TECHNICAL REPORT

ISO/TR 17177

First edition
2015-04-01

Petroleum and natural gas industries — Guidelines for the marine interfaces of hybrid LNG terminals

Pétrole et industries du gaz naturel — Lignes directrices pour les interfaces de terminaux hybrides de GNL

Reference number
ISO/TR 17177:2015(E)

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Published in Switzerland

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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).

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).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT), see the following URL: Foreword — Supplementary information.

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

Introduction

The recent expansion of the LNG industry has led to the development of marine LNG facilities and transfer systems that differ from conventional LNG facility designs. These LNG transfer facilities can require additional or alternative systems and/or operational procedures to enable their safe operation. This Technical Report is intended to provide guidance for aspects of these facilities not covered by current standards and guidelines.

Petroleum and natural gas industries — Guidelines for the marine interfaces of hybrid LNG terminals

1 Scope

This Technical Report provides guidance for installations, equipment and operation at the ship to terminal and ship to ship interface for hybrid floating and fixed LNG terminals that might not comply with the description of "Conventional LNG Terminal" included in ISO 28460.

This Technical Report is intended to be read in conjunction with ISO 28460 to ensure the safe and efficient LNG transfer operation at these marine facilities.

This Technical Report also addresses high pressure natural gas (HPNG) at the transfer interface at facilities where liquefaction or regasification is undertaken, but does not describe requirements for the process plant generally forming part of the terminal facility.

These guidelines are based around facilities that are currently in operation or under development.

2 Terms, definitions, and abbreviated terms

2.1 Terms and definitions

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

2.1.1
as low as reasonably practicable
ALARP
reducing a risk to a level that represents the point, objectively assessed, at which the time, trouble, difficulty, and cost of further reduction becomes unreasonably disproportionate to the additional risk reduction obtained

2.1.2
conventional onshore LNG terminal
LNG export or receiving terminal that is located on-shore and that has a marine transfer facility for the loading or unloading of LNG carriers in a harbour or other sheltered coastal location

Note 1 to entry: A conventional onshore LNG terminal typically includes marine transfer facility comprising a jetty equipped with loading arms or similar to enable the transfer of LNG between ship and shore.

2.1.3
double bank
to moor two vessels moored alongside each other at a terminal

Note 1 to entry: An example of double banking as part of a hybrid LNG terminal is where an LNGC moors and transfers LNG alongside an FSRU or FSU.

2.1.4
emergency release coupling
ERC
device to provide a means of quick release of LNG transfer system when such action is required only as an emergency measure

2.1.5
emergency release system
ERS
system that provides a positive means of quick release of LNG transfer systems and safe isolation between ship and terminal or between units, following a predefined procedure including an emergency shut-down (ESD)

Note 1 to entry: The operation of the emergency release system can be referred to as an "ESD II".

2.1.6
emergency disconnect system
EDS
system that provides a positive means of quick release of HPNG transfer systems and safe isolation between terminal units or between terminal and ship, following a predefined procedure including an emergency shut-down (ESD)

2.1.7
emergency shut-down
ESD
method that safely and effectively stops the transfer of LNG or vapour or HPNG between terminal units or between terminal unit and LNGC

Note 1 to entry: The operation of this system can be referred to as an "ESD I". Ship/shore ESD systems should not be confused with other emergency shut-down systems within the terminal or on board ship.

2.1.8
emergency disconnection coupler
EDC
coupler system that when adopted in HPNG transfer systems as part of EDS has combined routine maintenance and operation connection functionality and emergency disconnection functionality

2.1.9
floating storage and regasification unit
FSRU
floating unit for storage and regasification of LNG and for sending out HPNG and moored for prolonged periods as part of a hybrid LNG terminal

Note 1 to entry: FSRUs are often but not exclusively classified as sea-going vessels and can be purpose-built or be converted from a LNGC. Although designed to be moored long term as part of a terminal, FSRUs frequently have the capability to depart for periodic maintenance or in case of extreme weather.

2.1.10
floating storage unit
FSU
floating unit for storage of LNG and moored for prolonged periods as part of a hybrid LNG terminal

2.1.11
hybrid LNG terminal
LNG export or receiving terminal that is not wholly located onshore and has a marine transfer facility for the loading or unloading of LNG carriers and for transfer of HPNG to shore

Note 1 to entry: A hybrid LNG terminal can be located in a protected harbour, in a naturally sheltered coastal or near shore location, or in an unprotected near shore or offshore environment. The marine transfer facilities for hybrid LNG terminals can include fixed units such as jetties, platforms, and mooring structures. Marine transfer facilities can also include floating units such as FSRUs, FSUs, and LNGRVs. Transfer of LNG and/or HPNG can take place at a number of interfaces between fixed and floating units according to the terminal configuration.

2.1.12
liquefied natural gas regasification vessel
LNGRV
A sea-going vessel for storage and regasification of LNG and for sending out HPNG and moored for periods as part of a hybrid LNG terminal and also capable of operating as an LNGC supplying the hybrid LNG terminal

2.1.13
operating basis earthquake
OBE
maximum earthquake for which no damage is sustained and restart and safe operation can continue

2.1.14
safe shutdown earthquake
SSE
maximum earthquake event for which the essential terminal fail-safe functions and mechanisms are designed to be preserved but for which permanent damage can be expected provided that there is no loss of overall integrity and containment

2.1.15
rapid phase transition
RPT
explosive change in phase of liquid to vapour

Note 1 to entry: RPT can occur when LNG and water come into contact.

2.1.16
rollover
sudden mixing of two layers of LNG of different densities in a tank, resulting in massive vapour generation

2.1.17
spool piece
short length of pipe with flanges for matching the ship's manifold flange to the transfer system presentation flange

Note 1 to entry: Sometimes, reducer spool pieces are used to connect different diameters.

2.1.18
unit
discrete part of a hybrid LNG terminal which can be a fixed or floating structure

Note 1 to entry: Examples of a unit include FSRU, LNGRV, FSU or fixed platform.

2.2 Abbreviated terms

BOG	Boil off gas
CDI	Chemical Distribution Institute
CTMS	Custody transfer measurement system
EERP	Evacuation, escape, and rescue plan
EDC	Emergency disconnect coupler (HPNG)
EDS	Emergency disconnect system (HPNG)
ERC	Emergency release coupling (LNG)
ERS	Emergency release system (LNG)
ERM	Emergency response manual

ESD	Emergency shut-down
FES	Fire and explosion strategy
FSRU	Floating storage and regasification unit
FSU	Floating storage unit
GBS	Gravity based structures
GIIGNL	International Group of Natural Gas Importers
HPNG	High pressure natural gas
ICS	International Chamber of Shipping
IMO	International Maritime Organization
ISGOTT	International Safety Guide for Oil Tankers and Terminals
LNG	Liquefied natural gas
LNGC	Liquefied natural gas carrier
LNGRV	Liquefied natural gas regasification vessel
MLA	Marine loading arms
OBE	Operating basis earthquake
OCIMF	Oil Companies International Marine Forum
QC/DC	Quick connect/disconnect coupler
RPT	Rapid phase transition
SIGTTO	International Society of Gas Tanker and Terminal Operators
SSE	Safe shutdown earthquake
TOM	Terminal operating manual

3 Hazards of LNG and high pressure natural gas (HPNG) transfer

3.1 General

The transfer of LNG and HPNG at marine interfaces for hybrid LNG terminal operations results in a number of potential hazards and hazardous situations in respect of

— properties of LNG and HPNG, and

— the method and conditions of transfer.

Hazard management should be as described in Clause 8.

3.2 Hazards of LNG

Reference should be made to ISO 16903[1)] for guidance on the characteristics of LNG influencing design and material selection, including the general hazards of handling LNG.

1) To be published.

Potential hazards arising from the transfer of LNG for hybrid LNG terminals should be subject to risk assessment taking into account the following:

— cryogenic temperatures, which can cause cold injury to people (frostbite), and also brittle fracture to non-cryogenic materials such as carbon steel;

— pool fire, flash fire, explosion, or asphyxiation from leaks or spillage of LNG;

— surge pressure in LNG transfer systems;

— overpressure resulting in shock waves, caused by rapid phase transition (RPT) of LNG interacting with water;

— overpressure due to expansion or vaporization of trapped LNG;

— mechanical damage due to thermal stresses caused by uncontrolled cool-down of piping and transfer systems;

— rollover.

3.3 Hazards of high pressure natural gas

The potential hazards arising from the transfer of HPNG for hybrid floating and offshore LNG terminals should be subject to risk assessment taking into account the following:

— jet fire, flash fire, or confined vapour cloud explosion;

— asphyxiation;

— stored energy in high pressures systems;

— high noise level from release of HPNG;

— temperature drop caused by the release of HPNG (Joule-Thomson effect);

— mechanical damage due to vibration from high gas velocities in piping and transfer systems.

NOTE The flammability, explosion, and asphyxiation hazards of HPNG are similar to natural gas (NG), but the pressures used to transfer and export the HPNG result in very significant additional hazards due to the velocity and momentum of jet releases and also due to the effects of sudden release of stored energy from a highly pressurized system. High pressure gas release can entrain air, which if ignited, will result in a jet fire.

3.4 Potential hazardous situations associated with hybrid LNG terminal operations

In addition to the hazardous situations for conventional onshore LNG terminals set out in ISO 28460:2010, Clause 5, the following potentially hazardous situations should be considered for operational and contingency planning for hybrid terminals:

— LNG and HPNG transfer operations in close proximity to process equipment;

— simultaneous operations;

— venting and flaring;

— sloshing effects in partially loaded floating storage facilities;

— boil off gas (BOG) management and tank pressure control;

— flange and valve leaks for HPNG transfer systems including any failure or spurious release of the emergency disconnection system (EDS), if fitted, on the HPNG transfer system;

— relative motions at interfaces as a result of the terminal configuration (e.g. double banking, tandem, weather-vaning at turret or yoke mooring) and the resulting mechanical stresses and fatigue;

— metocean conditions and seismic events including:

  — earthquake;

  — tsunami;

  — icebergs;

  — extreme weather events such as tropical cyclones, tornadoes or squalls.

NOTE 1 HPNG gas transfer arms between FSRUs and fixed platforms have at some locations been fitted with emergency disconnection system (EDS), which provide an automated function similar to that of an emergency release coupling (ERC) for LNG transfer arms. Unlike the LNG ERC, HPNG EDS systems have typically combined ERS and QC/DC.

NOTE 2 The motion of floating units incorporating LNG storage can be influenced by the amount of LNG inventory.

NOTE 3 Floating regasification and storage units (FSRUs) may be configured either as permanently moored facilities, or alternatively, the FSRU can have the capability to depart for LNG supply, trading purposes, or to depart in advance of extreme metocean conditions.

4 Siting of facility

NOTE The siting considerations for conventional onshore LNG terminals listed in ISO 28460 ought to be taken into consideration, where applicable.

4.1 General

Site selection for the facility should be based upon a study in accordance with LNG industry best practice.

This study should include a risk assessment undertaken by a multi-discipline team with regard to identifying and mitigating risks to acceptable levels.

The multi-discipline team should include, as a minimum, expertise and experience of the following:

— marine and port operations;

— LNG carrier and terminal operations;

— metocean conditions;

— design and engineering of marine terminal infrastructure;

— risk assessment and hazard management.

4.2 Metocean conditions

Design and operation of the facility should take into account the environmental conditions at the site.

As a minimum, the following metocean parameters should be taken into consideration:

— wave heights, periods and directions;

— tsunamis;

— current speed and direction throughout the water column;

— wind speed and directions including incidence of tropical storms and local squalls;

— sea ice, icebergs, snow, and ice accretion;

— water level including tidal variations;

