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Petroleum and natural gas industries — Design and testing of LNG marine transfer arms for conventional onshore terminals

Industries du pétrole et du gaz naturel — Conception et essais des bras de transfert de GNL sur des terminaux terrestres conventionnels

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Foreword

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The committee responsible for this document is ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*.

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Petroleum and natural gas industries — Design and testing of LNG marine transfer arms for conventional onshore terminals

1 Scope

This International Standard specifies the design, minimum safety requirements and inspection and testing procedures for liquefied natural gas (LNG) marine transfer arms intended for use on conventional onshore LNG terminals, handling LNG carriers engaged in international trade. It can provide guidance for offshore and coastal operations. It also covers the minimum requirements for safe LNG transfer between ship and shore.

Although the requirements for power/control systems are covered, this International Standard does not include all the details for the design and fabrication of standard parts and fittings associated with transfer arms.

This International Standard is supplementary to local or national standards and regulations and is additional to the requirements of ISO 28460.

This International Standard needs not be applied to existing facilities.

2 Normative references

The following referenced documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

ISO 4406, *Hydraulic fluid power — Fluids — Method for coding the level of contamination by solid particles*

ISO 9934-1, *Non-destructive testing — Magnetic particle testing — Part1: General principles*

ISO 10474:2013, *Steel and steel products — Inspection documents*

ISO 10497, *Testing of valves — Fire type-testing requirements*

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 28460:2010, *Petroleum and natural gas industries — Installation and equipment for liquefied natural gas — Ship-to-shore interface and port operations*

IEC 60034-5, *Rotating electrical machines — Part 5: Degrees of protection provided by the integral design of rotating electrical machines (IP code) — Classification*

IEC 60079-0, *Explosive atmospheres — Part 0: Equipment — General requirements*

IEC 60079-1, *Explosive atmospheres — Part 1: Equipment protection by flameproof enclosures "d"*

IEC 60079-2, *Explosive atmospheres — Part 2: Equipment protection by pressurized enclosures "p"*

IEC 60079-5, *Explosive atmospheres — Part 5: Equipment protection by powder filling "q"*

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IEC 60079-6, *Explosive atmospheres — Part 6: Equipment protection by oil immersion "o"*

IEC 60079-7, *Explosive atmospheres — Part 7: Equipment protection by increased safety "e"*

IEC 60079-10-1, *Explosive atmospheres — Part 10-1: Classification of areas — Explosive gas atmospheres*

IEC 60079-11, *Explosive atmospheres — Part 11: Equipment protection by intrinsic safety "i"*

IEC 60079-14, *Explosive atmospheres — Part 14: Electrical installations design, selection and erection*

IEC 60079-18, *Explosive atmospheres — Part 18: Equipment protection by encapsulation "m"*

IEC 60079-25, *Explosive atmospheres — Part 25: Intrinsically safe electrical systems*

IEC 60529, *Degrees of protection provided by enclosures (IP Code) and IEC 60529/A1&A2, Amendment 1&2*

IEC 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems*

IEC 62305-3, *Protection against lightning — Part 3: Physical damage to structures and life hazard*

ASME B16.5, *Pipe Flanges and Flanged Fittings*

ASME*Boiler and Pressure Vessel Code Section IX: Welding and Brazing Qualifications*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
apex swivel
articulated, fluid-carrying joint located between the *inboard arm* (3.20) and *outboard arm* (3.32)

Note 1 to entry: See Figure B.2.

Note 2 to entry: It provides *luffing* (3.26) of the outboard arm relative to the inboard arm.

3.2
attitude
various modes of use and/or location of the *transfer arm* (3.59) (i.e. manoeuvring, stowed, connected, hydrostatic test, and maintenance)

Note 1 to entry: The transfer arm can take several positions for each attitude.

3.3
base riser
riser
vertical assembly which bolts to the loading platform and supports the articulated assembly of the *transfer arm* (3.59)

Note 1 to entry: See Figure B.2.

Note 2 to entry: Sometimes referred to as "standpost".

3.4
bottom swivel
accommodates *pitch*ing (3.35) motion of *LNG carrier* (3.25) and is located adjacent to *presentation flange* (3.37) in horizontal part of *TSA* (3.60)

Note 1 to entry: See Figure B.2.

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3.5
brinelling
any permanent indentation in *swivel* (3.55) or *structural bearing* (3.50) raceways caused by excessive loading of balls or rollers

3.6
cargo manifold
pipe assembly mounted onboard *LNG carrier* (3.25) to which the *presentation flange* (3.37) or *QCDC* (3.39) of the *transfer arm* (3.59) is connected

Note 1 to entry: See Figure B.2.

3.7
cavitation
formation and collapse of bubbles in a liquid when the pressure falls to or below the liquid vapour pressure; the collapse releases energy, sometimes with an audible sound and vibration

Note 1 to entry: Such low pressures occur in high velocity zones such as the inner radius of elbows, or at places with variations of diameters.

3.8
clash
any contact during design operational conditions, or as a result of an emergency separation, between any part of a *transfer arm* (3.59) and:

— adjacent transfer arm while both arms are operating or one arm is operating and the other arm is stowed [e.g. the *counterweights* (3.11)];

— adjacent section of the same transfer arm [e.g. *triple swivel assembly* (3.60) and *outboard arm* (3.32)];

— loading platform equipment [e.g. *counterweight* (3.11) and piping or valves]

3.9
contact angle
α
angle between the plane of the *swivel joint* (3.55) or *structural bearing* (3.50) balls or rollers and the centre of contact at the ball or roller raceway interface

3.10
conventional onshore LNG terminal
LNG exporting or receiving terminal that is located on-shore and that has a marine transfer arms for the loading or unloading of *LNG carriers* (3.25) in a harbour or other sheltered coastal location

3.11
counterweight
system of weights used to balance the *inboard arm* (3.20) and *outboard arm* (3.32) assemblies

Note 1 to entry: Some *transfer arms* (3.59) have a single counterweight for this function and others have multiple counterweights.

3.12
design pressure
pressure for which the *transfer arm* (3.59) is designed

Note 1 to entry: See Table A.1.

3.13
design temperature
range of temperatures for which the *transfer arm* (3.59) is designed

Note 1 to entry: See Table A.1.

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3.14
drift
longitudinal and/or lateral displacement of the *LNG carrier* (3.25) under the influence of environmental forces

Note 1 to entry: See also *surge fore* (3.52) *or aft* (3.51) and *sway* (3.54).

3.15
emergency release system
ERS
system that provides a positive means of quick release of *transfer arms* (3.59) and safe isolation between the *LNG carrier* (3.25) and shore, following a predefined procedure including an *emergency shutdown* (ESD) (3.16)

Note 1 to entry: See Figure B.2.

3.16
emergency shutdown
ESD
method that safely and effectively stops the transfer of LNG and vapour between the *LNG carrier* (3.25) and shore

3.17
freeboard
vertical distance between the ship's deck and the water level at the manifold location

Note 1 to entry: See Table A.3 and Figure A.1.

3.18
free wheel
ability of a hydraulically operated *transfer arm* (3.59) when connected to a *LNG carrier* (3.25) to follow freely without hydraulic restraint the vertical and horizontal motions of the LNG carrier's manifold (draft changes and *sway* (3.54) and surge motions)

3.19
heave
vertical motion of the *LNG carrier* (3.25) due to wave action

Note 1 to entry: See Table A.4 and Figure A.2.

3.20
inboard arm
product-carrying pipe and any structural members contained between the *apex swivel* (3.1) and the *trunnion swivel* (3.61)

Note 1 to entry: See Figure B.2.

3.21
included angle
angle formed between *inboard arm* (3.20) and *outboard arm* (3.32)

Note 1 to entry: See Figure B.2.

Note 2 to entry: The maximum and minimum included angles are left to the transfer arm manufacturer.

Note 3 to entry: The included angle in the stowed position of the *transfer arms* (3.59) is such, that the arms are parked with the *triple swivel assembly* (3.60) behind the berthing line.

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3.22
insulating flange
electrical insulating system, usually dedicated, which is installed in the lower end of the *outboard arm* (3.32) or in the vertical part of the *triple swivel assembly* (3.60)

Note 1 to entry: Its purpose is to prevent stray currents from causing an arc at the *LNG carrier's* (3.25) flange as the *transfer arm* (3.59) is connected or disconnected.

3.23
jack
permanent, adjustable load-carrying mechanism potentially installed in the *triple swivel assembly* (3.60) to transfer a portion of the *arm* (3.59) fluid weight to the deck instead of the *LNG carrier's* (3.25) manifold

Note 1 to entry: See Figure B.2.

3.24
jetty control centre
control centre situated on or adjacent to the jetty primarily to control and/or monitor the *transfer arms* (3.59)

Note 1 to entry: Sometimes referred to as "jetty control room" or "local control room".

3.25
LNG carrier
LNGC
tank ship designed for the carriage of LNG

3.26
luffing
rotary motions of the *inboard arm* (3.20) and *outboard arm* (3.32) in the vertical plane

Note 1 to entry: See Figure B.2.

3.27
main hydraulic unit
MHU
hydraulic unit that generates hydraulic power to ensure the normal operation and emergency release sequence of the arms

3.28
manifold setback
horizontal distance between the board side of *LNG carrier* (3.25) and the face of *cargo manifold* (3.6)

Note 1 to entry: See Table A.3 and Figure A.1.

3.29
manifold spacing
horizontal distance between two adjacent *cargo manifold* (3.6) flange axes

Note 1 to entry: See Table A.3 and Figure A.1.

3.30
middle swivel
accommodates *yawing* (3.63) and surge of *LNG carrier* (3.25) and is located between *top swivel* (3.57) and *bottom swivel* (3.4) in vertical part of *TSA* (3.60)

Note 1 to entry: See Figure B.2.

3.31
operating envelope
volume in which *presentation flange(s)* (3.37) of a (group of) *transfer arm(s)* (3.59) is (are) required to operate

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3.32
outboard arm
product-carrying pipe and any structural members contained between the *apex swivel* (3.1) and the *triple swivel assembly* (3.60)

Note 1 to entry: See Figure B.2.

3.33
owner
designated agent
company or group of companies for whose use the *transfer arms* (3.59) are installed, responsible for the safe design and construction of the installation

3.34
pantograph system
system for transmitting balancing loads from the *outboard arm* (3.32) to the *counterweight(s)* (3.11)

Note 1 to entry: The system comprises an assembly of linkages and pinned connections, or a cable and sheaves system (respectively, "rigid link pantograph" and "cables and sheaves pantograph").

3.35
pitch
rotation of the *LNG carrier* (3.25) around transversal horizontal axis

Note 1 to entry: See Table A.4 and Figure A.2.

3.36
powered emergency release coupling
PERC
powered device to provide a means of quick release of the *transfer arms* (3.59) when such action is required only as an emergency measure

3.37
presentation flange
transfer arm (3.59) flange for connection to either the *cargo manifold* (3.6) or *spool piece* (3.47)

Note 1 to entry: See Figure B.2.

3.38
product
fluid transferred using *transfer arms* (3.59)

Note 1 to entry: Fluids are LNG, NG or LN_2.

3.39
quick connect disconnect coupler
QCDC
coupler
manual or hydraulic mechanical device used to connect the *transfer arm* (3.59) to the *cargo manifold* (3.6) without employing bolts

Note 1 to entry: See Figure B.2.

3.40
remote pendant control
remote control
device to facilitate the fine manoeuvring operation of the *transfer arms* (3.59) from a remote location (e.g. *LNG carrier's* (3.25) *cargo manifold* (3.6) area)

Note 1 to entry: The system can use a trailing wire or radio-controlled system.

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3.41
riser and trunnion swivel assembly
fluid carrying system consists of *riser swivel* (3.43), *trunnion swivel* (3.61) and elbows and mounted on top of the *base riser* (3.3)

Note 1 to entry: See Figure B.2.

3.42
riser flange
transfer arm (3.59) flange for connection to LNG piping

Note 1 to entry: See Figure B.2.

3.43
riser swivel
swing joint in the *riser and trunnion swivel assembly* (3.41) which permits *slewing* (3.46) of the *transfer arm* (3.59)

Note 1 to entry: See Figure B.2.

3.44
roll
rotation of *LNG carrier* (3.25) around longitudinal horizontal axis

Note 1 to entry: See Table A.4 and Figure A.2.

3.45
safety integrity level
SIL
statistical representations of the integrity of the safety instrumented system when a process demand occurs

Note 1 to entry: See Clause 6.

3.46
slew
horizontal, rotary motion of the *transfer arm* (3.59) around the *base riser* (3.3)

Note 1 to entry: See Figure B.2.

3.47
spool piece
short length of pipe for the purpose of matching the *cargo manifold* (3.6) to the *presentation flange* (3.37) or *QCDC* (3.39)

Note 1 to entry: Sometimes referred to as “adaptor” or “short distance piece”.

3.48
spotting line
pre-determined location on the jetty used by the *LNG carrier* (3.25) when berthing to align with the LNG carrier vapour manifold

Note 1 to entry: See Figure A.4.

3.49
stress analysis
detailed calculation of the structural loading in the *transfer arm* (3.59) and *cargo manifold* (3.6) for various positions and attitudes to check the integrity of the transfer arm for the service intended

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3.50
structural bearing
bearing in the load carrying components supporting the product line that, in combination, allow the *transfer arm* (3.59) to follow freely the motion of the *LNG carrier* (3.25)

3.51
surge aft
longitudinal *LNG carrier* (3.25) afterward motion

Note 1 to entry: See Table A.4 and Figure A.2.

3.52
surge fore
longitudinal *LNG carrier* (3.25) forward motion

Note 1 to entry: See Table A.4 and Figure A.2.

3.53
surge pressure
rapid change in pressure as a consequence of a change in flow rate in a pipeline and/or piping systems (including *transfer arms* (3.59))

3.54
sway
transverse *LNG carrier* (3.25) motion

Note 1 to entry: See Table A.4 and Figure A.2.

3.55
swivel joint
swivel
swing joint contained in the *transfer arm* (3.59) to permit the arm to follow freely the motion of the *LNG carrier* (3.25)

3.56
terminal
LNG producing/receiving plant with loading/unloading facilities

3.57
top swivel
accommodates *roll*ing (3.44), heave and sway motion of *LNG carrier* (3.25) and is located between *outboard arm* (3.32) and *middle swivel* (3.30) in horizontal part of *TSA* (3.60)

Note 1 to entry: See Figure B.2.

3.58
transfer
loading or unloading operation

3.59
transfer arm
arm
articulated metal transfer system used for transferring *product* (3.38) to or from *LNG carrier* (3.25) with the capability of accommodating differences in tides, *freeboard* (3.17) and LNG carrier's motions

Note 1 to entry: See Figure B.2.

Note 2 to entry: It can be referred to as a "loading arm" or "unloading arm".

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3.60
triple swivel assembly
TSA
group of three *swivels* (3.55) and elbows located at the end of the *outboard arm* (3.32)

Note 1 to entry: See Figure B.2.

3.61
trunnion swivel
swing joint in the *riser and trunnion swivel assembly* (3.41) which permits the *inboard arm* (3.20) to rotate around the horizontal axis

Note 1 to entry: See Figure B.2.

3.62
uninterrupted power supply
UPS
back-up of the electrical supply system providing power to critical control and safety systems so that the plant can be kept in safe conditions

3.63
yaw
rotation of the *LNG carrier* (3.25) around vertical axis

Note 1 to entry: See Table A.4 and Figure A.2.

4 Abbreviated terms

For the purposes of this document, the following abbreviated terms apply.

CPMS constant position monitoring system

ERS emergency release system

ESD emergency shutdown

FL fluid load

LNG liquefied natural gas

LNGC liquefied natural gas carrier

LN_2 liquefied nitrogen gas

MHU main hydraulic unit

NDE non destruction examination

NG natural gas

N_2 nitrogen gas

OBE operating basis earthquake

PERC powered emergency release coupling

PL pressure load

PQR performance quality records

QCDC quick connect disconnect coupler

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