hose assemblies are part of transfer systems (it means that they may be fitted with ERS, QCDC, handling systems, hydraulic and electric components etc.) To avoid unnecessary repetition, cross-references to EN ISO 16904 and EN 1474-3 are made for all compatible items, and for references, definitions and abbreviations. Where additional references, definitions and abbreviations are required specifically for LNG hose assemblies, they are listed in this document.

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.

EN 1474-1:2008, *Installation and equipment for liquefied natural gas — Design and testing of marine transfer systems — Part 1: Design and testing of transfer arms*

EN 1474-3:2008, *Installation and equipment for liquefied natural gas - Design and testing of marine transfer systems - Part 3: Offshore transfer systems*

EN ISO 7369:2004, *Pipework - Metal hoses and hose assemblies - Vocabulary (ISO 7369:2004)*

EN ISO 8330:2014, *Rubber and plastics hoses and hose assemblies - Vocabulary (ISO 8330:2014)*

EN ISO 10012:2003, *Measurement management systems - Requirements for measurement processes and measuring equipment (ISO 10012:2003)*

EN ISO 10619-1:2018, *Rubber and plastics hoses and tubing - Measurement of flexibility and stiffness - Part 1: Bending tests at ambient temperature (ISO 10619-1:2017)*

EN ISO 16904:2016, *Petroleum and natural gas industries - Design and testing of LNG marine transfer arms for conventional onshore terminals (ISO 16904:2016)*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 7369:2004 and EN ISO 8330:2014 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at <https://www.electropedia.org/>

— ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1.1

annular space

space between the inner fluid carrying layer and a second layer which can be used for insulation and/or safety purposes

3.1.2

armour layer

either a braid made of wires (see braid) or strips of metal or plastic used to provide pressure strength and/or external protection

3.1.3

axial stiffness

extent to which a hose assembly resists tensile deformation in response to an applied axial force

3.1.4

bend stiffness

ability of a flexible pipe to resist deflection when subjected to bending loads at constant tension, pressure and temperature

3.1.5

bend restrictor

device for limiting the bend radius by mechanical means

Note 1 to entry: A bend restrictor typically comprises a series of interlocking metallic or moulded rings, applied over the outer surface.

3.1.6

bending stiffener

ancillary conical shaped component, which locally supports the pipe to limit bending stresses and curvature of the pipe to acceptance levels

Note 1 to entry: Bend stiffeners may be either attached to an end fitting or a support structure where the flexible pipe passes through the bend stiffener.

3.1.7

boil-off gas

BOG

natural evaporation from liquefied natural gas due to vaporization

3.1.8

burst test

test conducted on a hose sample until it failed by internal pressurization

3.1.9

buoyancy

degree, to which the hose assembly has buoyancy capabilities calculated according to [7.3.2.6](#)

3.1.10

connector

part of the end fitting used to provide a leak-tight structural connection between the end fitting and adjacent piping

3.1.11

crush test

application of a vertical load through a beam placed laterally across the hose assembly

3.1.12

double-envelope

layer or set of layers effecting the enclosure, and thus the isolation from the environment, of those structures, systems and components whose failure can lead to an unacceptable release of LNG

3.1.13

dynamic load

loads to flexible hose assembly or hose assembly configuration which vary in time, or whose deflections or boundary conditions vary in time, while hose is connected

3.1.14

emergency release system

ERS

system that provides a positive means of quick release of transfer system and safe isolation of LNG carrier and transfer system

Note 1 to entry: The ERS consists of an emergency release coupling (ERC) and interlocked isolating valves which automatically close on both sides, thereby containing the LNG or vapour in the lines (dry disconnect), and, if applicable, associated control system.

3.1.15

end termination

mechanical device which forms the transition between the flexible pipe body and the connector whose different pipe layers are terminated in the end fitting in such a way as to transfer the load between the flexible hose assembly and the connector

3.1.16

end fitting

assembly of connector and end termination

3.1.17

emergency release coupler

ERC

device to provide a means of quick release of the transfer system when such actions is required only as an emergency measure

3.1.18

fatigue life

number of cycles of a specified character that a given specimen sustains before failure of a specified nature occurs

3.1.19

hose assembly

hose and its fittings

3.1.20

impact test

test for determining the impact strength of a material

3.1.21

leak detection system

system able to detect a failure / leak from the fluid carrying part of the hose assembly

3.1.22

liquefied natural gas

LNG

natural gas that has been cooled and condensed into liquid form

3.1.23

maximum allowable impact energy

MAIE

maximum impact energy which can be applied to the hose assembly without bringing permanent damage to the hose assembly structure and performances

3.1.24

maximum allowable crush load

MACL

maximum allowable crush load which can be applied to the hose assembly without bringing permanent damage to the hose assembly structure and performances

3.1.25

maximum allowable working pressure

MAWP

maximum pressure (gauge) across the entire specified temperature range to which the hose may be exposed and operated

Note 1 to entry: It is commonly used by terminals to define their cargo system pressure capabilities (i.e. pump shut-in plus any static head or cargo system safety valve relief setting).

Note 2 to entry: This pressure rating is not expected to account for dynamic surge pressures, but does include nominal pressure variations during cargo transfer operations).

3.1.26

maximum working load

MWL

maximum allowable tensile force of the hose assembly in axial direction, applied to the end-fittings

3.1.27

minimum Bend Radius

MBR

minimum radius at which the hose assembly is designed to operate

3.1.28

non-destructive test

ND

test that is not expected to cause permanent damage to the hose assembly, so that the hose assembly can be used in subsequent tests and for operation as well

3.1.29

owner

business entity who has the legal or rightful title to the asset intended for LNG transfer

3.1.30

proof pressure

pressure to which the hose assembly is tested (i.e. during a Factory Acceptance Test) to demonstrate its structural integrity when subject to internal pressure

Note 1 to entry: According to the IMO IGC Code this pressure test at ambient temperature shall be not less than $1,5 \times \text{MAWP}$ and not more than two-fifths of its burst pressure.

3.1.31

pumping port

connection to attach a vacuum pump for vacuum insulated hose assemblies

3.1.32

quick connect disconnect coupler

QCDC

manual or hydraulic mechanical device used to connect a transfer arm or hose to the cargo manifold without employing bolts

3.1.33

service life

period of time during which the hose assembly fulfils all performance requirements for the specified or less severe condition in the same Hose Qualification Category

3.1.34

static load

flexible hose assemblies not exposed to significant cyclically varying loads or deflections during normal operations

3.1.35

storage bend radius

minimum radius at which the hose assembly is designed to be stored or handled. SBR may be lower than MBR

3.1.36

super-insulation

several high reflecting foils to reduce heat transfer via radiation as part of a vacuum insulation system

3.1.37

type approval certificate

certificate issued by an IVA confirming the suitability and appropriate limits on the manufacturer's design methodologies, manufacturing processes and materials

Note 1 to entry: The name of this certificate can differ according to the IVA.

3.1.38

visual inspection

examination of parts and equipment for visible defects in material and workmanship

3.2 Abbreviations

D internal bore diameter of the hose assembly

FAT factory acceptance test

FSRU floating Storage Regasification Unit

HQC hose qualification category

IVA Independent verification agency

L Length of flexible part of the hose assembly

LNGC liquefied natural gas carrier

MAAT Maximum allowable applied twist

4 Applications and qualification categories

4.1 Applications

This subclause describes the main application using LNG transfer hose assemblies.

As industry and technology is developing, other type of application may consider using LNG transfer hose assemblies and shall be covered in this standard.

List of applications (not exhaustive):

- Offshore tandem FLNG offloading / loading aerial or floating;
- Ship-To-Ship transfer such as LNGC to FSRU, LNG Bunkering;
- Shore-To-Ship such as LNG bunkering;
- Ship-To-Shore such as offloading / loading.

Based on the application and use of the hose assembly, there are different categories of hose assembly qualification required. Main difference are the dynamic loads on the hose assembly. The following subclause introduces Hose assembly Qualification Categories (HQC).

NOTE Guidelines for the owners regarding applications and relevant HQC are available in [Annex C](#). Selection of HQC remains the owner's responsibility.

4.2 Qualification categories

This subclause establishes criteria for definition of Hose Qualification Categories for the hose assemblies covered by this standard. The Hose Qualification Categories specified below define different design verification requirements as per [subclause 7.2.2](#).

The test scope within all Qualification Categories define the basis for the hose assemblies qualification but are independent of each project specific data (metocean data, waves & current data,). During the design for a project the required HQC should be checked by the owner and / or IVA.

The owner / IVA can require executing additional tests in order to determine if the proposed hose assembly is "Fit for Purpose" (For fatigue test for example, specific attention should be paid on bending loads adjacent to end terminations)

— Hose Qualification Category A

This HQC is intended to be used for quasi-static applications (i.e. application only driven by handling and/or thermal and pressure fatigue).

This category is including the performance requirements applicable to all aerial transfer hose assembly, typically transfer hose assemblies used in protected environment for intermittent usage without contact with water and with negligible dynamic motions.

— Hose Qualification Category B

This HQC is intended to be used for dynamic applications driven by aerial transfer fatigue including significant tensile and bending fatigue loads (e.g. by vessel motions or wind loads).

This Category is including the performance requirements applicable to all aerial transfer hose assemblies and typically applicable for the hose assemblies used in combination of weather exposed environment and/or permanent usage and used in configurations with contact with floating structures.

— Hose Qualification Category C

This HQC is intended to be used for dynamic applications for submerged or floating hose assemblies.

Qualification tests for this category includes representative tests of contact with water such as insulation, water tightness properties and permanent connection potential issues.

The hose assemblies manufacturer shall propose a fatigue assessment methodology, to be applied at project phase, verifying that the hose assembly is fit for purpose for the intended application.

The methodology shall be validated by an IVA.

5 Description of typical LNG transfer hose assembly designs and accessories

5.1 General

This standard is addressing hose assemblies as a flange-to-flange component.

It means that all statements and requirements based on the hose assemblies shall be considered between conveyed fluid tightening surfaces at both ends.

5.2 Mandatory components

An LNG Transfer Hose assembly shall consist of the following:

- flexible part of the hose assembly
- associated end fittings

Hose extremity end fittings can permit the mounting of a QCDC or a spool piece or permit direct connection to LNGC or LNG terminal or another hose assembly.

NOTE A description of QCDC is given in EN ISO 16904:2016, for transfer system reference is made to EN 1474-3:2008.

Hose extremity end fittings can permit the mounting of an emergency release system with valves and ERC (Emergency Release Coupler).

(A description of emergency release system is given in EN ISO 16904:2016 and EN 1474-3:2008).

- permanent identification marks
- hose handling device(s) (pad eye or lifting lugs, lifting collar, ...).

Hose assembly shall include necessary fittings for safe handling, coupling and uncoupling either from the LNGC or the onshore or offshore LNG terminal system as required by the system design according to EN 1474-3:2008.

5.3 Optional components

An LNG Transfer Hose assembly can consist of the following:

- leak detection system

If required by the owner, the hose assembly shall incorporate leak detection system e.

- insulation system (to minimize build-up of external ice)
- intermediate leak barrier(s)
- bending stiffeners or restrictors
- buoyancy
- weight elements
- specific supporting equipment

Hose assembly can support (e.g. piggy back mounted) hydraulic or pneumatic hoses, electric cables for the powering of the ERS and QCDC systems according to EN ISO 16904:2016, Clause 6.

5.4 Typical construction of LNG transfer hose assemblies

5.4.1 Main hose categories

At present LNG transfer hose assemblies are categorized in three types according to their method of construction:

- those based on a reinforced corrugated metal hose construction, hereafter called corrugated metal hose;
- those based on a construction in which polymeric films and fabrics are entrapped between a pair of close wound helical wires, hereafter called composite hose;

- those based on a hose-in-hose construction with annular space and which can derive from one of the above technologies.
- as the technology develops, other types of hose assemblies can become available and are also to be considered covered by this document.

5.4.2 Corrugated metal hose assemblies

A corrugated metal hose assembly consists of a core layer made of a stainless-steel corrugations, and several other layers, metallic or non-metallic, reinforcing mechanical strength of the flexible part of the hose assembly.

In sequence, starting from the bore, typical construction is as follow:

- a) Inner layer, made of stainless-steel corrugations (parallel or helical corrugated sometimes called bellows), parallel or helicoidal construction. Ensures the inner leakproofness of the structure, as well as sustaining the radial pressure.
- b) Armours layers, made of steel or textile, supporting the axial loads and reinforcing inner radial pressure resistance.
- c) Optionally, thermal insulation layers, ensuring that the inner temperature is conserved whilst preventing any build-up of ice on the exterior of the hose assembly.
- d) Optionally, Outer layers, protecting the hose assembly from external mechanical damages. These layers might be leak-proof, giving the hose assembly a double envelope (with an annulus between) thus permitting the detection of any leak of LNG as soon as it can occur. In case of a leak in the inner layer, the outer layer can be able to withstand some pressure at some temperature during certain amount of time.

The external layer, if leak-proof, prevents any ingress of water and air from the exterior.

The number, arrangement and sequence of the layers in steps b) to d) is specific to the hose assembly size and application and can vary based on metallic hose assembly technology.

The hose assembly construction shall ensure that all materials are used within their individual range of temperature.

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