FINAL DRAFT

INTERNATIONAL STANDARD

ISO/FDIS 20257-2

ISO/TC **67**/SC **9**

Secretariat: AFNOR

Voting begins on:
2021-03-02

Voting terminates on:
2021-04-27

Installation and equipment for liquefied natural gas - Design of floating LNG installations —

Part 2: Specific FSRU issues

Installations et équipements de gaz naturel liquéfié - Conception des installations flottantes de GNL —

Partie 2: Questions spécifiques aux FSRU

ISO/CEN PARALLEL PROCESSING

Reference number
ISO/FDIS 20257-2:2021(E)

Contents

Page

Foreword ... **vi**
1 Scope ... **1**
2 Normative references ... **1**
3 Terms, definitions and abbreviated terms ... **2**
3.1 Terms and definitions ... 2
3.2 Abbreviated terms ... 2
4 Basis of design ... **3**
4.1 General description of FSRU ... 3
4.2 Main design criteria for process facilities ... 5
4.3 Reliability, availability and maintainability of LNG floating installation ... 6
4.4 Specific requirements for FSRU operating as LNG carrier ... 6
4.5 Specific FSRU studies ... 6
4.5.1 General ... 6
4.5.2 Environmental impact of seawater intake and discharge study ... 6
4.5.3 Recirculation study ... 7
4.5.4 Scour protection study ... 7
5 Specific health, safety and environmental issues ... **7**
5.1 General ... 7
5.2 Environmental considerations related to water heating and cooling issues ... 7
5.3 Safety considerations ... 8
5.3.1 General requirements ... 8
5.3.2 Layout constrains ... 8
5.3.3 Layout constraints with respect to surroundings ... 9
5.3.4 Layout constraints with respect to facility arrangement ... 10
5.3.5 Risk prevention measures ... 11
6 Mooring and stationkeeping ... **16**
7 Hull design ... **16**
8 LNG storage ... **17**
8.1 Specific requirements for cargo tank pressure management ... 17
8.2 Specific requirements for LNGC overpressure protection ... 17
8.3 Rollover risk ... 17
9 Transfer systems ... **17**
9.1 General ... 17
9.2 Send-out natural gas: NG gas transfer requirements ... 17
9.2.1 Functional requirements ... 17
9.2.2 Transfer systems design ... 18
9.2.3 Emergency disconnection ... 19
9.2.4 Operating envelope ... 19
9.3 LNG sampling ... 20
10 BOG handling and recovery ... **21**
10.1 General ... 21
10.2 LNG tank design pressure flexibility ... 21
10.3 Specific requirements for recondenser ... 21
10.4 Specific requirements for gas compressors ... 22
10.4.1 General ... 22
10.4.2 Specific functional requirements for LD compressors ... 22
10.4.3 Specific functional requirements for HD compressors ... 22
10.4.4 Specific functional requirements for HP or MSO compressors ... 22
11 Regasification equipment requirements ... **23**
11.1 LNG pumps ... 23

11.1.1 General ... 23
11.1.2 Functional requirements ... 23
11.1.3 Materials selection ... 23
11.1.4 In-tank LNG pump ... 23
11.1.5 HP LNG pump ... 23
11.2 LNG vaporization system ... 24
11.2.1 Functional requirements ... 24
11.2.2 Vaporization type ... 24
11.2.3 Materials selection ... 25
11.2.4 Protective coating ... 25
11.2.5 Marine growth ... 25
11.2.6 Stability/vibration ... 25
11.2.7 Safety relief valves ... 26
11.3 Trim heater ... 26
11.4 Venting from regasification systems ... 26
12 Gas send out ... 26
12.1 High integrity pressure protection system ... 26
12.1.1 Send-out pressure control ... 26
12.1.2 Typical description of HIPPS ... 27
12.1.3 Design requirements for HIPPS ... 28
12.2 Send-out gas metering ... 29
12.2.1 Uses of send-out gas metering ... 29
12.2.2 Measurement devices type ... 29
12.2.3 Accuracy ... 29
12.2.4 External influences ... 29
12.2.5 Gas chromatograph – Gas analyser ... 30
12.2.6 Sparing philosophy ... 30
12.2.7 Z-configuration ... 30
12.3 Odorization systems ... 30
13 Utilities ... 30
13.1 General ... 30
13.2 Cooling and heating medium ... 30
13.2.1 Cooling medium ... 30
13.2.2 Heating medium ... 31
13.2.3 Nitrogen system ... 31
13.2.4 Fuel gas ... 31
14 Process and safety control systems ... 32
14.1 General requirements ... 32
14.2 Interfaces between FSRU and gas export connection ... 32
14.3 Communication onshore/offshore ... 32
15 Security management ... 32
16 Commissioning ... 32
17 Inspection and maintenance ... 33
17.1 General requirements ... 33
17.2 Cargo tank ... 33
17.3 In-tank LNG pump ... 33
17.4 Regasification equipment ... 33
17.4.1 HP LNG pump ... 33
17.4.2 LNG vaporizer ... 33
17.5 Recondenser ... 33
17.6 Handling/Crane equipment ... 33
18 Preservation and corrosion protection ... 34
19 Conversion of existing unit to floating LNG installations ... 34
Annex A (informative) **Regasification system description ... 35**

Bibliography **40**

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).

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.

This document was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 9, *Liquefied natural gas installations and equipment*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 282, *Installation and equipment for LNG*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

A list of all parts in the ISO 20257 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.

Installation and equipment for liquefied natural gas - Design of floating LNG installations —

Part 2: Specific FSRU issues

1 Scope

This document provides specific requirements and guidance for the design and operation of floating LNG storage and regasification units (FSRU) described in ISO 20257-1.

This document is applicable to offshore, near-shore or docked FSRUs and to both new-built and converted FSRUs.

This document includes requirements to the jetty when an FRSU is moored to a jetty.

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 20257-1:2020, *Installation and equipment for liquefied natural gas — Design of floating LNG installations — Part 1: General requirements*

AGA 9, *Measurement of Gas by Multipath Ultrasonic Meters*

AGA 10, *Speed of Sound in Natural Gas and Other Related Hydrocarbon Gases*

EN 1776, *Gas infrastructure — Gas measuring systems — Functional requirements*

EN 12186, *Gas infrastructure — Gas pressure regulating stations for transmission and distribution - Functional requirements*

ISO 13734, *Natural gas — Organic components used as odorants — Requirements and test methods*

EN 14382, *Safety devices for gas pressure regulating stations and installations — Gas safety shut-off devices for inlet pressures up to 100 bar*

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

IEC 61511 (all parts), *Functional safety — Safety instrumented systems for the process industry sector*

ISO 5168, *Measurement of fluid flow — Procedures for the evaluation of uncertainties*

ISO 6976, *Natural gas — Calculation of calorific values, density, relative density and Wobbe indices from composition*

ISO 8943, *Refrigerated light hydrocarbon fluids — Sampling of liquefied natural gas — Continuous and intermittent methods*

ISO 12213-1, *Natural gas — Calculation of compression factor — Part 1: Introduction and guidelines*

ISO 12213-2, *Natural gas — Calculation of compression factor — Part 2: Calculation using molar-composition analysis*

ISO 13709, *Centrifugal pumps for petroleum, petrochemical and natural gas industries*

ISO 16903, *Petroleum and natural gas industries — Characteristics of LNG, influencing the design, and material selection*

ISO 17089-1, *Measurement of fluid flow in closed conduits — Ultrasonic meters for gas — Part 1: Meters for custody transfer and allocation measurement*

CODE IGC *International Code of the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk*, International Maritime Organization (IMO)

OIML R 137-1, *Gas meters — Part 1: Metrological and technical requirements*

OIML R 137-2, *Gas meters — Part 2: Metrological controls and performance tests*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 20257-1:2020 and the following 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 http://www.electropedia.org/

3.1.1
fiscal metering
metering aimed to define the quantity and financial value of hydrocarbon product transaction

3.1.2
custody transfer
physical transfer of hydrocarbon product that results in change in ownership and/or a change in responsibility

3.2 Abbreviated terms

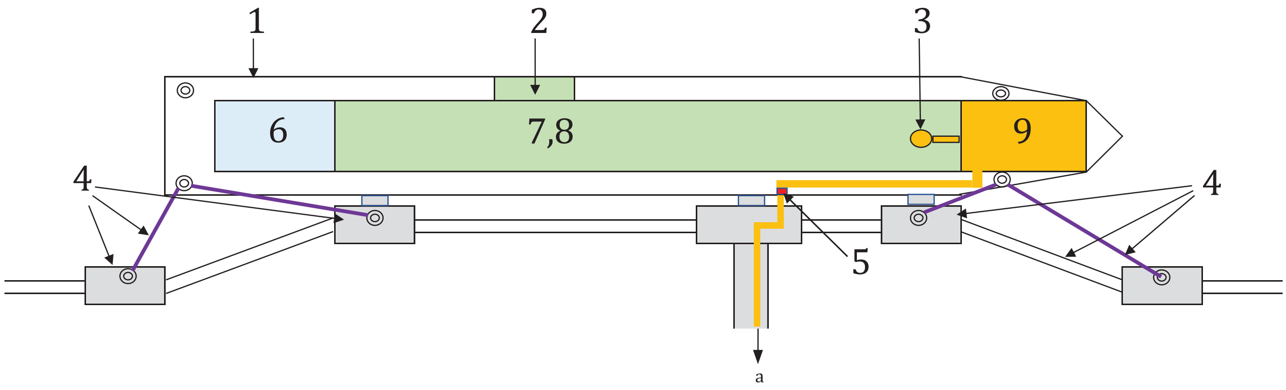
ALARP	as low as reasonably practicable
BOG	boil-off gas
CLV	closed loop vaporizer
EDS	emergency disconnection system
ERC	emergency release coupling
ESD	emergency shut down
FSRU	floating storage and regasification unit
GCU	gas combustion unit
HAZOP	hazard and operability (study)

HD	high duty
HIPPS	high integrity pressure protection system
HP	high pressure
HVAC	heating, ventilation and air conditioning
HW	hot water
IFV	intermediate fluid vaporizer
IR	infrared
LD	low duty
LNG	liquefied natural gas
LP	low pressure
MAC	manual alarm call
MOP	maximum operating pressure
MSO	minimum send out
NG	natural gas
NPSH	net positive suction head
OEM	original equipment manufacturer
OESD	Offloading Emergency Shut Down
OLV	open loop (direct contact) vaporizer
ORV	open rack vaporizer
QRA	quantitative risk analysis
RAM	reliability, availability, maintainability
SCV	submerged combustion vaporizer
SIL	safety integrity level
SIS	safety instrumented system
UV	ultraviolet

4 Basis of design

4.1 General description of FSRU

Figure 1 illustrates a typical arrangement of FSRU facilities, showing an FSRU berthed to a single jetty. The arrangement can differ in case of use of other mooring designs.



Key

1 hull (see Clause 7)

2 LNG transfer (see ISO 20257-1:2020, Clause 10)

3 regasification vent mast

4 mooring (see Clause 4)

5 HP manifold and FSRU ESD valve (see Clause 9)

6 living quarters

7 cargo containment system (see Clause 8)

8 cargo handling system – BOG handling system (see Clause 10)

9 regasification system (see Clause 11)

a Gas send out (see Clause 12).

Figure 1 — Example of FSRU arrangement (berthed to a jetty)

For safe loading, storage and regasification of LNG and discharging NG through HP manifolds to the shore, an FSRU is typically equipped with integrated systems for:

a) cargo handling;

b) cargo containment;

c) regasification.

Associated systems and equipment for cargo, such as BOG management systems, cargo tank spray systems, inert gas system, nitrogen system, venting system, auxiliary system., are provided in accordance with applicable (project, class, ...) requirements.

Figure 2 illustrates the terminology typically used in descriptions of the regasification system.

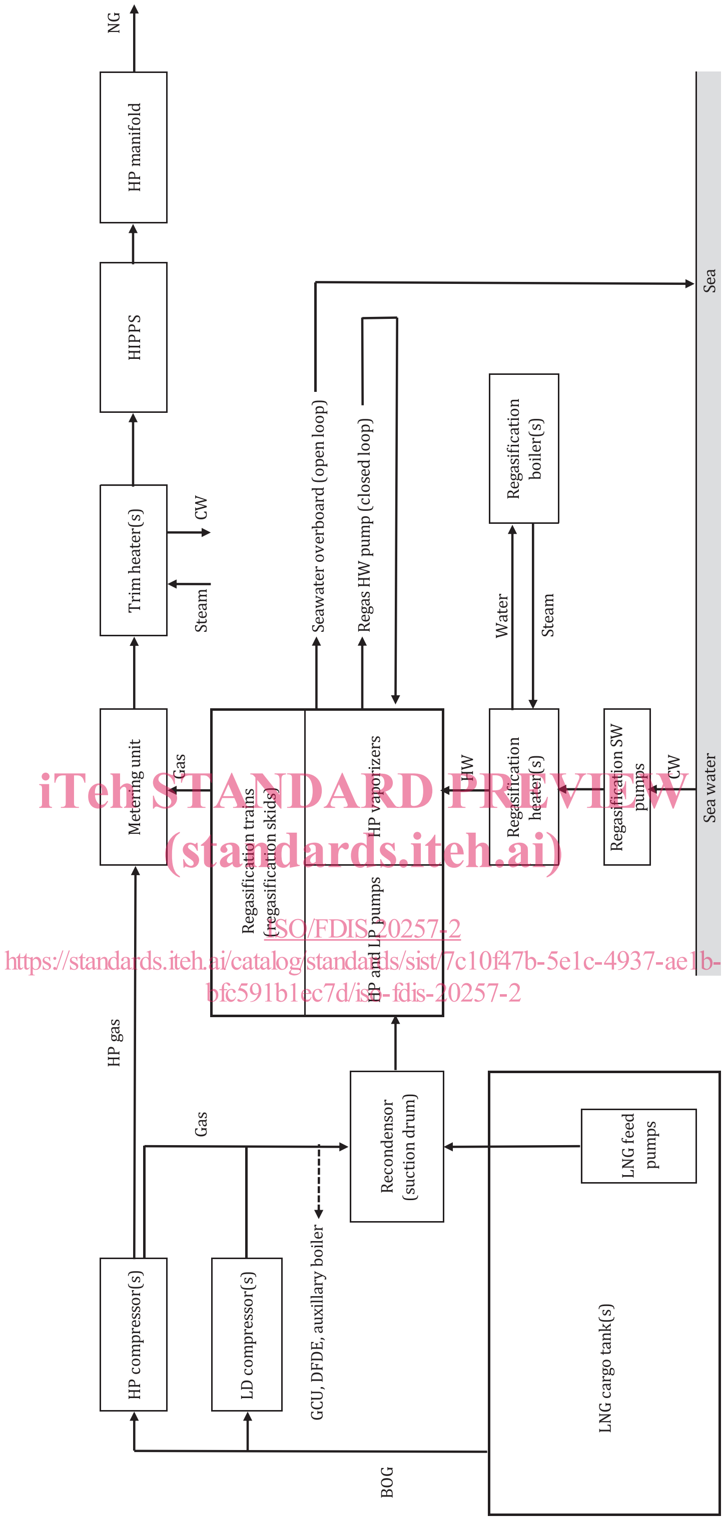


Figure 2 — Description of the regasification system

4.2 Main design criteria for process facilities

The process facilities of FSRU shall be designed considering the following conditions:

a) NG send-out capacity, which can be minimum, nominal, peak and zero;

b) redundancy, holding period and turn-down requirements of process facilities;

c) regasification type (e.g. open loop, combined or closed loop);

d) regasification operation (e.g. metocean and site conditions during regasification operation);

e) maximum operating and design send-out pressure at HP manifold;

f) minimum and maximum send-out temperature at HP manifold;

g) design range of seawater temperature and flowrate for regasification;

h) LNG loading rate concurrent with regasification (minimum send-out capacity to be considered);

i) LNG quality and chemical composition;

j) odorization, if required;

k) discharge seawater conditions (i.e. seawater used for regasification process);

l) BOG management (e.g. venting and flaring philosophy required);

m) dual operation FSRU and LNG carrier requirements.

4.3 Reliability, availability and maintainability of LNG floating installation

A RAM analysis should be performed to determine the availability of gas export from FSRU given a certain demand profile. Availability curves should be prepared for various demand scenarios.

Metocean conditions shall be considered while operating regasification facilities to define availability.

The design should consider N+1 configurations for all key equipment to ensure a high availability of gas export. Typically based on operational experience, the HD compressor and HP compressors would not be subject to the N+1 philosophy.

4.4 Specific requirements for FSRU operating as LNG carrier

When an FSRU is operating as LNG carrier (part time or after extended stay on location), provisions shall be taken to

a) shutdown and isolate the regasification facilities, and

b) fasten potential transfer systems.

After extended stay on location, additional requirements such as revision of drydock plan before starting operating as LNG carrier can be required by flag and/or class requirements.

4.5 Specific FSRU studies

4.5.1 General

The relevant studies mentioned in ISO 20257-1:2020, Clause 4 shall be performed. In addition, the process and environmental aspects described in 4.5.2 to 4.5.4 shall be addressed.

4.5.2 Environmental impact of seawater intake and discharge study

Specific studies related to environmental impact of seawater intake and discharge shall be performed in accordance with 5.2. Local requirements can have an impact on the regasification type selection.

4.5.3 Recirculation study

During the regasification process, an FSRU takes in seawater, extracts heat from it for regasification of LNG, and discharges the seawater at a lower temperature. The recirculation pattern of the discharged effluent towards the intake point can lead to lower intake temperature and reduce the unit's efficiency.

The aim of a recirculation study is to assess the risk of recirculating the cold water effluent based on the discharge characteristics during FSRU operations and the ambient characteristics of the receiving water body. A recirculation study can also assist the FSRU owner and builder by optimizing the intake and outlet locations in the design.

To assess the recirculation risk, the behaviour of the cold water plume in a mid-field, far-field and near-field model shall be analysed. A 3D far-field model can be used to analyse the large-scale circulation patterns and their influence on the recirculation risk and to generate the boundary conditions for a 3D near-field model. In a detailed near-field model, different scenarios are assessed on their potential for recirculation.

The following scenarios shall be considered:

a) For the far-field model: evaluation of the far-field transitional phase behaviour under varying hydrodynamic conditions.

b) For the near-field model:

  1) sensitivity analysis to evaluate near-field model performance and variation of ambient water characteristics and flow conditions;

  2) analysis of recirculation risk for varying water level conditions and draughts of FSRU, for flood conditions;

  3) analysis of recirculation risk with alternative outlet configurations, for varying water levels and draughts of FSRU, for both flood and ebb flow conditions;

  4) similar setup of conditions as in 2) and 3) adding an LNG carrier berthed alongside the FSRU, if this is a realistic scenario.

4.5.4 Scour protection study

Additional investigation concerning scour protection, where relevant, shall be performed due to water intake/outfall of regasification system.

5 Specific health, safety and environmental issues

5.1 General

This clause describes the specificities of FSRU application and shall be applied in addition to ISO 20257-1:2020, Clause 5.

5.2 Environmental considerations related to water heating and cooling issues

Systems used for seawater heating/cooling should follow the environmental recommendations of the World Bank Group[15]. Where chemicals are used to prevent marine fouling in the shipboard facilities, these should be minimized and alternate measures should be considered. This can involve taking water from depth where this is possible. For a near-shore FSRU, the limited water depth and limited potential for marine growth should be considered. Providing screens on water intakes to avoid entrainment of marine organisms should also be considered.

Change in ambient seawater temperature due to discharge of seawater should be limited to less than 3 °C at the edge of a defined mixing zone. In case of use of a chlorination system, free chlorine (total

