NR542 DT R05 JUNE 2025

CLASSIFICATION OF FLOATING GAS UNITS

NR542 – JUNE 2025

RULE NOTE

BUREAU VERITAS

BUREAU VERITAS
RULES, RULE NOTES AND GUIDANCE NOTES

NR542 DT R05 June 2025 takes precedence over previous revision.

The PDF electronic version of this document available on the Bureau Veritas Marine & Offshore website https://marine-offshore.bureauveritas.com/ is the official version and shall prevail if there are any inconsistencies between the PDF version and any other available version.

These rules are provided within the scope of the Bureau Veritas Marine & Offshore General Conditions, enclosed at the end of Part A of NR467, Rules for the Classification of Steel Ships. The latest version of these General Conditions is available on the Bureau Veritas Marine & Offshore website.

BUREAU VERITAS MARINE & OFFSHORE

Tour Alto
4 place des Saisons
92400 Courbevoie - France
+33 (0)1 55 24 70 00

marine-offshore.bureauveritas.com/rules-guidelines

NR542

CLASSIFICATION OF FLOATING GAS UNITS

Section 1	General
Section 2	Structure Design Principles
Section 3	Hydrodynamic Analysis
Section 4	Design Loads
Section 5	Hull Girder Strength
Section 6	Hull Scantlings
Section 7	Other Structures
Section 8	Local Structural Improvements
Section 9	Cargo Containment System
Section 10	Stability and Subdivision
Section 11	Arrangements, Access, Ventilation and Venting of Spaces in the Cargo Area
Section 12	Equipment and Safety Particulars
Section 13	Topside Arrangement and Systems
Section 14	Transfer Systems
Section 15	Piping Systems
Section 16	Use of Cargo as Fuel
Section 17	Electrical Installations
Section 18	Swivels and Turrets Compartments

June 2025

Table of Content

Section 1 General

1 General 9

1.1 Application
1.2 Class notations
1.3 Classification Society involvement
1.4 Structural requirements
1.5 Design life
1.6 Station keeping
1.7 Scope of additional class notations
1.8 Classification and towing/transit
1.9 Reference documents

2 Statutory requirements 14

2.1 General

3 Symbols and definitions 14

3.1 General
3.2 Definitions

4 Calculation 15

4.1 Calculations to be submitted

5 Design criteria and data 16

5.1 General
5.2 Site data
5.3 Operating loading conditions

6 Documentation to be submitted 17

6.1

Section 2 Structure Design Principles

1 Definition of the unit areas 19

1.1 Principles

2 Materials for construction 20

2.1 Material temperature in design condition
2.2 Offshore areas
2.3 Ship areas
2.4 Steels with specified through thickness properties
2.5 Inspection and checks

3 Structural principles 20

3.1 Typical arrangement
3.2 General construction
3.3 Plating
3.4 Ordinary stiffeners
3.5 Primary supporting members

4 Access 21

4.1 General
4.2 Means of access
4.3 Access to spaces located outside of the cargo area
4.4 Access to spaces in the cargo area
4.5 Underwater parts
4.6 Access manual

5 Net scantling approach 24

5.1 Principle
5.2 Corrosion additions

6 Thickness increments 24

6.1 General
6.2 Thickness increment values

Table of Content

7 Bottom, side and deck structures 24

7.1 General
7.2 Particular requirements for the side structure

8 Reinforcements in way of supporting structures for hull attachments 25

8.1 Local arrangement

9 Welding and weld connections 25

9.1 General
9.2 Offshore areas
9.3 Ship areas

Section 3 Hydrodynamic Analysis

1 Principle 27

1.1 Application

Section 4 Design Loads

1 General 28

1.1 Principles
1.2 Definitions
1.3 Application criteria

2 Still water loads 29

2.1 Loading manual
2.2 Hull girder still water loads
2.3 Loading instrument

3 Wave loads 30

3.1 Towing/transit and site conditions
3.2 Design wave loads
3.3 Hull girder wave loads
3.4 Unit motions and accelerations
3.5 Relative wave elevation

4 Load cases 31

4.1 Towing/transit and site conditions
4.2 Load cases for structural analysis based on partial unit models

5 Sea pressures 31

5.1 General
5.2 Towing/transit and site conditions
5.3 Still water pressure
5.4 Wave pressure

6 Internal pressures 31

6.1 Towing/transit and site conditions
6.2 Mass densities
6.3 Calculation

Section 5 Hull Girder Strength

1 General 33

1.1 Principle
1.2 Strength characteristics of the hull girder transverse sections

2 Yielding checks 33

2.1 Hull girder stresses
2.2 Checking criteria
2.3 Section modulus and moment of inertia

3 Ultimate strength check 33

3.1 General

Table of Content

Section 6 Hull Scantlings

1 General 34

1.1 Application
1.2 Principle

2 Plating 34

2.1 General

3 Ordinary stiffeners 35

3.1 General

4 Primary supporting members 35

4.1 General
4.2 Structural modelling
4.3 Flooding for ships with independent tanks
4.4 Load model
4.5 Yielding strength criteria for ship areas
4.6 Buckling check

5 Offshore areas 38

5.1 Strength criteria for offshore areas

6 Fatigue check of structural details 38

6.1 General
6.2 Structural details

Section 7 Other Structures

1 General 40

1.1 Application

2 Station keeping 40

2.1 General
2.2 Materials for mooring supporting structure

3 Supports for hull attachments and appurtenances 40

3.1 General
3.2 Materials
3.3 Calculations

4 Fore part 40

4.1 General

5 Aft part 40

5.1 General

6 Superstructures and deckhouses 41

6.1 General

7 Helicopter deck 41

7.1 General

8 Hull outfitting 41

8.1 Bulwarks and guard rails
8.2 Towing foundation

9 Launching appliances 41

9.1 Deck structure in way of launching appliances used for survival craft or rescue boat

Section 8 Local Structural Improvements

1 General 42

1.1 Application
1.2 References for the Offshore Rules

Table of Content

Section 9 Cargo Containment System

1 Design loads 43

1.1 Internal pressure for all types of cargo tank
1.2 Thermally induced loads
1.3 Accidental design conditions

2 Structural analysis of integral tanks 44

2.1 Scantlings

3 Structural analysis of membrane tanks 44

3.1 General
3.2 Ultimate design conditions
3.3 Accidental design conditions

4 Structural analysis of type A independent tanks 44

4.1 Plating
4.2 Ordinary stiffeners
4.3 Primary supporting members

5 Structural analysis of type B independent tanks 45

5.1 Material properties
5.2 Plating and ordinary stiffeners
5.3 Primary supporting members
5.4 Fatigue analysis
5.5 Crack propagation analysis

6 Structural analysis of type C independent tanks 47

6.1 Scantlings
6.2 Stiffening rings in way of tank supports

7 Supports 47

7.1 Supporting arrangement
7.2 Calculation of reaction forces in way of tank supports
7.3 Supports of type A and type B independent tanks primarily constructed of plane surfaces
7.4 Supports of independent tanks of type B primarily constructed of bodies of revolution
7.5 Supports of type C independent tanks

8 Secondary barrier 49

8.1 Secondary barrier extent

9 Insulation 49

9.1 Heating of structures

10 Materials 49

10.1 Materials of construction
10.2 Insulation material characteristics

11 Construction and testing 49

11.1 General

12 Structural details 49

12.1 General

Section 10 Stability and Subdivision

1 General 50

1.1 Application
1.2 Documentation to be submitted

Table of Content

2 Stability 50

2.1 Trim and stability booklet
2.2 Operational procedures
2.3 Inclining test and lightweight survey
2.4 Stability calculations
2.5 Intact stability
2.6 Damage stability for units not assigned the service notation liquefied gas storage
2.7 Damage stability for units assigned the service notation liquefied gas storage

3 General arrangement 53

3.1 All units
3.2 Units assigned the service notation liquefied gas storage

Section 11 Arrangements, Access, Ventilation and Venting of Spaces in the Cargo Area

1 General 55

1.1 Application
1.2 Definitions

2 Units with service notation liquefied gas storage 56

2.1 Segregation of the cargo area
2.2 Accommodations, service and machinery spaces and control stations
2.3 Cargo pump rooms and cargo compressor rooms
2.4 Access to spaces in the cargo area
2.5 Air locks
2.6 Bilge, ballast and fuel oil arrangements
2.7 Cargo tank venting system
2.8 Mechanical ventilation in the cargo area

Section 12 Equipment and Safety Particulars

1 General 59

1.1 Application

2 Hazardous areas 59

2.1 General
2.2 Classification of hazardous areas due to storage and offloading

3 Side discharges 60

3.1 Side discharges below the freeboard deck

4 Life saving appliances 60

4.1 Additional requirement

5 Additional requirements for units assigned the service notation liquefied gas storage 60

5.1 General
5.2 Fire safety
5.3 Water spray system
5.4 Dry chemical powder fire-extinguishing systems
5.5 Cargo compressor rooms and cargo pump rooms
5.6 Portable fire extinguishers

Section 13 Topside Arrangement and Systems

1 General 62

1.1 Application
1.2 Additional class notation PROC-GP
1.3 Additional class notation PROC-GL
1.4 Additional class notation liquefied gas transfer
1.5 New technology

Table of Content

2 Unit safety requirements 63

2.1 Topside layout
2.2 Risk analysis
2.3 Cryogenic embrittlement protection
2.4 Temporary refuge
2.5 Fire zone
2.6 Fire protection

3 Topside systems requirements 64

3.1 Application
3.2 Topside systems and components
3.3 Process systems and components (PROC-GP and PROC-GL)
3.4 Cargo transfer systems (liquefied gas transfer)

4 Topside layout 65

4.1 Application
4.2 General
4.3 Safety principles
4.4 Fire zones
4.5 System arrangement
4.6 Means of escape
4.7 Fire protection

Section 14 Transfer Systems

1 General 69

1.1 Application
1.2 Scope of the additional class notation liquefied gas transfer
1.3 Definitions

2 Classification procedure 71

2.1 General
2.2 Definition of the transfer system
2.3 Definition of Owner's acceptance criteria and performance standards
2.4 Definition of limiting loading conditions for loading/offloading operations
2.5 Risk assessment
2.6 Identification and qualification program of new technology
2.7 Design studies and/or model tests
2.8 Elaboration of approval scheme for classification
2.9 Verification of approval scheme for classification

3 Design requirements 73

3.1 Dimensions and clearance
3.2 Materials
3.3 Model tests and hydrodynamic analysis
3.4 Design loads for the structural elements
3.5 Structural design assessment
3.6 Mooring and fendering equipment
3.7 Release mooring hooks
3.8 Winches
3.9 Mooring fittings
3.10 Transfer line
3.11 Swivel joints and structural bearings
3.12 Embrittlement protection
3.13 Other design requirements

4 Inspections and testing 82

4.1 General
4.2 Prototype testing
4.3 Manufacturing
4.4 Factory acceptance tests
4.5 Site acceptance tests
4.6 Additional requirements
4.7 Inspection and tests of transfer systems using flexible hoses

Table of Content

Section 15 Piping Systems

1 General 84

1.1 Application
1.2 Definitions
1.3 Alternative requirements
1.4 Separation of systems

2 Cargo pipings of units with service notation liquefied gas storage 84

2.1 General
2.2 Design pressure
2.3 Scantlings based on internal pressure
2.4 Flanges not complying with standards
2.5 Stress analysis
2.6 Aluminised pipes
2.7 Cargo system valving
2.8 Cargo transfer methods
2.9 Bonding

3 Production piping intended to carry liquefied gas or liquefied gas vapours 87

3.1 General

Section 16 Use of Cargo as Fuel

1 General 88

1.1 Application
1.2 General references

Section 17 Electrical Installations

1 General 89

1.1 Application
1.2 Documentation to be submitted
1.3 Earth detection
1.4 Mechanical ventilation of hazardous spaces
1.5 Electrical installation precautions

2 Hazardous locations and types of equipment 90

2.1 Electrical equipment permitted in gas-dangerous spaces and zones
2.2 Submerged cargo pumps

3 Product classification 90

3.1 Temperature class and explosion group

Section 18 Swivels and Turrets Compartments

1 Swivels 92

1.1 Pressure swivels
1.2 Electrical swivels
1.3 Test of pressure swivels

2 Turret compartments 92

2.1 General

Section 1 General

1 General

1.1 Application

1.1.1 The present Rule Note provides requirements for the classification of floating gas units. The requirements are only applicable for steel units having one of the structural type notations and service notations defined in [1.2].

1.1.2 The requirements of this Rule Note are complementary to the provisions of NR445 Rules for the Classification of Offshore Units, which remain applicable, except where otherwise specified.

1.1.3 Units intended to be assigned with the service notation **liquefied gas storage**, as defined in [1.2.2], are to comply with the requirements of IGC Code, except where otherwise specified in this Rule Note. This Rule Note provides additional requirements and interpretations of IGC Code to be considered for the purpose of classification. The Society may refer to IGC Code when deemed necessary, as defined in [3.2.3].

1.1.4 The provisions of this Rule Note are applicable to the design and construction of new built units. For units based on conversion of existing seagoing ships, the minimum requirements are to be defined on a case-by-case basis.

1.1.5 The requirements for the maintenance of class of units covered by the present Rule Note (see [1.1.1]) are given in Pt A, Ch 2 of the Offshore Rules.

1.1.6 The provisions of this Rule Note are applicable for permanent installations, as defined in [3.2.4].

In case of mobile units, as defined in Pt A, Ch 1, Sec 1, [4.5.1] of the Offshore Rules, not considered as permanent installations, special requirements are to be met based on the operating requirements. Such requirements are to be mentioned in the Design Criteria Statement which may influence not only the design but also the in-service inspections.

Note 1: The provisions of the present Note are not applicable to gas carriers used temporarily as gas terminals. This type of units is to comply with the requirements of the Ship Rules (see [3.2.1]) applicable for the service notation **liquefied gas carrier**, with or without the additional service features **REGAS** or **STL-SPM**.

1.2 Class notations

1.2.1 Structural type notations

This Rule Note applies to surface units, as defined in Pt A, Ch 1, Sec 1, [4.3.1] of the Offshore Rules.

Surface units complying with this Rule Note are assigned one of the following structural type notations, as defined in Pt A, Ch 1, Sec 2, [4] of the Offshore Rules:

- **offshore barge** - for non-propelled surface units, including the case of converted ships when unable to perform non-assisted voyages
- **offshore ship** - for surface units having a propulsion system and steering appliances.

Note 1: Units assigned with the structural type notation **offshore ship** are not to be involved in the transport of cargoes.

1.2.2 Service notations

At least one of the following service notations, as defined in Pt A, Ch 1, Sec 2, [5] of the Offshore Rules, is to be assigned to units complying with this Rule Note

- **liquefied gas storage** - mandatory for units designed and equipped for the storage of liquefied gas in integral or independent tanks within the hull.
- **gas production unit** - may be assigned to units designed and equipped to receive gas and to process it.
- **gas liquefaction unit** - may be assigned to units designed and equipped for gas liquefaction

Production equipment is not included in the scope of classification except when one of the additional class notation **PROC-GP** or **PROC-GL**, as defined in Pt A, Ch 1, Sec 2, [8.3.3] of the Offshore Rules, is assigned (see [1.2.4] and [1.7.1]).

1.2.3 Additional service features

The following additional service features, as defined in Part A, Ch 1, Sec 2, [5] and Part A, Ch 1, Sec 2, [6] of the Offshore Rules, may be assigned to units complying with this Rule Note:

- **SLOSHING** - mandatory for units with service notation **liquefied gas storage** using membrane tanks for cargo containment.

Note 1: **SLOSHING** may also be requested by the Society on a case-by-case basis for containment systems other than membrane type, if deemed necessary considering the specific design of the containment system.

- One of the additional service features **POSA**, **POSA-HR** or **POSA JETTY** - mandatory for permanent installations.
- **INERTGAS** - may be assigned to units having the service notation **liquefied gas storage** or **gas production unit** or **gas liquefaction unit**, when they are equipped with an inert gas plant for condensate storage tanks complying with the corresponding provisions of Part D, Chapter 1 of the Offshore Rules. This additional service feature applies also to gas blanketing systems.

  On a case-by-case basis, the Society may require the assignment of the additional service feature **INERTGAS** for units fitted with condensate storage tanks.

1.2.4 Additional class notations

The following additional class notations, defined in Pt A, Ch 1, Sec 2, [8] of the Offshore Rules, are mandatory for units covered by this Rule Note:

- **AUTO**, as defined in Pt A, Ch 1, Sec 2, [8.3.14] of the Offshore Rules.
- **VeriSTAR-HULL**, as defined in Pt A, Ch 1, Sec 2, [8.2.2] of the Offshore Rules.

The following additional class notations may be assigned to units covered by this Rule Note:

- **REGAS**, as defined in Pt A, Ch 1, Sec 2, [8.3.13] of the Offshore Rules.

  The requirements for the assignment of this notation are given in NR645, Sec 10.
- **PROC-GP**, as defined in Pt A, Ch 1, Sec 2, [8.3.3] of the Offshore Rules.

  The requirements for the assignment of this notation are given in [1.7.1] and Sec 13.
- **PROC-GL**, as defined in Pt A, Ch 1, Sec 2, [8.3.3] of the Offshore Rules.

  The requirements for the assignment of this notation are given in [1.7.1] and Sec 13.
- **liquefied gas transfer**, as defined in Pt A Ch 1 sec 2, [8.3.8] of the Offshore Rules.

  The requirements for the assignment of this notation are given in Sec 14.
- **SUR2SUB**, as defined in Pt A Ch 1, Sec 2, [8.3.4] of the Offshore Rules.

  The requirements for the assignment of this notation are given in Pt D, Ch 1, Sec 21 of the Offshore Rules.
- **VeriSTAR-HULL FLM**, as defined in Pt A, Ch 1, Sec 2, [8.2.3] of the Offshore Rules.

  The requirements for the assignment of this notation are given in NR 551.

Note 1: The additional class notation **INWATERSURVEY** is mandatory for the permanent units.

Furthermore, the additional class notations as mentioned in the Ship Rules may be assigned.

1.2.5 Site, transit and navigation notations

Site, transit and navigation notations are assigned in accordance with the provisions of Pt A, Ch 1, Sec 2, [7] of the Offshore Rules.

1.3 Classification Society involvement

1.3.1 The scope of classification for units listed in [1.2] is based on appraisal of the integrated unit covering, in general:

a) Hull, accommodation, helideck and hull attachments and appurtenances including:
   - riser support structure
   - structure to which the moorings are attached, and supports for mooring equipment
   - foundations for the support of topsides modules, the flare tower, and the hull mounted equipment
   - support structure for life saving appliances
   - passive fire protection
   - cathodic protection

b) Cargo containment system including integral tanks, membrane tanks, independent tanks and their supports to the hull

c) Intact and damage stability

d) Marine equipment (with foundations) pertaining to the offloading facilities and associated control / safety equipment, including:
   - offloading fixed cargo piping, up to the isolating flange(s) between fixed cargo pipe(s) and flexible hose(s)
   - cargo pressure containment equipment (e.g. pumps, metering unit…)
   - hose handling (winches) foundations on hull deck
   - active and passive fire protection
   - inlets/outlets of enclosed spaces in the vicinity
   - offloading control station.

e) Accommodation quarters

f) Mooring system:
   - for the additional service feature **POSA, POSA-HR** or **POSA JETTY**:
     mooring line components (anchors, chains, wire and accessories)
   - hull mounted equipment (fairleads, stoppers...)
   - for the additional class notation **OHS**:
     mooring line handling equipment (winch and associated sheaves...)

g) Lifting appliances (in case of additional class notation **ALM**, see Pt A, Ch 1, Sec 2, [8.3.1] of the Offshore Rules)

h) Equipment and systems necessary for the safe operation of the hull and to the safety of personnel on board as defined in the Offshore Rules and related applicable Rules (taking into account the additional class notation **LSA**, see Pt A, Ch 1, Sec 2, [8.3.5] of the Offshore Rules)

i) Equipment and systems installed in the hull, the failure of which may jeopardise the safety of the floating unit

j) The fire and gas detection system for the hull as well as the definition of the hazardous areas of the hull

k) The fire water and foam system for the protection of the hull

l) Topsides systems, as follows:
   - gas process plant, in case of additional class notation **PROC-GP** (see Pt A, Ch 1, Sec 2, [8.3.3] of the Offshore Rules)
   - gas liquefaction plant, in case of additional class notation **PROC-GL** (see Pt A, Ch 1, Sec 2, [8.3.3] of the Offshore Rules)
   - cargo transfer system, in case of additional class notation **liquefied gas transfer**

m) The revaporization plant, in case of additional class notation **REGAS**

n) Propulsion plant:

For each project, the detailed boundaries for the classification of units intended to be assigned the structural type notation **offshore barge** or **offshore ship** are defined by the Society on a case-by-case basis and with reference to the requested structural type and service notations, additional class notations and additional service features.

1.3.2 Classification - Design Criteria Statement

Classification is based upon the design data or assumptions specified by the party applying for classification.

A Design Criteria Statement is to list the services performed by the unit and the design conditions and other assumptions on the basis of which class is assigned to the unit.

The Design Criteria Statement is to be:
- issued by the Society
- referred to on the unit classification certificate
- incorporated in the Operating Manual, as stated in Pt A, Ch 1, Sec 1, [3.4] of the Offshore Rules.

Additional details about the Design Criteria Statement are given in Pt A, Ch 1, Sec 1, [1.6] of the Offshore Rules.

1.4 Structural requirements

1.4.1 The structural requirements in Pt D, Ch 1, Sec 1, [1.5] of the Offshore Rules are to be complied with for units covered by this Rule Note, as applicable.

1.5 Design life

1.5.1 The requirements about design life, unit modifications and unit re-assessment are given in Pt A, Ch 1, Sec 1, [1.7] of the Offshore Rules.

1.6 Station keeping

1.6.1 Permanent installations

Permanent installations covered by the present Note are to comply with the requirements stipulated in Pt D, Ch 1, Sec 1, [1.7.1] of the Offshore Rules.

1.6.2 Dynamic positioning system

For units having a mooring system consisting, partly or entirely, of dynamic positioning system, the Society makes reference to the requirements given for the additional class notation **DYNAPOS** (see Pt A, Ch 1, Sec 2, [8.3.2] of the Offshore Rules).

1.6.3 Mooring to buoy

When the mooring of unit is assured through a floating buoy, the buoy and its mooring system are to be classed by the Society.

The buoy is to be considered as a permanent installation having one of the following service notations:

- **gas/condensate loading**
- **gas/condensate offloading**.

The arrangement of the buoy is to comply with the requirements of NR494 Rules for the Classification of Offshore Loading and Offloading Buoys, as applicable.

The additional service feature **POSA** or **POSA-HR** is to be assigned to the buoy.

For mooring to an existing Single Point Mooring (SPM) (possibly classed by another Classification Society), detailed documentation of the SPM is to be submitted to the Society for review. This documentation is to include certificate, design and maintenance. The Society reserves the right to require complete re-classification of the installation, including remeasurement of lines and anchors.

1.7 Scope of additional class notations

1.7.1 Classed topsides - Notations PROC-GP and PROC-GL

When the additional class notation **PROC-GP** or **PROC-GL** is assigned, in addition to requirements given in Sec 13, the structure of deck modules, flare boom and other structures housing production equipment, as well as related facilities, are to be designed and built in accordance with the relevant requirements of Part B, Chapter 2 and Part B, Chapter 3 of the Offshore Rules.

When not subjected to green waters, and subject to the Society agreement, topsides structures may be designed following other recognized standards, provided due consideration is given to inertial loads, overall deformations of the unit, differential displacements of support points and other relevant loadings, in accordance with the provisions of Part B, Chapter 2 of the Offshore Rules.

1.7.2 Notation PROC-GP or PROC-GL not requested

When the additional class notation **PROC-GP** or **PROC-GL** is not requested, the structure of deck modules, flare boom and other structures housing production equipment are not covered by the classification.

For equipment and piping installations, where classed systems within the hull have some part of their facilities located within the topsides, these facilities are covered by the classification. The Society reserves the right to include, in the scope of classification, the structure of the supporting skid and its connection to the topside structure, even if this structure is mainly supporting production facilities.

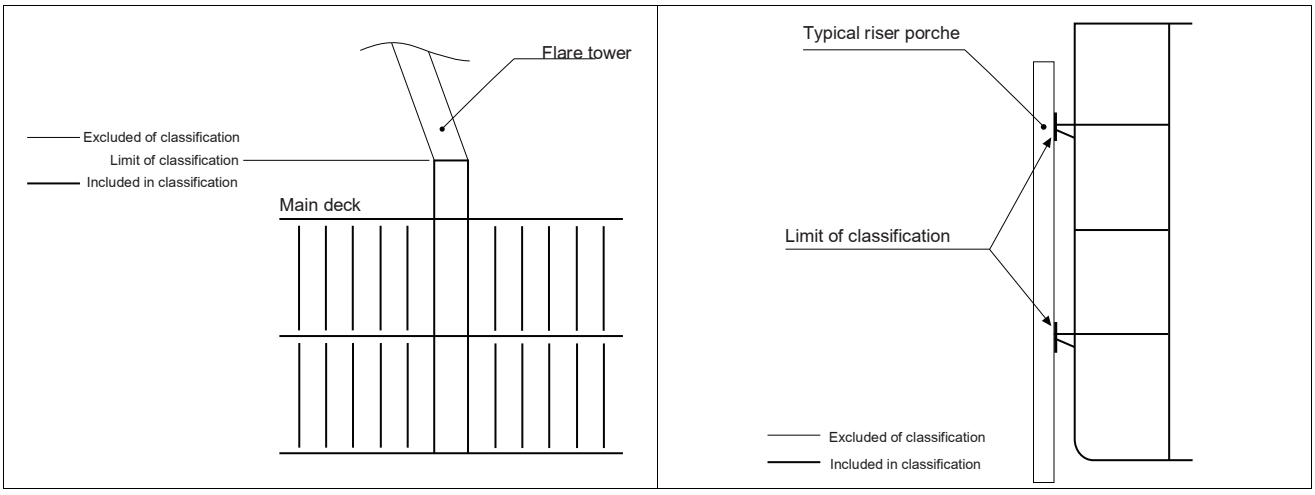
The classification covers the equipment necessary to the proper operation of these systems, as requested by this Rule Note and other related applicable rules or standards.

Classification excludes all the equipment only necessary to the operation of the topsides systems. For these systems, upon receipt of specific information and request, the Society endeavours to verify that failure of equipment and systems external to the scope of classification does not impair significantly the hull installation. For the structure supporting classed equipment, the attending Surveyor verifies the proper fitting of the local supporting elements, as indicated by the equipment manufacturer.

Particular attention is to be paid to the design of the pipe rack on the main deck, which remains within the scope of classification, regardless of the presence of pipes serving the topsides process plants.

Tab 1 show examples of classification limits for different types of appurtenances.

Table 1 : Examples of classification limits



1.7.3 Lifting appliances - Notations ALP and ALM

The additional class notations **ALP** and **ALM**, as defined in Offshore Rules Pt A, Ch 1, Sec 2 [8.3.1], may be assigned to units equipped with cranes and other lifting appliances meeting the relevant requirements of NR526 Rules for the Certification of Lifting Appliances onboard Ships and Offshore Units.

When no additional class notation for lifting appliances is assigned, the classification covers only the crane pedestal and its foundation welded to the hull, considering the loads specified by the designer.

When the crane pedestal and its foundation are welded to a classed topside structure covered by the additional class notation **PROC-GP** or **PROC-GL**, they are covered by class for the specific loads provided by the designer.

When one of the additional class notations **ALP** and **ALM** is assigned and the crane pedestal is partially or completely supported by a topside structure not covered by class (additional class notation **PROC-GP** or **PROC-GL** not requested), the crane pedestal and its foundation are not covered by class. In case the pedestal is connected to the topside structure and extended over the hull, only the part of pedestal connected to the hull is classed for the specific loads provided by the shipyard.

The structure calculation for the crane pedestal and its foundation is to be submitted to the Society for information if not requested otherwise for classification.

Note 1: For the additional class notations **ALP** and **ALM**, the construction mark as defined in Pt A, Ch 1, Sec 2, [3] of the Offshore Rules is required.

1.8 Classification and towing/transit

1.8.1 The towing or sailing by means of own propulsion system, between the construction shipyard and the intended site, is covered by classification requirements.

To flag the unit is:

- recommended for the towing
- mandatory in international waters and when people is onboard. Attention is to be paid to the compliance with international codes and standards as required by National Authorities.

The Society issues a provisional certificate upon completion of the hull, with design criteria for towing/transit condition clearly identified.

1.8.2 Temporary conditions

In accordance with the provisions of classification, any temporary conditions during fabrication and load out, any intermediate towing between two construction sites before complete finalisation of the unit and final load out of topside modules are considered beyond the scope of classification, unless a specific demand has been received from the party applying for classification.

Corrosion protection systems are to be arranged for the hull during the outfitting phase. The documentation is to be submitted to the Society for information. The Society may require thickness measurements to be carried out prior to the hull leaving the yard.

1.8.3 Environmental conditions for towing/transit

The Society may require:

- detailed documentation for the intended route between the construction shipyard and the intended site, and
- further investigation of slamming loads, green waters, bow impact and ice loads, if any, depending on the severity of the intended route, the planned period of the year and duration for the towing.

Extreme loads for towing/transit are to be taken by default for a return period of 10 years (typically referred to as a probability level of $10^{-7,7}$). Different values may be considered if specified by the party applying for classification.

Limitations on sea heading (for avoidance of beam seas) including possible seasonal limitations are to be defined by the Owner and/or the party applying for classification.

1.8.4 Fatigue strength during towing/transit

The Society reserves the right to require, for structural members, a direct fatigue analysis resulting from the towing/transit. Such fatigue analysis is to be combined with the overall fatigue verification of the unit in operation at intended site.

1.9 Reference documents

1.9.1 Society's Rules

- NR266 Requirements for Survey of Materials and Equipment for the Classification of Ships and Offshore units
- NR426 Construction Survey of Steel Structures of Offshore Units and Installations
- NR445 Rules for the Classification of Offshore Units.
  Hereafter referred to as "Offshore rules" (see [3.2.2]).
- NR467 Rules for the Classification of Steel Ships.
  Hereafter referred to as "Ship rules" (see [3.2.1]).
- NR493 Rules for Classification of Mooring Systems for Permanent and Mobile Offshore Units.

When reference is made to these Society's Rules, the latest version of these ones is applicable.

1.9.2 International Maritime Organisation (IMO)

- International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk.
  Hereafter referred as “IGC Code” (see [3.2.3]).

When reference is made to the IGC Code, the latest version is applicable.

2 Statutory requirements

2.1 General

2.1.1 Project specification

Prior to commencement of the review of drawings, the complete list of Regulations, Codes and Statutory Requirements to be complied with is to be submitted for information:

- International Regulations
- Flag State requirements
- Coastal State requirements
- Owner standards and procedures
- Industry standards.

The project specification is also to specify the list of statutory certificates requested by the Owner.

2.1.2 Conflict of Rules

In case of conflict between the Classification Rules and any Statutory Requirements as given by Flag State or Coastal State, the latter ones are to take precedence over the requirements of this Rule Note.

3 Symbols and definitions

3.1 General

3.1.1 Unless otherwise specified, the units, symbols, definitions and reference co-ordinate system given in Pt D, Ch 1, Sec 1, [3] of the Offshore Rules remain applicable.

3.1.2 In addition, specific definitions are given in [3.2].

3.2 Definitions

3.2.1 Ship Rules

Ship Rules means NR467 Rules for the Classification of Steel Ships (see [1.9.1]).

The applicable requirements of the Ship Rules are those for ships greater than 65 m in length.

3.2.2 Offshore Rules

Offshore Rules means NR445 Rules for the Classification of Offshore Units (see [1.9.1]).

3.2.3 IGC Code

IGC Code means the IMO International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (see [1.9.2]).

Where requirements of IGC Code are quoted as excerpts, they are printed in italic type.

3.2.4 Permanent installation

Surface units having one of the structural type notations given in [1.2.1] are considered as permanent installations when performing their service either:

- at a single location, or
- on a single site for a duration not less than, typically, 5 years.

Two types of permanent installations are to be considered:

- disconnectable, when the unit has a means of disengaging from its mooring and riser systems in extreme environmental or emergency conditions
- non-disconnectable.

A permanent installation is assigned with a site notation consisting in the name of the unit operation field.

3.2.5 Cargo

Cargo means liquefied gas stored and processed by units subject to the present Rule Note. The list of products to be considered as cargo is given in Pt D, Ch 9, Sec 19 of the Ship Rules.

3.2.6 Condensate

Condensate is a low density cargo (high API gravity hydrocarbon phase) that generally occurs in association with natural gas. The presence of condensate depends on temperature and pressure conditions allowing condensation of liquid from vapours.

3.2.7 Cargo containment system

Cargo containment system is the arrangement for containment of cargo, including, where fitted, a primary and secondary barrier, associated insulation and any intervening spaces, and adjacent structure if necessary for the support of these elements. If the secondary barrier is part of the hull structure, it may be a boundary of the hold space.

3.2.8 Primary barrier

Primary barrier is the inner element designed to contain the cargo when the cargo containment system includes two boundaries.

3.2.9 Secondary barrier

Secondary barrier is the liquid resistant outer element of a cargo containment system designed to afford temporary containment of any envisaged leakage of liquid cargo through the primary barrier and to prevent the lowering of the temperature of the unit's structure to an unsafe level.

3.2.10 Integral tank

Integral tanks form a structural part of the unit's hull and are influenced in the same manner and by the same loads which stress the adjacent hull structure. Integral tanks may be used for cargoes having a boiling point not below –10°C.

3.2.11 Independent tank

Independent tanks are self-supporting tanks; they do not form part of the unit's hull and are not essential to the hull strength. There are three types of independent tanks:

- type A
- type B
- type C

as defined in IGC Code.

3.2.12 Membrane tanks

Membrane tanks are non-self-supporting tanks which consist of a thin layer (membrane) supported through insulation by the adjacent hull structure. The membrane is designed in such a way that the thermal and other expansion or contraction is compensated for without undue stressing of the membrane.

3.2.13 Corrosion addition

The corrosion addition is the thickness to be added to the net thickness in view of corrosion allowance, as defined in Sec 2, [5.2].

3.2.14 Thickness increment

The thickness increment is the thickness that may be added to the gross thickness, in accordance with Sec 2, [6.2].

4 Calculation

4.1 Calculations to be submitted

4.1.1 Procedures and calculations

Procedures and assumptions used for structural and hydrodynamic calculations requested by the Rules are to be submitted to the Society for review prior to submission of final report with conclusions of the analysis.

The following procedures and calculations are to be submitted:

- Model test procedures, including a listing of possible sources of error and limits of applicability
- Hydrodynamic calculations:
  - direct calculation report
  - model test report and calibration report, if relevant
- Calculation of material temperature in the design condition (see Sec 2, [2.1])
- Sloshing study, as relevant

- Finite element calculations:
  - primary supporting members, including those of cargo tanks
  - topside supports
  - turret supports
  - spread mooring seats
  - fatigue structural details
  - supports, keys and stiffening rings of independent tanks, if any
  - topsides, when additional class notation **PROC-GL** or **PROC-GP** is assigned
  - spectral fatigue when additional class notation **Spectral Fatigue** is assigned
- Additional calculations reports are recommended and may be submitted for information, if they are performed:
  - dropped object analysis report
  - collision analysis report
  - explosion analysis report.

Detailed documentation of software used, demonstrating calculation accuracy, may be requested by the Society.

4.1.2 Calculation report

The calculation report is to follow the procedure as described and agreed to, prior to commencement of the study. Input data, considerations for decision of boundary conditions and detailed stress results are to be available.

Finite element models usually consist of plate elements. Normal and shear stresses are usually obtained in the centre of the element and stress plots are to show element stresses and not a node average.

Graphically, information for several loading conditions is to show deformation of structure and Von Mises stress values.

5 Design criteria and data

5.1 General

5.1.1 The party applying for classification is to provide the Society with the classification data and assumptions.

Relevant information is entered in the Design Criteria Statement.

5.2 Site data

5.2.1 The party applying for classification is to specify the site at which the unit will operate, and is to provide relevant design data and background information.

Note 1: Units intended to operate on several sites or units not being permanent installations are specially considered.

5.3 Operating loading conditions

5.3.1 The data on unit operation are to include the information required from [5.3.2] to [5.3.5].

5.3.2 Cargoes and processed products

Characteristics of processed hydrocarbons and cargoes intended to be stored (in particular H_2S content).

5.3.3 Environmental conditions

a) Extreme environmental conditions during unit operations

b) Most severe environmental conditions, if relevant, during offloading operations towards a shuttle tanker, moored alongside or in tandem mode

c) Limiting conditions before disconnection from the single point mooring, if relevant

d) Most severe environmental conditions, if relevant, during maintenance operations such as dismantling of main bearings of connection with the single point mooring

e) Environmental conditions during towing/transit from construction/conversion location to offshore site, when not covered by a navigation notation.

5.3.4 Loads

a) Loads induced by connection to a single point mooring, if any, in all relevant conditions detailed in [1.6.3], including:
   - loads in bearings, in case of arm and yoke connections
   - loads on secondary bearings during maintenance operations

b) Hawser loads, in case of connection by a hawser

c) Maximum loads induced by shuttle gas carrier

d) Loads induced by process and other equipment.

5.3.5 Loading conditions

a) Loading conditions in normal operations, including distribution of stored cargo, ballast, stores and others, for the full sequence of loading-unloading of the unit

b) Loading conditions in any other particular condition of operation, such as light ballast, or tank cleaning/inspection, and related limiting conditions for environment

c) Loading conditions for towing/transit.

Note 1: For control of loadings during operations, refer to Sec 4, [2.3].

6 Documentation to be submitted

6.1

6.1.1 The documentation to be submitted is to include the following information, in addition to the documentation required in Pt A, Ch 1, Sec 4 of the Offshore Rules:

a) Design criteria and data, as defined in Article [5]

b) Data for hydrodynamic analysis:

- lines plan and appendices on hull
- environmental data as required in Pt B, Ch 2, Sec 2 of the Offshore Rules
- properties of the unit related to the assessment of wind and current loads (areas, coefficients), when a heading analysis is performed (see Sec 3)
- properties of mooring system and relevant information
- loading manual with description of each loading condition.

c) General drawings:

- general arrangement of the unit, showing, as relevant:
  - location of the storage tanks with their openings, ballast tanks, cofferdams and void spaces, accesses to hazardous and safe spaces, cargo storage, production piping and vent piping on the open deck, bow or stern transfer lines, etc.
  - general arrangement of process, utility and control spaces
  - general arrangement of risers, riser supports and manifolds
- general arrangement of hazardous areas
- flare radiation level plots
- arrangement of the fore and aft spaces
- general arrangement of the mooring system, or SPM connection.

d) Structural drawings, specifications and supporting documents:

- booklet of loading conditions
- mooring system foundations (fairleads, tensioners, winches, bollards, etc.), where applicable
- connections and supporting structure in case of floating units connected to a single point mooring by an arm or a yoke
- turret structural and mechanical drawings
- riser supports
- foundations of deck modules and flare, if any, together with the corresponding loads
- deck modules, as relevant
- flare structure
- specification of coatings and drawings of cathodic protection, including hull outside and tank inside, with drawings of anode securing devices.

e) Machinery and piping drawings:
- oil and gas processing plant (general arrangement, PID)
- cargo offloading equipment
- gas disposal system
- diagram of cargo and gas piping systems, including offloading piping
- connections to risers
- diagram of stripping system of cofferdams, pump rooms and other spaces within the storage area
- diagram of cargo tank vent systems
- specification of pumps, valves, expansion joints and other cargo piping fittings
- drawing of cargo pump shaft stuffing boxes at bulkhead penetrations
- arrangement of gastight bulkhead penetrations
- bilge and drainage systems for hazardous areas
- ballast pumping within storage area
- remote control of cargo and ballast pumping systems
- specifications and drawings of cargo hoses
- cargo tank heating system
- crude oil tank washing systems, together with specification of equipment
- arrangements for gas-freeing of cargo tanks
- drawings of product swivels
- drawings of electrical swivels
- arrangements for venting cargo tanks, including specification of venting fittings
- pressure-vacuum valves
- arrangement and capacity of air ducts, fans and motors in storage area, together with justification of their anti-sparking properties
- rotating parts and casings of fans
- level-gauging arrangements, including drawings and specifications
- emergency shut-down system
- remote control and monitoring systems, including specifications of instrumentation
- arrangement of instrumentation in control stations.

f) Inert gas installations:
- single-wire diagram of the installation, together with the following main characteristics: capacity, pressure, temperature, O_2 content, water content
- list of the components (with their characteristics) of: pipes, scrubber, blowers, non-return devices, valves, pumps, protective devices for overpressure and vacuum
- general arrangement plan of installations on board
- diagram of monitoring and alarm systems
- specifications of O_2 analyser, recorder and portable control instruments.

g) Safety plans:
- drawing and specification of fire and gas detection systems
- the dedicated sections of the Operating Manual related to classification as specified in Pt A, Ch 1, Sec 1, [3.4] of the Offshore Rules
- fire protection details in accommodation areas
- pressure water fire main
- fire-extinguishing systems in machinery and accommodation areas
- foam extinguishing systems within storage area: general arrangement diagram, calculation note, foam agent specification, characteristics of foam monitors and hoses
- fire-extinguishing system in cargo pump rooms: general arrangement plan and calculation note
- fire-extinguishing system in process areas.

h) Others:
- documents relevant to the contemplated additional class notations.

i) Risk analysis reports, as required in this Rule Note.

Section 2 Structure Design Principles

1 Definition of the unit areas

1.1 Principles

1.1.1 Following the analysis of the stress level in the structure and design environment, the Society may categorize some of the areas as 'ship areas' or as 'offshore areas'.

The elements and their types of area are listed in Tab 1.

The Society reserves its right, according to appropriate structural analyses, to declare other elements as belonging to offshore areas.

1.1.2 Offshore area requirements

Offshore areas listed in Tab 1 are to be in accordance with the requirements of Part B of the Offshore Rules:

a) Concerned areas are to include the part of the unit structure affected by the loads on listed elements

b) Structural elements contributing to the longitudinal strength of the hull girder are also to comply with the strength requirements for ship areas (see [1.1.3]).

1.1.3 Ship area requirements

Ship areas listed in Tab 1 are to be in accordance with Part B and Part D, Chapter 9 of the Ship Rules which remain applicable except where otherwise specified in this Rule Note.

1.1.4 Limits between ship areas and offshore areas

The offshore areas always include the following items:

- the foundations of modules and equipment defined in Tab 1 and their additional local structural members
- the inserts in primary supporting members, decks, bulkheads and side shell
- the reinforced longitudinal stiffeners
- the partial stringers, deck girders and web frames.

For other members and when the limits of offshore area is not obvious from engineering judgment, the offshore area is to be extended up to a distance where the equivalent membrane stress is lower than 30 N/mm^2 when only appurtenance forces are applied.

1.1.5 Structural categories for offshore areas

Offshore areas are divided into three categories (special, first and secondary) for the structural members.

These categories are defined in Pt B, Ch 3, Sec 2, [2] of the Offshore Rules.

Components in load transmission areas and contributing to the load path, including stiffener brackets, flanges etc. are to be categorized as first or special category area.

In principle, topside supports are to be categorized as first category elements with the highly stressed area as special category element.

The helideck structure is considered as first category element.

Table 1 : Types of areas

Elements	Area
Flare tower supports	Offshore area
Turret moon pool, casing, and surrounding area	
Topside supports at main deck	
Crane pedestals and foundation into hull	
Helideck support structure	
Mooring supports	
Hose handling crane pedestal and foundation into hull	
Offloading equipment foundations	
Riser porches and their foundations to the hull	
Foundations of riser and mooring lines tensioning systems	
Towing brackets and their foundations	
Other elements	Ship area

2 Materials for construction

2.1 Material temperature in design condition

2.1.1 Principle of calculation

The calculation of material temperature in design condition is to take into account the following assumptions:

- the secondary barrier is to be assumed to be at cargo temperature, at atmospheric pressure
- for tanks without secondary barrier, the primary barrier may be assumed to be at the cargo temperature
- the ambient sea temperature is to be taken as the design temperature defined in Pt B, Ch 2, Sec 2, [6.3] of the Offshore Rules
- the ambient air temperature is to be taken as the design temperature defined in Pt B, Ch 2, Sec 2, [6.2] of the Offshore Rules.

A detailed calculation report is to be submitted to the Society, as required in Sec 1, [4].

2.1.2 Heating systems

The heat load of heating systems fitted inside internal spaces, such as transverse or longitudinal cofferdams, may be taken into account for the calculation of temperature in design condition of related structural elements, provided that:

- the design and construction of the heating system are at the satisfaction of the Society
- the heating system is considered as equipment for essential service and complies with the relevant requirements of Part C of the Offshore Rules
- the heating system is so arranged that, in the event of failure in any part of the system, stand-by heating could be maintained at 100% of the theoretical heat load.

Heating systems fitted in double-bottom, duct keel, double hull or other void spaces adjacent to unit's external shell are not to be taken into account for the calculation of temperature in the design condition.

2.2 Offshore areas

2.2.1 The steel grade of elements belonging to offshore areas, as defined in [1.1.2], is to be determined in accordance with the requirements of Pt B, Ch 3, Sec 2 of the Offshore Rules.

2.2.2 Secondary category elements

The steel grades of structural elements categorized as secondary category are to comply with the most stringent between Pt B, Ch 3, Sec 2 of the Offshore Rules and Pt B, Ch 4, Sec 1 of the Ship Rules.

2.2.3 Low temperature in design condition

The steel grades of structural elements belonging to offshore areas and having a calculated temperature in the design condition (as defined in [2.1]) lower than –5°C are to comply with the most stringent between Pt B, Ch 3, Sec 2 of the Offshore Rules and Chapter 6 of IGC Code.

2.3 Ship areas

2.3.1 The steel grade of elements belonging to ship areas, as defined in [1.1.3], is to be selected in accordance with Pt B, Ch 4, Sec 1 of the Ship Rules.

2.3.2 Low temperature in design condition

The steel grades of structural elements belonging to ship areas and having a calculated temperature in the design condition (as defined in [2.1]) lower than – 5°C are to comply with the requirements of IGC Code, Chapter 6.

2.4 Steels with specified through thickness properties

2.4.1 The steels with specified through thickness properties are to comply with the requirements in Pt B, Ch 3, Sec 2, [4] of the Offshore Rules.

2.5 Inspection and checks

2.5.1 The requirements for inspection and checks of ship and offshore areas are given in Pt D, Ch 1, Sec 3, [2.5] of the Offshore Rules.

3 Structural principles

3.1 Typical arrangement

3.1.1 Large openings in web frames and stringers may be verified and necessary documentation/calculation notes are to be submitted to the Society.

3.2 General construction

3.2.1 Units covered by the present Rule Note are to comply with the general principle requirements given in Pt D, Ch 1, Sec 3, [3.2.2] to [3.2.6] of the Offshore Rules.

3.3 Plating

3.3.1 The requirements for the plating are those given in Pt D, Ch 1, Sec 3, [4] of the Offshore Rules.

3.4 Ordinary stiffeners

3.4.1 The requirements for the ordinary stiffeners are those given in Pt D, Ch 1, Sec 3, [5] of the Offshore Rules.

3.5 Primary supporting members

3.5.1 The requirements for the primary supporting members are those given in Pt D, Ch 1, Sec 3, [6] of the Offshore Rules.

4 Access

4.1 General

4.1.1 The requirements for access defined in this Rule Note are applicable instead of the requirements given in Pt B, Ch 3, Sec 1, [4] of the Offshore Rules.

4.2 Means of access

4.2.1 Complex areas like turret, riser porches, etc., are to be accessible for inspection.

The means of access in the hull are to allow inspection of the critical structure connections identified during the drawing review by the Society and/or the designer.

The number of inaccessible areas is to be limited and clearly identified on the structure drawings. The Society reserves the right to require additional corrosion allowances for these areas. Special attention is to be paid to fatigue strength.

Direct access to non-cargo tanks such as wing and side ballast tanks and voids within the cargo hold block is to be provided from the hull main deck. Such spaces are to have their own access without passing through another such tank.

Web frame numbering is to be attached to structure or walkway inside of tanks, to the satisfaction of the attending Surveyor.

Equipment on deck may be arranged to allow inspections of the deck plating and to avoid permanent concentration of dust and remaining water.

4.3 Access to spaces located outside of the cargo area

4.3.1 Access to spaces located outside of the cargo area are to comply with the requirements of Pt B, Ch 3, Sec 1, [4.2] of the Offshore Rules.

4.4 Access to spaces in the cargo area

4.4.1 Designated passageways below and above cargo tanks are to have at least the arrangements and dimensions as specified in Pt D, Ch 9, Sec 3, [1.5.6], item a) of the Ship Rules.

4.4.2 Passage through cargo tanks

Passage through cargo tanks are to be in accordance with [1.5.4] and [1.5.5] in Pt D, Ch 9, Sec 3 of the Ship Rules.

For the purpose of these requirements, the following applies:

a) Where the Surveyor needs to pass between the flat or curved surface to be inspected and structural elements such as deck beams, stiffeners, frames, girders etc., the distance between that surface and the free edge of the structural elements is to be at least 380 mm. The distance between the surface to be inspected and the surface to which the above structural elements are fitted, e.g. deck, bulkhead or shell, is to be at least 450 mm in the case of a curved tank surface (e.g. type C-tank) or 600 mm in case of a flat tank surface (e.g. type A-tank) (see Fig 1).

b) Where the Surveyor does not need to pass between the surface to be inspected and any part of the structure, for visibility reasons the distance between the free edge of that structural element and the surface to be inspected is to be at least 50 mm or half the breadth of the structure's face plate, whichever is the greater (see Fig 2).

c) If, for inspection of a curved surface, the Surveyor needs to pass between that surface and another flat or curved surface, to which no structural elements are fitted, the distance between both surfaces is to be at least 380 mm (see Fig 3). Where the

Surveyor does not need to pass between a curved surface and another surface, a smaller distance than 380 mm may be accepted, taking into account the shape of the curved surface.

d) If, for inspection of an approximately flat surface, the Surveyor needs to pass between two approximately flat and approximately parallel surfaces, to which no structural elements are fitted, the distance between those surfaces is to be at least 600 mm (see Fig 4). Where fixed access ladders are fitted, a clearance of at least 450 mm shall be provided for access.

e) The minimum distances between a cargo tank sump and adjacent double bottom structure in way of a suction well may not be less than those defined in Fig 5. If there is no suction well, the distance between the cargo tank sump and the inner bottom may not be less than 50 mm.

f) The distance between a cargo tank dome and deck structures may not be less than 150 mm (see Fig 6).

g) Where necessary for inspection, fixed or portable staging is to be installed. This staging may not impair the distances specified in Pt D, Ch 9, Sec 3, [1.5.6] of the Ship Rules.

h) Where fixed or portable ventilation ducting is to be fitted in compliance with Pt D, Ch 9, Sec 12, [1.3] of the Ship Rules, such ducting may not impair the distances specified in Pt D, Ch 9, Sec 3, [1.5.6] of the Ship Rules.

Figure 1 : Minimum passage over cargo tanks

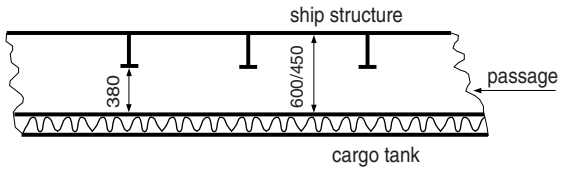


Figure 2 : Minimum distances between structures and cargo tank to allow visual inspection

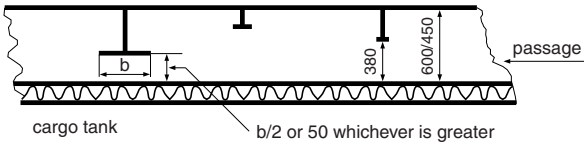


Figure 3 : Minimum passage between curved surfaces

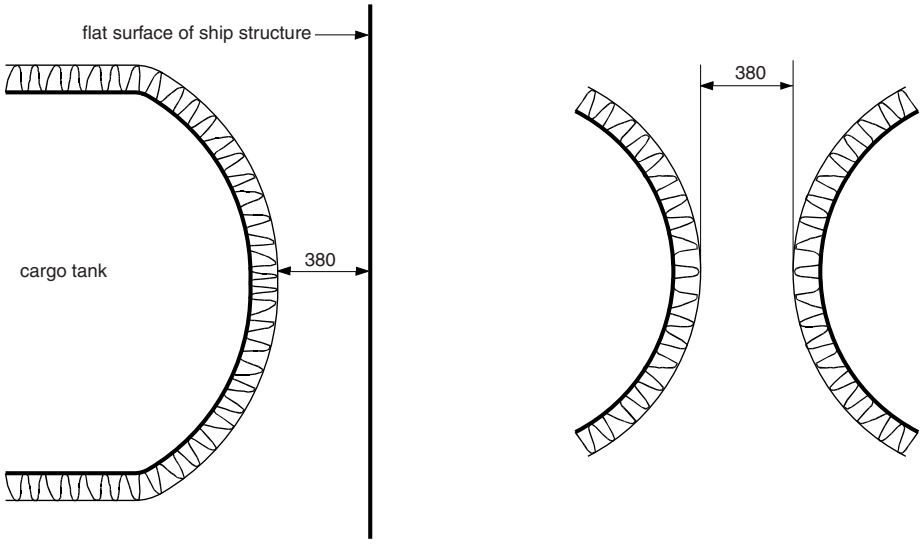


Figure 4 : Minimum passage between flat surfaces

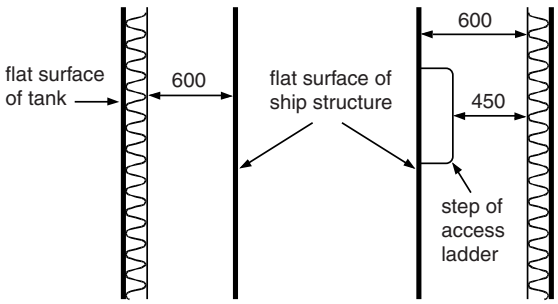


Figure 5 : Minimum distances between cargo tank sump and inner bottom

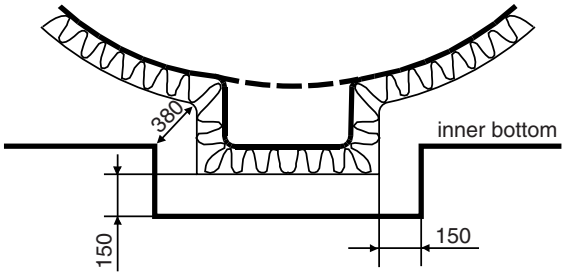
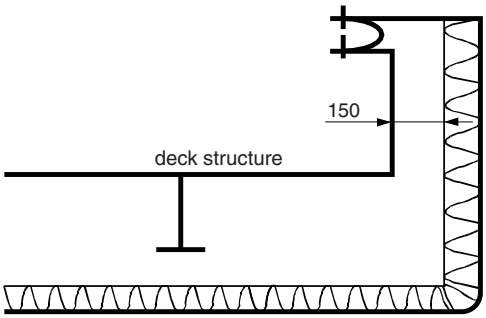


Figure 6 : Minimum distance between cargo dome and deck structures



4.4.3 Cofferdams

Where fitted, cofferdams are to have sufficient size for easy access to all their parts. The width of the cofferdams may not be less than 600 mm.

4.4.4 Pipe tunnels

Pipe tunnels are to have enough space to permit inspection of pipes. The pipes in pipe tunnels are to be installed as high as possible from the unit's bottom.

4.4.5 Access to pipe tunnels

Access to pipe tunnels through manholes in the engine space is not permitted.

4.5 Underwater parts

4.5.1 Requirements for underwater parts are given in Pt D, Ch 1, Sec 3, [3.1.2] of the Offshore Rules.

4.6 Access manual

4.6.1 An access manual is to be incorporated in the operating manual of the unit. The access manual is to describe unit's means of access to carry out overall and close-up inspections and thickness measurements.

4.6.2 The access manual is to be updated as necessary, and an up-dated copy is to be maintained onboard.

4.6.3 The access manual is to include, for each space, the following information:

- plans showing the means of access to the space, with appropriate technical specifications and dimensions
- plans showing the means of access within each space to enable an overall inspection to be carried out, with appropriate technical specifications and dimensions; the plans are to indicate from where each area in the space can be inspected
- plans showing the means of access within each space to enable close-up inspection to be carried out, with appropriate technical specifications and dimensions; the plans are to indicate the position of structural critical areas, whether the means of access are permanent or portable and from where each area can be inspected

Note 1: Critical structural areas are locations identified from calculations to require monitoring, or, from the service history of similar or sister units, to be sensitive to cracking, buckling, deformation or corrosion which would impair the structural integrity of the unit.

- instructions for inspecting and maintaining the structural strength of all means of access and means of attachment, taking into account any corrosive atmosphere that may be within the space
- instructions for safety guidance when rafting is used for close-up inspections and thickness measurements
- instructions for the rigging and use of any portable means of access in a safe manner
- an inventory of all portable means of access
- records of periodical inspections and maintenance of the unit's means of access.

5 Net scantling approach

5.1 Principle

5.1.1 Except when otherwise specified, the scantlings obtained by applying the criteria specified in this Rule Note and in applicable requirements of the Ship Rules are net scantlings (see Pt D, Ch 1, Sec 3, [7.1] of the Offshore Rules).

5.2 Corrosion additions

5.2.1 The corrosion additions are to be calculated as defined in Pt D, Ch 1, Sec 3, [7.2] of the Offshore Rules for service notation **liquefied gas carrier**.

The net scantling plus the corrosion addition is equal to the gross thickness.

5.2.2 If the party applying for classification specifies values of corrosion additions greater than those defined in [5.2.1], these values are to be taken into account for calculations and stated in the Design Criteria Statement.

6 Thickness increments

6.1 General

6.1.1 Principle

A thickness increment of platings and, where relevant, of stiffeners may be added to the gross thickness in special areas subject to mechanical wastage due to abrasion or in areas of difficult maintenance.

$t_{net} = t_{gross} - t_c$

$t_{gross} = t_{as\text{-}built} - t_i$

where:

t_i : Thickness increment

t_c : Corrosion addition as defined in [5.2]

t_{net} : Net thickness

t_{gross} : Gross thickness.

The gross thickness plus the thickness increment is equal to the as-built thickness.

6.1.2 Checking criteria

For the checking criteria specified in this Rule Note and in applicable requirements of the Ship Rules, the thickness increments are not to be considered.

6.2 Thickness increment values

6.2.1 Units without the additional class notation STI

When the additional class notation **STI** is not assigned to the unit, the thickness increments are to be taken equal to zero.

6.2.2 Units with the additional class notation STI

When the additional class notation **STI** is assigned to the unit, the thickness increments may be defined by the Owner or by the Society, as follows:

a) When the Owner specifies its own thickness increments, it is to be notified to the Society where thickness increments are provided.Thickness increments are to be stated in the Design Criteria Statement.

b) When the Owner does not provide its own thickness increments, the values to be considered are those defined in Pt D, Ch 1, Sec 3, Tab 3 of the Offshore Rules.

Adequate indications (location, value of thickness increments) are to be given in the relevant structural drawings.

Note 1: The additional class notation **STI**, as defined in Pt A, Ch 1, Sec 2, [8.4.2] of the Offshore Rules, is strongly recommended for permanent units covered by this Rule Note.

7 Bottom, side and deck structures

7.1 General

7.1.1 The requirements for bottom, side and deck structures are given respectively from Pt D, Ch 1, Sec 3, [10], to Pt D, Ch 1, Sec 3, [12] of the Offshore Rules.

7.1.2 The topside supports are to be fitted in way of bulkheads or beams.

7.2 Particular requirements for the side structure

7.2.1 Riser attachment

Equipment located on the side shell (e.g. risers, fenders) are to be fitted in way of primary supporting members.

8 Reinforcements in way of supporting structures for hull attachments

8.1 Local arrangement

8.1.1 Generally, the supports for attachments and appurtenances are to be fitted in way of longitudinal and transverse bulkheads or in way of deck beams. Other supports are to be fitted in way of large primary supporting members.

The main structure may be locally reinforced by means of insert plates.

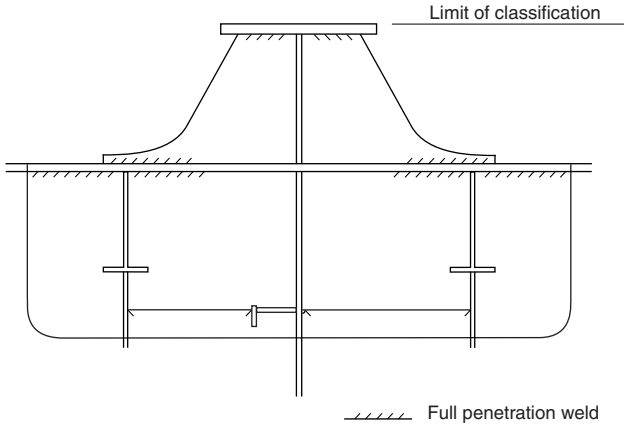
When the supports are only located on transverse web beams, the longitudinal structure is to be adequately reinforced.

The cut-outs in the deck transverses for the passage of ordinary stiffeners are to be closed in way of supports.

Particular attention is to be paid to buckling below supports.

An example of local supporting structure for hull attachment is shown in Fig 7.

Figure 7 : Example of local reinforcements in way of supporting structure



9 Welding and weld connections

9.1 General

9.1.1 The standards applicable for offshore areas and for ship areas are different, as stated in [9.2] and [9.3].

9.2 Offshore areas

9.2.1 Rule Note NR426 Construction Survey of Steel Structures of Offshore Units and Installations is to be applied for weldings and weld connections in offshore areas.

9.2.2 For size of fillet welds, reference may be made to AWS D1.1 Structural Welding Code - Steel - the latest edition.

9.3 Ship areas

9.3.1 Pt B, Ch 13, Sec 1 to Pt B, Ch 13, Sec 3 of the Ship Rules is to be applied for ship areas.

9.3.2 For the members, the web is to be connected to the face plate by means of double continuous fillet welding.

It is recommended to use continuous fillet welding to connect the web to its associated shell plating. The throat thickness of such a welding is neither to be less than the value specified in Pt B, Ch 13, Sec 3, Tab 4 of the Ship Rules nor greater than 0,45 t, where t is the thickness of the thinner plate in the considered assembly.

Discontinuous welds and scallop welds are generally not allowed in the cargo tank area.

9.3.3 The minimum leg length of continuous fillet welding is not to be less than 5,5 mm for assemblies of high tensile steel.

9.3.4 Special structural details

Welding and weld connections for special structural details are described in Tab 2.

Table 2 : Special structural details

Area description	Detail description	Reference tables in Pt B, Ch 13, App 2 of the Ship Rules
Side shell, bottom, inner bottom, longitudinal bulkheads	Connection of longitudinal ordinary stiffeners with transverse primary supporting members	Tab 1 to Tab 6
	Connection of longitudinal ordinary stiffeners with stiffeners of transverse primary supporting members	Tab 7 to Tab 13
Double bottom in way of transverse bulkheads	Connection of bottom and inner bottom longitudinal ordinary stiffeners with floors	Tab 27 to Tab 29
	Connection of inner bottom with transverse cofferdam bulkheads	Tab 31
Double bottom in way of hopper tanks	Connection of inner bottom with hopper tank sloping plates	Tab 36 to Tab 38
Lower part of inner side	Connection of hopper tank sloping plates with inner side	Tab 61 to Tab 62

Section 3 Hydrodynamic Analysis

1 Principle

1.1 Application

1.1.1 Hydrodynamic analysis is to be performed for both site conditions and towing/transit phases in accordance with the requirements of Pt D, Ch 1, Sec 4 of the Offshore Rules.

Section 4 Design Loads

1 General

1.1 Principles

1.1.1 Application

The design loads are to be determined in accordance with this Section and are to consider the relevant loading conditions and associated loads including:

- still water conditions
- extreme environmental conditions during unit's operation (100 years wave)
- loading and offloading conditions, taking into account side-by-side or tandem configuration, as relevant
- limiting conditions before the disconnection from single point mooring, if relevant
- conditions during maintenance or inspection operations
- transit/towing conditions, from the construction/conversion location to offshore site and between constructing shipyards, if more than one
- loads induced by process and other equipment, in above conditions, as relevant
- damaged conditions, taking into account the provisions and damage assumptions as given in Sec 10.

1.1.2 Site conditions

The design loads for site conditions are to be determined as stated in this Sec 4, taking into account the results of hydrodynamic analysis (see Sec 3). Two situations may be considered:

- when a navigation notation completes the site notation of the unit, the rule values of wave loads for this navigation notation are to be superimposed with the values obtained from hydrodynamic analysis as defined in Sec 3
- when no navigation notation is assigned to the unit for on-site conditions, the wave loads obtained from hydrodynamic analysis are to be superimposed with the rule values calculated for sheltered area, as defined in Article [3].

1.1.3 Towing/transit conditions

The design loads for towing/transit conditions are to be determined as stated in this Sec 4, taking into account the results of hydrodynamic analysis. Two situations may be considered:

- when a navigation notation completes the transit notation of the unit, the rule values of wave loads for this navigation notation are to be superimposed with the values obtained from hydrodynamic analysis, as defined in [3.2]
- when no navigation notation is assigned to the unit for towing/transit conditions, the wave loads obtained from hydrodynamic analysis are to be used, as defined in [3.2].

1.2 Definitions

1.2.1 The definition of the following terms are given in Pt D, Ch 1, Sec 5, [1.2] of the Offshore Rules:

- still water loads
- wave loads
- dynamic loads
- local loads
- hull girder loads
- loading condition
- load case.

1.3 Application criteria

1.3.1 Hull girder loads

The wave and dynamic hull girder loads are to be used for the determination of:

- the hull girder strength, according to the requirements of Sec 5
- the structural scantling of platings, ordinary stiffeners and primary supporting members contributing to the hull girder strength, in combination with the local loads given in Articles [5] and [6], according to the requirements of Sec 6.

1.3.2 Load cases

The local loads defined in Articles [5] and [6] for the towing/transit and site conditions are to be calculated in each of the mutually exclusive load cases described in Article [4].

1.3.3 Unit motions and global accelerations

The wave local loads are to be calculated on the basis of the reference values of unit motions and global accelerations specified in [3.4].

1.3.4 Calculation and application of local loads

The criteria for the calculation of:

- still water local loads
- wave local loads on the basis of the reference values of unit motions and global accelerations

are specified in Articles [5] and [6].

1.3.5 Flooding conditions

The still water and wave pressures in flooding conditions are specified in [6.3.5].

1.3.6 Accidental loading cases

The design of the floating unit is to consider the possibility of accidental loads as may result from collisions, dropped objects, fire or explosions (see Pt B, Ch 2, Sec 1, [4.3] of the Offshore Rules).

Accidental loading cases are required for the towing/transit and site phases.

In accidental conditions, environmental loads are to be evaluated taking into account the circumstances in which the considered situation may realistically occur, and the time needed for evacuation or other remedial action. The return period of such environmental loads is generally taken as 1 year.

1.3.7 Load definition criteria to be adopted in structural analyses of plates and secondary stiffeners

a) Application

This requirement applies for the definition of local loads to be used in the scantling checks of plating according to Sec 6, [2] and ordinary stiffeners according to Sec 6, [3].

b) Load model

1) When calculating the local loads for the structural scantling of an element which separates two adjacent compartments, the latter may not be considered simultaneously loaded. The local loads to be used are those obtained considering the two compartments individually loaded.

2) For elements of the outer shell, the local loads are to be calculated considering separately:

- the still water and wave external sea pressures, considered as acting alone without any counteraction from the unit internal compartments. This calculation is to be done considering the maximum draught
- the still water and wave differential pressures (internal minus external sea pressures) considering the compartment adjacent to the outer shell as being loaded. This calculation is to be made considering the minimum draught.

Note 1: The external wave pressure in case “b” is to be taken equal to 0.

In the absence of more precise information, the unit minimum draught at site, in m, is to be obtained from the following formula:

T_{mini} = 0,03 L, without being greater than 7,5 m

where:

L : Rule length, in m, as defined in Pt D, Ch 1, Sec 1, [3.2.6] of the Offshore Rules.

1.3.8 Load definition criteria to be adopted in structural analyses of primary supporting members

This requirement applies for the definition of local loads to be used in the scantling checks of primary supporting members.

The most severe loading conditions and associated draught for the structural elements under investigation are specified in Sec 6, [4.4].

For primary supporting members, a three-dimensional structural model is required.

2 Still water loads

2.1 Loading manual

2.1.1 A loading manual is to be submitted for approval.

The loading manual is, as a minimum, to be in compliance with the requirements of Pt B, Ch 1, Sec 5, [1] and Pt B, Ch 1, Sec 5, [2] of the Ship Rules for the service notation **liquefied gas carrier**.

In addition, the requirements given in Pt D, Ch 1, Sec 5, [2.1.2] to Pt D, Ch 1, Sec 5, [2.1.8] of the Offshore Rules are to be satisfied.

The loading manual is to be approved by the Owner.

2.2 Hull girder still water loads

2.2.1 Towing/transit and site loads

The hull girder still water loads as per [2.2.2] and [2.2.3] are to be defined for both towing/transit and on-site conditions. For this purpose, two distinct sets of still water bending moments and shear forces are to be specified.

2.2.2 Still water bending moment distribution

Design or allowable still water bending moment distribution is to be presented in a diagram or a table indicating the bending moment values at the longitudinal location of each compartment centre and at each transverse bulkhead.

2.2.3 Still water shear force distribution

Design or allowable still water shear force distribution is to be presented in a diagram or a table indicating the shear force values at each transverse bulkhead.

2.3 Loading instrument

2.3.1 The loading instrument is to be in accordance with the requirements of Pt B, Ch 1, Sec 5, [3] of the Ship Rules. Units covered by this Rule Note are to be considered as belonging to “Category I ships”.

2.3.2 The loading instrument is also to perform stability calculations according to the procedures indicated in the Ship Rules as referenced above.

3 Wave loads

3.1 Towing/transit and site conditions

3.1.1 Wave loads defined in Article [3] are to be processed for both towing/transit and on-site conditions. For this purpose, two distinct sets of design wave loads are to be considered.

3.2 Design wave loads

3.2.1 Definitions

The following terms are used to describe the wave loads:

- Wave load values: wave load parameters constant along the length of the unit (unit motions and accelerations).
- Wave load distributions: wave load parameters varying along the length of the unit (hull girder wave loads, relative wave elevation).

3.2.2 Determination of the design wave loads

The design values and distributions of wave loads are to be determined as per Pt D, Ch 1, Sec 5, [3.2] of the Offshore Rules.

3.3 Hull girder wave loads

3.3.1 Vertical wave bending moment

The vertical wave bending moment at any hull transverse section in upright ship condition is to be obtained as required in Pt D, Ch 1, Sec 5, [3.3.1] of the Offshore Rules.

3.3.2 Horizontal wave bending moment

The horizontal wave bending moment at any hull transverse section is to be obtained as required in Pt D, Ch 1, Sec 5, [3.3.2] of the Offshore Rules.

3.3.3 Vertical wave shear force

The vertical wave shear force at any hull transverse section is to be obtained as required in Pt D, Ch 1, Sec 5, [3.3.3] of the Offshore Rules.

3.4 Unit motions and accelerations

3.4.1 Absolute motions and global accelerations

Rule values of the unit absolute motions and global accelerations are to be determined according to Pt D, Ch 1, Sec 5, [3.4] of the Offshore Rules taking into account the following values for GM, when not know from loading manual or Trim and Stability Booklet:

- 0,07 B for full loading condition
- 0,18 B for the other loading conditions.

3.4.2 Local accelerations

The design values of total longitudinal, transverse and vertical accelerations at any point are obtained from Pt D, Ch 1, Sec 5, [3.6.1] of the Offshore Rules, for upright and inclined ship conditions and based on the design unit absolute motions and global accelerations.

Note 1: As an alternative, the local accelerations directly calculated by hydrodynamic analysis may be specially considered by the Society.

3.5 Relative wave elevation

3.5.1 Design distributions

The design distributions of the relative wave elevation in upright and inclined ship conditions are obtained from Pt D, Ch 1, Sec 5, [3.5] of the Offshore Rules.

4 Load cases

4.1 Towing/transit and site conditions

4.1.1 Load cases defined in Article [4] are to be processed for both towing/transit and on-site conditions.

4.2 Load cases for structural analysis based on partial unit models

4.2.1 Load cases to be considered for structural analysis based on partial models of the unit, and the associated wave loads and hull girder loads, are to be in accordance with the provisions and definitions of Pt D, Ch 1, Sec 5, [4] of the Offshore Rules.

5 Sea pressures

5.1 General

5.1.1 The sea pressures to be taken into account are those given in this Article [5].

However the Society may accept calculations based on pressures coming directly from hydrodynamic calculation, if duly justified.

5.2 Towing/transit and site conditions

5.2.1 Sea pressures defined in Article [5] are to be processed for both towing/transit and on-site conditions. For this purpose, two distinct sets of sea pressures are to be calculated.

5.3 Still water pressure

5.3.1 Still water pressure on sides and bottom, and pressure on exposed decks are to be calculated according to Pt D, Ch 1, Sec 5, [5.3] of the Offshore Rules.

5.4 Wave pressure

5.4.1 Upright ship conditions

The wave pressure on sides, bottom and exposed decks in upright ship conditions at any point of the hull is to be calculated as required in Pt D, Ch 1, Sec 5, [5.4] of the Offshore Rules.

5.4.2 Inclined ship conditions

The wave pressure on sides, bottom and exposed decks in inclined ship conditions at any point of the hull is to be calculated as required in Pt D, Ch 1, Sec 5, [5.5] of the Offshore Rules.

6 Internal pressures

6.1 Towing/transit and site conditions

6.1.1 Internal pressures defined in Article [6] are to be processed for both towing/transit and on-site conditions. For this purpose, two distinct sets of internal pressures are to be calculated.

6.2 Mass densities

6.2.1 Cargo mass density

The maximum mass density of each product stored and processed by the unit is to be indicated on drawings or in the loading manual.

Where the maximum mass density of the liquid carried is not given, the following values, in t/m^3, are to be considered:

- ρ_L = 0,50 t/m^3 for methane
- ρ_L according to Pt D, Ch 9, Sec 19, Tab 2 of the Ship Rules for the other products.

6.2.2 Sea water mass density

A sea water mass density of 1,025 t/m^3 is to be considered.

6.3 Calculation

6.3.1 Internal pressures

The internal still water pressure and the internal inertial pressure for all types of tanks and at any point are to be calculated following the provisions of Pt D, Ch 1, Sec 5, [6.3.1] and Pt D, Ch 1, Sec 5, [6.3.2] of the Offshore Rules.

6.3.2 Pressure for swash bulkheads

The still water and inertial pressures transmitted to the swash bulkhead structures are calculated according to Pt D, Ch 1, Sec 5, [6.3.3] of the Offshore Rules.

6.3.3 Partly filled tanks

For units intended to be assigned the additional service feature **SLOSHING**, as defined in Sec 1, [1.2.3], all cargo tanks are to be checked for several relevant partial filling levels. A direct sloshing calculation is to be submitted to the Society, as required in Sec 1, [4.1.1].

Note 1: Guidelines for sloshing calculations are given in NI 554, Design Sloshing Loads for LNG Membrane Tanks.

6.3.4 Accommodations

The still water and inertial pressures transmitted to the deck structures are to be calculated as required in Pt D, Ch 1, Sec 5, [6.5] of the Offshore Rules.

6.3.5 Flooding

The requirements of Pt D, Ch 1, Sec 5, [6.6] of the Offshore Rules are to be complied with.

6.3.6 Testing

Testing still water and inertial pressures are to be calculated in accordance with Pt D, Ch 1, Sec 5, [6.7] of the Offshore Rules.

Section 5 Hull Girder Strength

1 General

1.1 Principle

1.1.1 The hull girder transverse sections are to comply with Pt D, Ch 1, Sec 6 of the Offshore Rules taking into account the requirements of the present Section.

1.1.2 The hull girder strength is to be evaluated independently for the towing/transit phases covered by classification and the on-site conditions.

1.2 Strength characteristics of the hull girder transverse sections

1.2.1 The strength characteristics of the hull girder transverse sections are to comply with Pt D, Ch 1, Sec 6, [2] of the Offshore Rules.

2 Yielding checks

2.1 Hull girder stresses

2.1.1 Normal stresses induced by the vertical bending moments and shear forces are to be obtained as required in Pt D, Ch 1, Sec 6, [3.1] of the Offshore Rules.

2.2 Checking criteria

2.2.1 Normal stresses induced by the vertical bending moments and shear forces are to comply with the requirements stipulated in Pt D, Ch 1, Sec 6, [3.2] of the Offshore Rules.

2.3 Section modulus and moment of inertia

2.3.1 Units covered by this Rule Note are to comply with the requirements stipulated in Pt D, Ch 1, Sec 6, [3.3] of the Offshore Rules.

3 Ultimate strength check

3.1 General

3.1.1 The ultimate strength of the hull girder is to be checked according to Pt D, Ch 1, Sec 6, [4] of the Offshore Rules.

Section 6 Hull Scantlings

Symbols

k : Material factor for steel defined in Pt B, Ch 4, Sec 1, [2.2] of the Ship Rules

ℓ : Span, in m, of ordinary stiffeners, measured between supporting members (see Pt D, Ch 1, Sec 3, [5.2] of the Offshore Rules)

L : Rule length, in mm, as defined in Pt D, Ch 1, Sec 1, [3.2.6] of the Offshore Rules

$M_{SW,H}$: Design still water bending moment, in kN.m, in hogging condition, at the hull transverse section considered, defined in Sec 4, [2.2] for towing/ transit and site conditions

$M_{SW,S}$: Design still water bending moment, in kN.m, in sagging condition, at the hull transverse section considered, defined in Sec 4, [2.2] for towing/ transit and site conditions

R_y : Minimum yield stress, in N/mm^2, of the material, to be taken equal to 235/k unless otherwise specified

s : Spacing, in m, of ordinary stiffeners

T_{maxi} : Maximum site draught, in mm, as defined in Pt D, Ch 1, Sec 1, [3.2.11] of the Offshore Rules

T_{mini} : Minimum site draught, in mm, as defined in Pt D, Ch 1, Sec 1, [3.2.11] of the Offshore Rules.

1 General

1.1 Application

1.1.1 Sec 6 applies to the hull structure, with the exception of the independent tank structure.

This Section covers the assessment of structural elements for the towing/transit and site conditions of the unit, except when otherwise specified.

The hull scantlings are to be evaluated independently for towing/transit and site conditions.

1.2 Principle

1.2.1 Plating and ordinary stiffeners

Plating are to comply with the requirements of Pt D, Ch 1 Sec 7 of the Offshore Rules, taking into account the net thickness as defined in [1.2.3].

Ordinary stiffeners are to comply with the requirements of Pt D, Ch 1 Sec 8 of the Offshore Rules, taking into account the net thickness as defined in [1.2.3].

Additional requirements are respectively given in [2] and [3]. In case of conflict between the Offshore Rules and this Rule Note, this latter is to take precedence.

1.2.2 Primary supporting members

Requirements for scantlings of primary supporting members are given in [4].

1.2.3 Net thickness

All thicknesses referred to in this Section are net, i.e. they do not include any margin for corrosion.

The applicable corrosion additions are those specified in Sec 2, [5].

2 Plating

2.1 General

2.1.1 Minimum net thickness

The net thickness of the weather strength deck, trunk deck, tank bulkhead and watertight bulkhead plating is to be not less than the values given in Tab 1.

Table 1 : Minimum net thickness of weather strength deck, trunk deck, tank bulkhead and watertight bulkhead plating

Plating	Framing	Minimum net thickness, in mm	
Weather strength deck and trunk deck, if any, for the area within 0,4 L amidships **(1)**	longitudinal	$1,6 + 0,032\ L\ k^{1/2} + 4,5\ s$ $6\ k^{1/2} + 5,7 + s$	for L < 220 m for L ≥ 220 m
	transverse	$1,6 + 0,04\ L\ k^{1/2} + 4,5\ s$ $6\ k^{1/2} + 7,5 + s$	for L < 220 m for L ≥ 220 m
Weather strength deck and trunk deck, if any, at fore and aft parts and between hatchways **(1)**	$2,1 + 0,013\ L\ k^{1/2} + 4,5\ s$		
Tank bulkhead	$1,7 + 0,013\ L\ k^{1/2} + 4,5\ s$		
Watertight bulkhead	$1,3 + 0,013\ L\ k^{1/2} + 4,5\ s$		

(1) The minimum net thickness is to be obtained by linear interpolation between the value required for the area within 0,4 L amidships and the one at the fore and aft parts.

Note 1:

s : Length, in m, of the shorter side of the plate panel.

2.1.2 Plating subjected to sloshing pressures

For units for which the additional service feature **SLOSHING** is requested (see Sec 1, [1.2.3]), the net thickness of the plating is to comply with the following requirements:

- Pt D, Ch 1, Sec 7, [3.5.1] of the Offshore Rules, considering the partial safety factors defined in Pt D, Ch 1, Sec 7, Tab 1 of the Offshore Rules, column “Sloshing pressure”.

  The dynamic sloshing pressure is to be taken from a direct analysis (see Sec 4, [6.3.3]) and is not to account for any impact pressure.
- Pt D, Ch 1, Sec 7, [3.6.1] of the Offshore Rules. The impact sloshing pressure is to be taken from a direct analysis (see Sec 4, [6.3.3]).

No buckling check is required.

3 Ordinary stiffeners

3.1 General

3.1.1 Minimum net thickness

The net thickness of the web of ordinary stiffeners is to be not less than the value obtained, in mm, from the following formulae:

- for L < 220 m: $t_{MIN} = 0,8 + 0,013\ L\ k^{1/2} + 4,5\ s$
- for L ≥ 220 m: $t_{MIN} = 3\ k^{1/2} + 4,5 + s$

3.1.2 Ordinary stiffeners subjected to sloshing loads

For units for which the additional service feature **SLOSHING** is requested (see Sec 1, [1.2.3]), the net section modulus and the net shear sectional area of the ordinary stiffeners, including longitudinals, are to comply with the following requirements:

- Pt D, Ch 1, Sec 8, [3.4.2] of the Offshore Rules, considering the partial safety factors defined in Pt D, Ch 1, Sec 8, Tab 1 of the Offshore Rules, column “Sloshing pressure”.

  The dynamic sloshing pressure is to be taken from a direct analysis (see Sec 4, [6.3.3]) and is not to account for any impact pressure.
- Pt D, Ch 1, Sec 8, [3.7.1] of the Offshore Rules. The impact sloshing pressure is to be taken from a direct analysis (see Sec 4, [6.3.3]).

No buckling check is required.

4 Primary supporting members

4.1 General

4.1.1 Minimum net thickness

The net thickness of plating which forms the web of the primary supporting members is to be not less than the value obtained, in mm, from the following formula:

$t_{MIN} = 4,1 + 0,015\ L\ k^{1/2}$

4.1.2 Partial safety factors

The partial safety factors to be taken into account for the checking of the scantlings of the primary supporting members are those defined in Pt D, Ch 1, Sec 9, [2.5] of the Offshore Rules.

4.1.3 Finite element model

For the checking of the scantlings of the primary supporting members, a three-dimensional finite element model is required.

The check is to be made in accordance with Pt D, Ch 1, Sec 9 of the Offshore Rules, taking into account the:

- partial safety factors
- wave loads
- finite element modelling criteria
- loading conditions
- checking criteria

as given in this Rule Note.

In addition, design mooring loads and appurtenances design loads defined in Pt D, Ch 1, Sec 14, [1] and Pt D, Ch 1, Sec 14, [2] of the Offshore Rules are to be considered in the model for the verification of the Ship area.

4.1.4 Number of models

Each typical cargo tank is to be subject of finite element calculation.

At least three cargo tanks are to be assessed:

- cargo tank at midships
- forward cargo tank (fore model)
- afterward cargo tank (aft model).

Note 1: For units having less than three cargo tanks in longitudinal direction, all cargo tanks are to be assessed.

4.2 Structural modelling

4.2.1 The requirements given in Pt D, Ch 1, Sec 9, [3] of the Offshore Rules are to be complied with.

4.2.2 Modelling principles

The following primary supporting members are to be modelled:

- outer shell, inner bottom, longitudinal and transverse bulkhead plating
- double-bottom longitudinal girders
- double-side horizontal stringers
- deck longitudinal girders
- transverse web frames with main frames if relevant
- primary supporting members of transverse bulkheads.

4.2.3 Model extension for units with independent tanks

For units with independent tanks, the structural model is to include the primary supporting members of the hull (see [4.2.2]) and the tanks with their supporting members and key systems.

The cargo tank model is to include the following primary members:

- shell plating
- bulkhead plating, including wash bulkheads if any
- bottom plating
- top plating
- transverse web frames
- horizontal stringers
- girders.

4.2.4 Modelling of supports and keys

The cargo tanks are linked to the hold by the following supports and keys, acting in one direction:

- vertical supports (Z direction)
- antipitching keys (X direction), used also as anticollision keys
- antirolling keys (Y direction)
- antiflotation keys (Z direction).

They can be modelled by either linear elements (bar, flexible mounts, springs), or non-linear elements (gap elements).

When linear elements are used to model keys and supports not allowing tension loads, they are to be deleted when in tension.

Stiffness of these linear and/or non-linear elements is to be representative of the actual stiffness of the supports and keys.

4.2.5 Stiffness of supports and keys for independent tanks

The axial stiffness of elements used for the modelling of supports and keys of independent tanks is to be calculated taking into account the stiffness of:

- the support in way of tank
- the spacer
- the support in way of hull.

The stiffness K, in N/mm, of the wooden part between lower and upper parts of the support may be calculated as follows:

$K = E S / h$

where:

E : Young modulus of the wooden part, in N/mm^2

S : Sectional area of the wooden part, in mm^2

h : Height of the wooden part, in mm.

The stiffness of the gap or spring element is to be taken as:

$K_{element} = K / N_{elements}$

with:

$N_{elements}$: Number of elements used to model the wooden part.

4.2.6 Size of the elements

The mesh size may be equal to the spacing of longitudinal stiffeners. Each longitudinal ordinary stiffener is to be modelled. The aspect ratio of the elements may be as close to 1 as possible.

4.3 Flooding for ships with independent tanks

4.3.1 In flooding condition, the lateral pressure to be considered is to be calculated according to Sec 4, [6.3.5]. The structure of the transverse bulkheads are to be checked

The structure of the transverse bulkheads are to be checked for flooding design condition according to:

- for plating: Pt D, Ch 1, Sec 7, [3.3.2] of the Offshore Rules
- for ordinary stiffeners: Pt D, Ch 1, Sec 8, [3.5] of the Offshore Rules
- for primary supporting members: Pt D, Ch 1, Sec 9 of the Offshore Rules.

4.4 Load model

4.4.1 Loading conditions

The design on-site loading conditions specified in [4.4.2] or [4.4.3], as relevant, are to be considered in the analysis of primary supporting members in cargo and ballast tanks.

In addition, the still water and wave loads are to be calculated for the most severe loading conditions as given in the loading manual, with a view to maximizing the stresses in the longitudinal structure and primary supporting members.

When some of the on-site loading conditions shown in [4.4.2] or [4.4.3], as relevant, are not included in the loading manual, in particular the alternate and the non-symmetrical loading conditions, it is to be indicated, on the midship section drawing as well as in the loading manual, that these cases are not allowed. In addition, it may be demonstrated that these cases will never happen during the life of the unit, in particular in case of accidental conditions.

When the conditions shown in [4.4.2] or [4.4.3], as relevant, are foreseen in the loading manual, the analysis is to be carried out, taking into account the associated draughts and still water bending moments as specified in [4.4.2] and [4.4.3].

The loads of the topside facilities are to be added, in static conditions, to represent the light weight of the unit, as well as the weight of the external structures (riser supports, etc.).

For fore and aft models, the loading patterns are to be adjusted considering the capacity plan of the unit in the studied area. The loading conditions selected cases are to maximize internal pressure applied on watertight bulkheads, local shear stress at bulkheads location and torsion on the hull.

4.4.2 Design loading conditions for units with independent tanks

Direct calculation of units having independent tanks is to take into account at least the loading conditions with their associated draughts and still water bending moments as defined in Tab 2.

4.4.3 Design loading conditions for units with integral tanks and/or membrane tanks

Direct calculation of units having integral tanks and/or membrane tanks is to take into account at least the loading conditions with their associated draughts and still water bending moments as defined in Tab 3.

Table 2 : Design loading conditions for units with independent tanks

Description	Draught	SWBM
Homogeneous cargo condition with all cargo tanks full and all ballast tanks empty	T_{maxi}	$M_{SW, S}$
Ballast condition with all cargo tanks empty and all ballast tanks full	T_{mini}	$M_{SW, H}$
Alternate condition with empty tanks in the middle hold of structural model	0,9 T_{maxi}	0,7 $M_{SW, H}$
Alternate condition with full tanks in the middle hold of structural model	0,8 T_{maxi}	0,7 $M_{SW, S}$
Any non-symmetrical (chess) loading condition	**(1)**	**(1)**
(1) The relevant draught and SWBM are to be taken from loading manual.		

Table 3 : Design loading conditions for units with integral tanks and/or membrane tanks

Description	Draught	SWBM
Homogeneous cargo condition with all cargo tanks full and all ballast tanks empty	T_{maxi}	$M_{SW, S}$
Ballast condition with all cargo tanks empty and all ballast tanks full	T_{mini}	$M_{SW, H}$
Alternate condition with empty tanks in the middle hold of structural model	0,90 T_{maxi}	0,9 $M_{SW, H}$
Alternate condition with full tanks in the middle hold of structural model	0,75 T_{maxi}	0,9 $M_{SW, S}$
Any non-symmetrical (chess) loading condition	**(1)**	**(1)**
(1) The relevant draught and SWBM are to be taken from loading manual.		

4.4.4 Local loads

The local loads to be taken into account are given in Sec 4.

The loads induced by the topside on deck are to be taken into account.

The loads induced by the mooring system are to be taken into account.

4.4.5 Hull girder loads

The hull girder loads to be taken into account are given in Pt D, Ch 1, Sec 9, [4.3] of the Offshore Rules.

4.4.6 Load cases

The loading conditions are to be combined with the load cases with the relevant wave loads and sea pressures as defined in Sec 4.

The sea state return periods for towing/transit and site conditions are defined in Pt D, Ch 1, Sec 4, [1.1.3] of the Offshore Rules.

4.5 Yielding strength criteria for ship areas

4.5.1 Yielding strength criteria for ship areas are defined in Pt D, Ch 1, Sec 9, [5] of the Offshore Rules.

4.6 Buckling check

4.6.1 A local buckling check is to be carried out, according to Pt D, Ch 1, Sec 7, [4] of the Offshore Rules, for plate panels which constitute primary supporting members.

For this check, the stresses in the plate panels are to be calculated according to this Article [4].

5 Offshore areas

5.1 Strength criteria for offshore areas

5.1.1 The allowable stresses for elements in offshore areas are given in Pt B, Ch 3, Sec 3, [5] of the Offshore Rules.

6 Fatigue check of structural details

6.1 General

6.1.1 The fatigue check of structural details is to be performed in accordance with the provisions of Pt D, Ch 1, Sec 10 of the Offshore Rules, taking into account this Article [6].

6.2 Structural details

6.2.1 The structural details to be checked are those defined in Pt B, Ch 13, Sec 5 of the Ship Rules for the service notation **liquefied gas carrier**.

6.2.2 In addition, the following structural details are to be checked:

- topside connection with the main deck
- crane pedestal
- mooring integration structure with hull (turret, buoy or spread mooring)
- flare tower connection with hull
- turret: the long term distribution of forces is to be submitted by the turret designer.

Section 7 Other Structures

1 General

1.1 Application

1.1.1 This Section provides requirements and guidelines for:

- turret mooring system
- spread mooring system
- supports for the hull attachments and appurtenances
- fore part arrangement and scantlings
- aft part arrangement and scantlings
- superstructures and deckhouses
- hull outfitting
- launching appliances.

2 Station keeping

2.1 General

2.1.1 The supporting structure of the turret or spread mooring system, as relevant, is to comply with the requirements of Pt D, Ch 1, Sec 14, [1] of the Offshore Rules.

2.2 Materials for mooring supporting structure

2.2.1 The structure supporting the equipment of the mooring system is to be considered as offshore area as defined in Sec 2, [1.1.5]. The selection of steel grades is to be done in accordance with Sec 2, [2.2].

3 Supports for hull attachments and appurtenances

3.1 General

3.1.1 The major supports for hull attachments are to comply with the requirements stipulated in Pt D, Ch 1, Sec 14, [2] of the Offshore Rules.

3.2 Materials

3.2.1 As a rule, the affected supporting structures under the deck or inboard the side shell are to be considered as offshore area and are to be categorized as required in Sec 2, [1.1.5].

The steel grade selection is to be done in accordance with Sec 2, [2.2].

3.3 Calculations

3.3.1 A three-dimensional finite element calculation of the support structure is to be performed in accordance with the provisions of Pt D, Ch 1, Sec 14, [2.2] of the Offshore Rules.

4 Fore part

4.1 General

4.1.1 The scantlings and the arrangement of the fore part are to be in accordance with the requirements of Pt D, Ch 1, Sec 11 of the Offshore Rules.

5 Aft part

5.1 General

5.1.1 The scantlings and the arrangement of the aft part are to be in accordance with Pt D, Ch 1, Sec 12 of the Offshore Rules.

6 Superstructures and deckhouses

6.1 General

6.1.1 The superstructures and deckhouses are to be in accordance with the requirements of Pt D, Ch 1, Sec 13 of the Offshore Rules.

7 Helicopter deck

7.1 General

7.1.1 The requirements for the arrangement and structure of helidecks are given in Pt B, Ch 3, Sec 4, [4] of the Offshore Rules.

8 Hull outfitting

8.1 Bulwarks and guard rails

8.1.1 Bulwarks and guard rails are to comply with the requirements of Pt B, Ch 12, Sec 2 of the Ship Rules.

8.1.2 In case of large bulwarks, a direct calculation (including fatigue calculation) may be requested by the Society.

8.2 Towing foundation

8.2.1 The towing foundation is to be in accordance with Pt B, Ch 2, Sec 3, [4.2] and Pt B, Ch 3, Sec 3, [5.4] of the Offshore Rules.

9 Launching appliances

9.1 Deck structure in way of launching appliances used for survival craft or rescue boat

9.1.1 Deck structure in way of such appliances is to be considered as ship area and is to fulfil the requirements of Pt D, Ch 1, Sec 14, [5.1] of the Offshore Rules for ordinary stiffeners and primary supporting members.

Section 8 Local Structural Improvements

1 General

1.1 Application

1.1.1 The requirements related to local structural improvements specified in Pt D, Ch 1, Sec 15 of the Offshore Rules are applicable for units covered by the present Rule Note.

1.2 References for the Offshore Rules

1.2.1 The summary of applicable requirements and their references to the Offshore Rules are indicated in Tab 1.

Table 1 : Summary of applicable requirements

Requirements	References in Offshore Rules
Protection of hull metallic structures	Pt D, Ch 1, Sec 15, [1]
Post welding treatment	Pt D, Ch 1, Sec 15, [2]
Accidental loads	Pt D, Ch 1, Sec 15, [3]

Section 9 Cargo Containment System

Symbols

R_y : Minimum yield stress, in N/mm^2, of the material, to be taken equal to 235/k N/mm^2, unless otherwise specified

R_{eH} : Minimum yield stress, in N/mm^2, of the material, defined in Pt B, Ch 4, Sec 1, [2] of the Ship Rules

R_m : Minimum ultimate tensile stress, in N/mm^2, of the material

k : Material factor for steel, defined in Pt B, Ch 4, Sec 1, [2.2] of the Ship Rules

s : Spacing, in m, of ordinary stiffeners, see Pt D, Ch 1, Sec 3 of the Offshore Rules

ℓ : Span, in m, of ordinary stiffeners, measured between the supporting members, see Pt D, Ch 1, Sec 3, [5.2] of the Offshore Rules

c_a : Aspect ratio of the plate panel, equal to:

$$c_a = 1{,}21\sqrt{1 + 0{,}33\left(\frac{s}{\ell}\right)^2} - 0{,}69\frac{s}{\ell}$$

to be taken not greater than 1,0

c_r : Coefficient of curvature of the panel, equal to:

$c_r = 1{,}0 - 0{,}5\ s / r$

to be taken not less than 0,5

β_b , β_s : Coefficients defined in Pt D, Ch 1, Sec 8, [3.4.2] of the Offshore Rules.

1 Design loads

1.1 Internal pressure for all types of cargo tank

1.1.1 General

The internal still water and inertial pressure in cargo tanks is to be calculated according to Sec 4, [6].

Note 1: No filling rate limitation is to be considered for the calculation of internal pressures on-site.

1.1.2 Sloshing pressure

Natural periods of liquid motions in cargo tanks are to be calculated through model test or direct calculation, and compared to unit motions in order to evaluate the risks of resonance and potentially high sloshing pressures to be considered.

For units assigned the additional service feature **SLOSHING**, the requirements are given in NI554 Sloshing Assessment.

Corresponding report is to be submitted to the Society, as required in Sec 1, [4.1.1].

1.2 Thermally induced loads

1.2.1 Stationary thermally induced loads are to be considered for cargo containment systems where the design supporting arrangements or attachments and operating temperature may give rise to significant thermal stresses.

Thermally induced loads resulting from partial loading are also to be considered, as relevant.

1.3 Accidental design conditions

1.3.1 General

The loads resulting from the accidental design conditions need not be combined with any other environmental loads.

1.3.2 Integral and membrane tanks

The tank primary supporting members of integral and membrane tanks are to be designed for the collision condition corresponding to a collision force acting on the tank taken equal to one quarter of the weight of the tank and cargo in the forward and aft directions.

1.3.3 Independent tanks

The tank primary supporting members and tank supports are to be designed for the following accidental design conditions:

- heel condition which corresponds to a static angle of heel of 30°
- collision condition corresponding to a collision force acting on the tank taken equal to one quarter of the weight of the tank and cargo in the forward and aft directions
- flooding condition corresponding to flooding loads defined in Sec 4, [6.3.5].

2 Structural analysis of integral tanks

2.1 Scantlings

2.1.1 The net scantlings of plating, ordinary stiffeners and primary supporting members of integral tanks are to be not less than those obtained from Sec 6, with the hull girder loads and the internal pressure calculated according to Sec 4.

3 Structural analysis of membrane tanks

3.1 General

3.1.1 Specific allowable hull girder stresses and/or deflections, indicated by the Designer, are to be taken into account for the determination of the scantlings

3.2 Ultimate design conditions

3.2.1 The net scantlings of plating, ordinary stiffeners and primary supporting members of membrane tanks are to be not less than those obtained from Sec 6, with the hull girder loads and the internal pressure calculated according to Sec 4.

3.3 Accidental design conditions

3.3.1 The partial safety factors to be taken into account are defined as follows:

- the resistance partial safety factor is to be taken equal to 1.
- the material partial safety factor is to be taken equal to 1,02.

3.3.2 The net scantlings of plating, ordinary stiffeners and primary supporting members of membrane tanks are to be not less than those obtained from Sec 6, considering the loads defined in [1.3] and the partial safety factors defined in [3.3.1].

4 Structural analysis of type A independent tanks

4.1 Plating

4.1.1 Principle

Plating of type A independent tanks is to be calculated as plating not contributing to the hull girder longitudinal strength.

4.1.2 Minimum gross thickness

The gross thickness of plating of type A independent tanks, in mm, is to be not less than:

$t = 3,5 + 5\ s$

4.1.3 Plating subject to lateral pressure

The gross thickness of plating subject to lateral pressure, in mm, is to be not less than:

$$t = 16,5 c_a c_r s \sqrt{\frac{p}{R_y}}$$

where:

p : Internal lateral pressure, in kN/m^2, in the tank, obtained according to [1.1.1].

4.1.4 Plating subject to testing conditions

The gross thickness of plating subject to testing pressure, in mm, is to be not less than:

$$t = 15,4 c_a c_r s \sqrt{\frac{p_{ST}}{R_y}}$$

where:

p_{ST} : Testing pressure, in kN/m^2, obtained according to Ship Rules, Pt D, Ch 9, Sec 4, [8.5.1].

4.2 Ordinary stiffeners

4.2.1 Minimum gross thickness

The gross thickness of the web of ordinary stiffeners, in mm, is to be not less than:

$t = 4,5 + 0,02\ L\ k^{1/2}$

where L, in m, is to be taken not greater than 275.

4.2.2 Ordinary stiffeners subjected to lateral pressure

The gross section modulus w, in cm^3, and the gross shear sectional area A_{sh}, in cm^2, of ordinary stiffeners subject to lateral pressure are to be not less than the values obtained from the following formulae:

$$w = \beta_b \frac{p}{12\sigma_{ALL}} s\ell^2 10^3$$

$$A_{sh} = 10\beta_s \frac{p}{\sigma_{ALL}}\left(1 - \frac{s}{2\ell}\right)s\ell$$

where:

p : Internal lateral pressure, in kN/m^2, in the tank, obtained according to [1.1.1].

σ_{ALL} : Allowable stress, in N/mm^2, taken equal to the lower of $R_m/2,66$ or $R_{eH}/1,33$

4.2.3 Ordinary stiffeners subject to testing conditions

The gross section modulus w, in cm^3, and the gross shear sectional area A_{sh}, in cm^2, of ordinary stiffeners subject to testing pressure are to be not less than the values obtained from the following formulae:

$$w = 1,22\beta_b \frac{p_{ST}}{12R_y} s\ell^2 10^3$$

$$A_{sh} = 12,2\beta_s \frac{p_{ST}}{R_y}\left(1 - \frac{s}{2\ell}\right)s\ell$$

where:

p_{ST} : Testing pressure, in kN/m^2, obtained according to Ship Rules, Pt D, Ch 9, Sec 4, [8.5.1].

4.3 Primary supporting members

4.3.1 Minimum gross thickness

The gross thickness of the web of primary supporting members, in mm, is to be not less than:

$t = 5 + 0,02\ L\ k^{1/2}$

where L, in m, is to be taken not greater than 275.

4.3.2 Scantlings of primary supporting members

The scantlings of primary supporting members are to be checked through a three-dimensional finite element model.

Structural modelling is to comply with the requirements of Sec 6, [4.2.1] and Sec 6, [4.2.3].

The load model is to comply with the applicable requirements of [1] and Sec 6, [4.4]. For the calculation of the internal pressure, the presence of the dome may be disregarded.

The requirements of Sec 6, [4.5] and Sec 6, [4.6] related to yielding strength criteria and buckling check criteria are to be complied with.

The partial safety factors to be taken into account are defined as follows:

- the resistance partial safety factor is defined in Tab 1
- the material partial safety factor is to be taken equal to 1,02.

Table 1 : Type A primary supporting members - Resistance partial safety factors

Type of three dimensional model **(1)**	Ultimate design condition	Accidental design condition
Beam or coarse mesh finite element model	1,30	1,13
Standard mesh finite element model	1,15	1,00
Fine mesh finite element model	1,15	1,00
(1) As defined in Pt D, Ch 1, Sec 9, [3.5] of the Offshore Rules		

5 Structural analysis of type B independent tanks

5.1 Material properties

5.1.1 For the purpose of the requirements given in [5.2] to [5.5], as relevant, the minimum yield stress and minimum tensile strength of the material may be considered at low reference temperature, on a case-by-case basis, provided that the tank equipment and operational procedures are such as to ensure that the tank temperature during operations is never higher than the reference temperature.

5.1.2 Material properties at low reference temperatures, as mentioned in [5.1.1], may be considered only for loading conditions covering on-site operations.

5.2 Plating and ordinary stiffeners

5.2.1 Strength check of plating and ordinary stiffeners

The scantlings of plating and ordinary stiffeners of type B independent tanks are to comply with the requirements given in [4.1] and [4.2].

5.2.2 Buckling check

The scantlings of plating and ordinary stiffeners of type B independent tanks are to comply with the buckling requirements given respectively in Pt D, Ch 1, Sec 7, [4] and Pt D, Ch 1, Sec 8, [4] of the Offshore Rules.

5.3 Primary supporting members

5.3.1 Principle

The scantlings of primary supporting members are to be checked through a three-dimensional finite element model.

5.3.2 Structural and load model

Structural modelling is to comply with the requirements of Sec 6, [4.2.1] and Sec 6, [4.2.3].

The load model is to comply with the applicable requirements of [1] and Sec 6, [4.4].

5.3.3 Yielding check of primary supporting members of type B independent tanks primarily constructed of bodies of revolution

The requirements of Pt D, Ch 9, Sec 4, [9.3.2], a) of the Ship Rules are to be complied with.

For the accidental design conditions defined in [1.3], the value of allowable stress is to be increased by 20% compared to the ultimate design condition.

5.3.4 Yielding check of primary supporting members of type B independent tanks primarily constructed of plane surfaces

The requirements of Pt D, Ch 9, Sec 4, [9.3.2], b) of the Ship Rules are to be complied with.

For the accidental design conditions defined in [1.3], the value of allowable stress is to be increased by 20% compared to the ultimate design condition.

5.3.5 Local buckling of plate panels of primary supporting members

A local buckling check is to be carried out according to Sec 6, [4.6.1].

For this check, the stresses in the plate panels are to be obtained from direct calculations carried out in accordance with [5.3.2].

5.4 Fatigue analysis

5.4.1 The fatigue analysis is to be performed for areas where high wave induced stresses or large stress concentrations are expected, for welded joints and parent material. Such areas are to be defined by the Designer and agreed by the Society on a case-by-case basis.

5.4.2 Material properties

The material properties affecting fatigue of the items checked are to be documented. Where this documentation is not available, the Society may request to obtain these properties from experiments performed in accordance with recognized standards.

5.4.3 Checking criteria

The fatigue check is to be performed in accordance with the provisions of Pt D, Ch 9, Sec 4, [9.4] of the Ship Rules, taking into account the requirements of [5.4.1] and [5.4.2].

5.5 Crack propagation analysis

5.5.1 A crack propagation analysis is to be carried out for highly stressed areas. These areas are to be defined by the Designer and agreed by the Society on a case-by-case basis. Propagation rates in the parent material, weld metal and heat-affected zone are to be considered.

The crack propagation analysis is to be performed in accordance with Pt D, Ch 9, Sec 4, [9.4.5] of the Ship Rules, taking into account the requirements of [5.5.2] and [5.5.3].

5.5.2 Most probable stress over the life of the unit

The most probable maximum stress over the life of the unit is to be calculated using the loads defined in this Rule Note.

5.5.3 Simplified stress distribution for crack propagation analysis

The simplified stress distribution for crack propagation analysis is to be applied over a period defined by the Designer according to the operational procedure, but not less than 15 days.

6 Structural analysis of type C independent tanks

6.1 Scantlings

6.1.1 The scantlings of type C independent tanks are to comply with the requirements of Pt D, Ch 9, Sec 4, [10.3] to [10.5] of the Ship Rules, as appicable.

6.2 Stiffening rings in way of tank supports

6.2.1 The stiffening rings in way of tank supports are to be checked as required in Pt D, Ch 9, Sec 4, [10.3.4] of the Ship Rules, taking into account the requirements of [6.2.2] and [6.2.3].

6.2.2 Lateral pressure

The lateral pressure to be considered for the check of the stiffening rings is to be obtained from [1.1].

6.2.3 Buckling check

The buckling strength of stiffening rings is to be checked in accordance with the applicable requirements of Pt D, Ch 1, Sec 7, [4] of the Offshore Rules.

7 Supports

7.1 Supporting arrangement

7.1.1 *The cargo tanks shall be supported by the hull in a manner that prevents bodily movement of the tank under the static and dynamic loads defined in Sec 4, where applicable, while allowing contraction and expansion of the tank under temperature variations and hull deflections without undue stressing of the tank and the hull.*

7.1.2 The reaction forces in way of tank supports are to be transmitted as directly as possible to the hull primary supporting members, minimising stress concentrations.

Where the reaction forces are not in the plane of primary members, web plates and brackets are to be provided in order to transmit these loads by means of shear stresses.

7.1.3 Special attention is to be paid to continuity of structure between circular tank supports and the primary supporting members of the ship.

7.1.4 Openings in tank supports and hull structures in way of tank supports are to be minimized and local strengthening may be necessary.

7.1.5 Insulating materials for tank supports are to be type approved by the Society.

Note 1: In addition to the justification of mechanical properties, the water absorption of the material should not be more than 6% when determined in accordance with DIN 53 495.

7.2 Calculation of reaction forces in way of tank supports

7.2.1 The reaction forces in way of tank supports are to be obtained from the structural analysis of the tank or stiffening rings in way of tank supports, as specified in:

- [4.3] for type A independent tanks
- [5.3] for type B independent tanks
- [6.2] for type C independent tanks.

The final distribution of the reaction forces at the supports is not to show any tensile forces.

7.3 Supports of type A and type B independent tanks primarily constructed of plane surfaces

7.3.1 The supports of independent tanks of type A and type B which are primarily constructed of plane surfaces are to be checked in accordance with [7.3.2] to [7.3.5].

7.3.2 Vertical supports

The structure of the tank and of the ship is to be reinforced in way of the vertical supports so as to withstand the reactions and the corresponding moments.

It is to be checked that the combined stress, in N/mm^2, in vertical supports complies with the following criterion:

$$\sigma_c \leq \frac{230}{k}$$

For the purpose of this assessment, the frictional coefficient of vertical supports is to be taken equal to 0,3 unless duly justified.

Dam plates, fitted to secure the wood, are to be designed to withstand, in all seagoing cases and assuming a failure of the resin hodling the wook, an horizontal force taken equal to the minimum between:

- 10% of the vertical reaction on the support
- the horizontally accelerated weight of the tank in a direction perpendicular to the dam plates and distributed among all the vertical supports.

7.3.3 Antirolling supports

a) Antirolling supports are to be checked under transverse and vertical reactions, as defined in [7.2.1] for the inclined ship conditions, and applied on the maximum weight of the full tank.

It is to be checked that the combined stress, in N/mm^2, in antirolling supports complies with the following criterion:

$$\sigma_c \leq \frac{230}{k}$$

b) Antirolling supports are also to be checked for a static angle of heel of 30° with a combined stress which is to comply with the following criterion:

$$\sigma_c \leq \frac{235}{k}$$

For the purpose of this assessment, the frictional coefficient of the antirolling supports is to be taken equal to 0,1 unless duly justified.

7.3.4 Antipitching supports

a) Antipitching supports are to be checked under longitudinal and vertical reactions, as defined in Sec 4 for the upright conditions, and applied on the maximum weight of the full tank.

It is to be checked that the combined stress, in N/mm^2, in antipitching supports complies with the following criterion:

$$\sigma_c \leq \frac{230}{k}$$

b) Antipitching supports are also to withstand a collision force acting on the tank corresponding to one quarter of the weight of the tank and cargo in the forward and aftward directions.

It is to be checked that the combined stress, in N/mm^2, in antipitching supports complies with the following criterion:

$$\sigma_c \leq \frac{235}{k}$$

Note 1: For the collision condition, antipitching supports may be referred to as anticollision supports.

7.3.5 Antiflotation supports

Antiflotation supports are to be provided and are to be suitable to withstand an upward force caused by an empty tank in a hold space flooded to the scantling draught of the unit.

It is to be checked that the combined stress, in N/mm^2, in antiflotation supports complies with the following criterion:

$$\sigma_c \leq \frac{235}{k}$$

Adequate clearance between the tanks and the hull structures is to be provided in all operating conditions.

7.4 Supports of independent tanks of type B primarily constructed of bodies of revolution

7.4.1 Cylindrical skirt

Cylindrical skirts supporting spherical independent tanks of type B are to be checked under longitudinal, transverse and vertical reactions, as defined in [7.2.1] for the upright and inclined conditions, and applied on the tank assumed full.

It is to be checked that the combined stress, in N/mm^2, in cylindrical skirts complies with the criterion from Pt D, Sec 4, [9.3.2], a) of the Ship Rules.

For the accidental design conditions defined in [1.3], the value of allowable stress is to be increased by 20% compared to the ultimate design condition.

7.5 Supports of type C independent tanks

7.5.1 The net scantlings of plating, ordinary stiffeners and primary supporting members of tank supports and hull structures in way are to be not less than those obtained by applying the criteria in Sec 6.

The hull girder loads and the lateral pressure to be considered are to be determined in accordance with Sec 4.

7.5.2 In addition to [7.5.1], the antipitching supports and antiflotation supports are to be checked according to [7.3.4] and [7.3.5] and the antirolling supports are to be checked according to [7.3.3].

8 Secondary barrier

8.1 Secondary barrier extent

8.1.1 The extent of the secondary barrier is to comply with the requirements stipulated in Pt D, Ch 9, Sec 4, [2.4] of the Ship Rules.

9 Insulation

9.1 Heating of structures

9.1.1 The requirements of Pt D, Ch 9, Sec 4, [2.9.1] and Pt D, Ch 9, Sec 4, [5.2.5] of the Ship Rules are to be complied with.

10 Materials

10.1 Materials of construction

10.1.1 Materials for the construction of independent tanks are to comply with the applicable requirements of Pt D, Ch 9, Sec 6 of the Ship Rules.

10.2 Insulation material characteristics

10.2.1 The requirements stipulated in Pt D, Ch 9, Sec 4, [5.4] of the Ship Rules are to be complied with.

11 Construction and testing

11.1 General

11.1.1 The requirements of Pt D, Ch 9, Sec 4, [6] of the Ship Rules are to be complied with.

12 Structural details

12.1 General

12.1.1 The following requirements of the Ship Rules are to be complied with:

- the specific provisions of Pt B, Ch 13, Sec 5 associated to the service notation **liquefied gas carrier**
- the provisions of Pt D, Ch 9, Sec 4, [11.5.1].

Section 10 Stability and Subdivision

1 General

1.1 Application

1.1.1 The requirements of this Section, including those related to damage stability, are applicable for all the units covered by this Rule Note, as defined in Sec 1, [1.1].

1.1.2 Specific criteria

If the Owner specifies criteria for intact and damage stability more severe than those in this Section, these criteria are to be taken into account and stated in the Design Criteria Statement.

1.2 Documentation to be submitted

1.2.1 A stability file is to be submitted by the Owner or its representative. It is to include line plans, capacity plans, justification of lightweight characteristics, definition of loading conditions, trim and stability booklet, damage stability booklet, damage control plan and damage control booklet.

2 Stability

2.1 Trim and stability booklet

2.1.1 The trim and stability booklet of the unit is to be approved by the Society.

2.1.2 List of information

The information defined in Pt B, Ch 3, App 2, [1.1.2] of the Ship Rules, as relevant, is to be included in the trim and stability booklet.

2.1.3 Standard loading conditions for all units

The following standard loading conditions are to be included in the trim and stability booklet:

- lightweight condition
- transit/towing arrival and departure conditions (for units with structural type notation **offshore ship**)
- transit/towing condition, if relevant
- normal operation conditions with maximum deck loads and equipment in the most unfavourable positions, if relevant
- inspection conditions consistent with the operational procedures
- severe storm conditions assuming the same weight distribution as for transit/towing, as relevant, except for the ballast adjustments necessary to bring the unit to the survival draught and for the possible dumping of variable deck load, if specified in the operational procedures
- severe storm conditions assuming the same weight distribution as for normal operation conditions with the ballast adjustments necessary to place the unit in the survival draught configuration. In these conditions:
  - equipment liable to be disconnected, such as risers or single point mooring systems, is assumed disconnected
  - equipment liable to be disconnected and stored on deck is assumed disconnected and secured on deck
  - equipment having a rest position, such as crane booms, is assumed in rest position.

  The maximum amount of loads is assumed to be stored on deck. Account may be taken of dumping of variable deck loads if specified in the operational procedures.

2.1.4 Standard loading conditions for units with service notation liquefied gas storage

For units intended to receive the service notation **liquefied gas storage**, the following standard loading conditions are to be submitted in addition to those defined in [2.1.3]:

- Selected operational conditions covering foreseen fillings of cargo tanks. One of the conditions is to correspond to the maximum draught. The selection is to include loading and offloading conditions.

  For the assignment of a tropical freeboard, the corresponding loading condition is also to be submitted.
- Loading condition for inspection of cargo tanks, where one cargo tank or two consecutive cargo tanks is/are empty (to be considered in accordance with operational procedures).

2.2 Operational procedures

2.2.1 Adequate instructions and information related to the stability, watertightness and weathertightness of the unit are to be provided by the Owner and included in the Operating Manual. The submission and content of the Operating Manual are defined in Pt A, Ch 1, Sec 4, [2.4] of the Offshore Rules.

2.3 Inclining test and lightweight survey

2.3.1 The requirements related to inclining test and lightweight survey stipulated in Pt B, Ch 1, Sec 1, [3] of the Offshore Rules are to be complied with.

2.4 Stability calculations

2.4.1 As a minimum, stability calculations for the standard loading conditions defined in [2.1.3] and [2.1.4], as relevant, are to be carried out and submitted to the Society. The Society may require stability calculations for additional loading conditions, based on the investigation of the Loading Manual or on the information previously submitted. These additional loading conditions are to be stated in the Design Criteria Statement.

2.4.2 Ice and snow conditions

For units covered by this Rule Note and liable to operate in areas of snow and glazed frost, the verification of the intact and damage stability is to be performed, taking into account the possible overloads due to ice and snow accumulation.

The requirements stipulated in Pt B, Ch 1, Sec 2, [2] of the Offshore Rules are to be complied with.

2.4.3 Free surface effects

The free surface effects of partially filled tanks are to be taken into account in the stability calculations. Filling restrictions entered in the operating manual are to be given special consideration by the Society.

Free surface effects are to be considered whenever the filling level in a tank is less than 98% of full condition. Free surface effects need not be considered where a tank is nominally full, i.e. filling level is 98% or above.

Nominally full cargo tanks may be corrected for free surface effects at 98% filling level. In doing so, the correction to initial metacentric height may be based on the inertia moment of liquid surface at 5° of the heeling angle divided by displacement, and the correction to righting lever is suggested to be on the basis of real shifting moment of cargo liquids.

In calculating the free surfaces effect in tanks containing consumable liquids, it is to be assumed that for each type of liquid at least one transverse pair or a single centreline tank has a free surface and the tank or combination of tanks taken into account are to be those where the effect of free surface is the greatest.

Where gutter bars are provided on the cargo tank deck in order to avoid the spillage of flammable liquids, as required by Pt D, Ch 1, Sec 16, [1.7] of the Offshore Rules, the free surface effect caused by containment of cargo spill, boarding seas or rain water is to be considered with respect to the vessel's available margin of positive initial stability (GMo).

Gutter bars are not to be accepted without an assessment of the initial stability (GMo) for compliance with the relevant intact stability requirement taking into account the free surface effect caused by liquids contained by the gutter bars.

2.4.4 Permeability of spaces assumed to be damaged

The permeability values of spaces assumed to be damaged are to be taken as given in Tab 1.

Other values may be used if adequately supported by calculations and consistent with operating practices.

Table 1 : Permeability of spaces

Spaces	Permeabilities
Appropriated to stores	0,60
Occupied by accommodation	0,95
Occupied by machinery	0,85
Voids	0,95
Hold spaces	0,95 **(2)**
Intended for consumable liquids	0 to 0,95 **(1)**
Intended for other liquids	0 to 0,95 **(1)**
(1) The permeability of partially filled compartments is to be consistent with the amount of liquid carried in the compartment. **(2)** Other values of permeability may be considered based on detailed calculations; refer to MSC/Circ.651.	

2.4.5 Buoyancy of superstructures

The buoyancy of any superstructure directly above the side damage defined in [2.7.4] is to be disregarded. However, the unflooded parts of superstructures beyond the extent of damage may be taken into account provided that:

- they are separated from the damaged spaces by watertight divisions
- all immersed openings in such divisions are capable of being closed watertighly and unprotected openings are not immersed within the minimum range of residual stability required in [2.7.3] item b); however the immersion of any other openings capable of being closed weathertight may be permitted.

2.4.6 Computation model

The mathematical model used for stability computations is to comply with the applicable requirements of Pt B, Ch 1, Sec 2, [3.3] of the Offshore Rules.

2.4.7 Righting moment and wind heeling moment curves

Curves of righting moments and of wind heeling moments are to comply with the provisions of Pt B, Ch 1, Sec 2, [4] of the Offshore Rules.

2.5 Intact stability

2.5.1 Unit stability for the loading conditions specified in [2.4.1] is to comply with the applicable requirements of Pt B, Ch 3, Sec 2 of the Ship Rules and the criteria defined in the Offshore Rules, Pt B, Ch 1, Sec 3, [1] for surface units.

2.6 Damage stability for units not assigned the service notation liquefied gas storage

2.6.1 Damage stability of units not intended to receive the service notation **liquefied gas storage** is to comply with the requirements of Pt B, Ch 1, Sec 3, [3] of the Offshore Rules, taking into account the extent of damage for surface units defined in Pt B, Ch 1, Sec 3, [4] of the Offshore Rules.

2.7 Damage stability for units assigned the service notation liquefied gas storage

2.7.1 Units intended to receive the service notation **liquefied gas storage** are to comply with the requirements of [2.7.3], taking into account the extent of damage defined in [2.7.4] and the standard of damage defined in [2.7.5].

2.7.2 The unit is to have sufficient reserve stability in damaged condition to withstand the wind heeling moment based on a wind speed of 25,8 m/s (50 knots) superimposed from any direction. In this condition the final waterline, after flooding and heeling due to the effect of wind, is to be below the lower edge of any opening through which progressive flooding of buoyant compartments may take place. Such openings include air pipes (regardless of closing appliances), ventilation air intakes or outlets, ventilators, non watertight hatches or doorways not fitted with watertight closing appliances.

2.7.3 Survival requirements

The survival requirements given in Pt D, Ch 9, Sec 2, [7] of the Ship Rules are to comply with the following conditions:

a) In any stage of flooding:

- *the waterline, taking into account sinkage, heel and trim, should be below the lower edge of any opening through which progressive flooding or downflooding may take place. Such openings should include air pipes and openings which are closed by means of weathertight doors or hatch covers and may exclude those openings closed by means of watertight manhole covers and watertight flush scuttles, small watertight cargo tank hatch covers which maintain the high integrity of the deck, remotely operated watertight sliding doors, and sidescuttles of the non-opening type*
- *the maximum angle of heel due to unsymmetrical flooding shall not exceed 30 degrees*
- *the residual stability during intermediate stages of flooding shall not be less than that required by [2.7.3], item b).*

b) At final equilibrium after flooding:

- *the righting lever curve should have a minimum range of 20 degrees beyond the position of equilibrium in association with a maximum residual righting lever of at least 0,1 m within the 20 degrees range; the area under the curve within this range should not be less than 0,0175 m·rad. The 20° range may be measured from any angle commencing between the position of equilibrium and the angle of 25° (or 30° if no deck immersion occurs). Unprotected openings should not be immersed within this range unless the space concerned is assumed to be flooded. Within this range, the immersion of any of the openings listed in a) and other openings capable of being closed weathertight may be permitted*
- *the emergency source of power should be capable of operating.*

Note 1: Small deviations from the criteria given in Pt D, Ch 9, Sec 2, [7.1.4], item a) of the Ship Rules, related to residual stability during intermediate stages of flooding, may be accepted by the Society on a case-by-case basis.

Note 2: As stated in Pt D, Ch 9, Sec 2, [5.1.6] of the Ship Rules, equalization arrangements requiring mechanical aids such as valves or cross-levelling pipes, if fitted, are not to be considered for the purpose of compliance with the survival requirements.

2.7.4 Extent of damage

The extent of damage on the bottom is disregarded.

The assumed maximum extent of damage on the side shell is to be as follows:

- longitudinal extent ℓ_c:

  ℓ_c = 1/3 $L_{LL}^{2/3}$ or 14,5 m whichever is the lesser
- transverse extent t_c measured inboard from the side shell plating, at right angle to the centreline, at the level of summer load line:

  t_c = B/5 or 11,5 m whichever is the lesser
- vertical extent v_c, from the moulded line of the bottom shell plating at centreline: upwards without limits.

If any damage of a lesser extent than the maximum damage specified above would result in a more severe condition, such damage is to be assumed.

Local side damage anywhere in the cargo area extending inboard distance "d" as defined in Pt D, Ch 9, Sec 2, [4.1.1] of the Ship Rules, measured normal to the loulded line of the outer shell is to be considered. Bulkheads are to be assumed damaged when the relevant requirementf [2.7.5] applies. If a damage of a lesser extent "d" would result in a more severe condition, such damage is to be assumed.

2.7.5 Standard of damage

Units covered by this Rule Note are to sustain the damage indicated in [2.7.4] to the extent determined by the unit's type according to the following standards:

a) a type 1G unit should be assumed to sustain damage anywhere in its length

b) a type 2G unit of more than 150 m in length should be assumed to sustain damage anywhere in its length

c) a type 2G unit of 150 m in length or less should be assumed to sustain damage anywhere in its length except involving either of the bulkheads bounding a machinery space located aft

d) a type 2PG unit should be assumed to sustain damage anywhere in its length except involving transverse bulkheads spaced further apart than the longitudinal extent of damage as specified in [2.7.4].

3 General arrangement

3.1 All units

3.1.1 When pipes, ducts, trunks or tunnels are situated within the assumed extent of damage penetration, arrangements are to be such that progressive flooding cannot thereby extend to compartments other than those assumed to be flooded for each case of damage.

3.1.2 Side discharges below the freeboard deck

The choice of valves fitted to discharges led through the shell from spaces below the freeboard deck or from within the superstructures and deck-houses on the freeboard deck fitted with weathertight doors, is to be limited to:

- one automatic non-return valve with a positive means of closing from above the freeboard deck, or
- when the vertical distance from the summer load waterline to the inboard end of the discharge pipe exceeds 0,01 L, two automatic non-return valves without positive means of closing, provided that the inboard valve is always accessible for examination in operating conditions.

The automatic non-return valves are to be of a type acceptable to the Society and fully effective in preventing the admission of water into the unit.

3.2 Units assigned the service notation liquefied gas storage

3.2.1 Cargo tanks location

Cargo tanks of units intended to receive the service notation **liquefied gas storage** are to be located as required in Pt D, Ch 9, Sec 2, [4] of the Ship Rules, taking into account the extent of damage defined in [2.7.4].

3.2.2 Double bottom

For units with membrane tanks or type A or type B independent tanks, and intended for the storage of cargoes at a temperature less than –10°C, the hold spaces are to be segregated from the sea by a double bottom.

3.2.3 Longitudinal bulkhead

For units subject of [3.2.2] and intended for the storage of cargoes at a temperature of less than –55°C, the hold spaces are also to be designed with a longitudinal bulkhead forming side tanks.

3.2.4 Collision bulkhead

A collision bulkhead is to be provided to prevent flooding during transit and/or site conditions.

The collision bulkhead is to comply with Pt B, Ch 2, Sec 1, [3] of the Ship rules.

Subject to the agreement of the flag Administration, if any, the Society may accept an exemption from having a collision bulkhead when the risk of collision is mitigated and duly justified (collision analysis, external turret, damage stability...).

Subject to the agreement of the flag Administration, if any, the Society may, on a case by case basis, accept a distance from the collision bulkhead to the forward perpendicular FPLL greater than the maximum specified in Pt B, Ch 2, [3.1.1] of the Ship rules,

provided that subdivision and stability calculations show that, when the unit is in upright condition on full load draft, flooding of the space forward of the collision bulkhead will not result in any part of the freeboard deck becoming submerged, or in any unacceptable loss of stability.

3.2.5 Aft peak bulkhead

As a rule, units are to be provided with an aft peak bulkhead in accordance with Pt B, Ch 2, [4] of the Ship rules, except when the risk of collision is mitigated and duly justified (collision analysis, external turret, damage stability...).

Section 11 Arrangements, Access, Ventilation and Venting of Spaces in the Cargo Area

1 General

1.1 Application

1.1.1 This Section provides requirements relating to arrangements, access, ventilation and venting of spaces in the cargo area, additional to those of Pt C, Ch 4, Sec 3 of the Offshore Rules.

1.1.2 For spaces situated in the cargo area, as defined in [1.2.1], and constituting an interface with areas where topside systems are installed (process, liquefaction plant, revaporization plant, transfer system), the requirements of Sec 13 are to be complied with, in addition to the requirements of this Section. For any conflict between these requirements, the Society is to be consulted for clarification.

1.1.3 All the requirements of Sec 11 may be adapted, based on the finding and conclusions of the risk analysis report which is to be submitted to the Society for information.

Detailed follow-up report of actions and mitigation measures taken in response to risk analysis findings is to be submitted to the Society for information.

Note 1: Risk analysis reports are considered for information only, to ensure that findings and conclusions of the risk analysis are properly taken into account for the design of the unit.

1.1.4 Units assigned the service notation **liquefied gas storage** are to comply with the following provisions:

- the requirements in Article [2]
- the relevant requirements of Pt D, Ch 9 of the Ship Rules
- the relevant requirements of Pt D, Ch 1, Sec 16 of the Offshore Rules.

Note 1: In case of conflict between requirements, IGC Code and the requirements in Article [2] are to prevail.

1.2 Definitions

1.2.1 Cargo area

The cargo area is that part of the unit which contains the cargo containment system, cargo pump room, compressor room, and includes deck areas above these spaces. Where fitted, the cofferdams, ballast or void spaces at the after end of the aftermost hold space or at the forward end of the forwardmost hold space are excluded from the cargo area.

1.2.2 Cargo control room

A cargo control room is a space used for the control of cargo handling operations.

1.2.3 Hold space

An hold space is a space enclosed by the unit structure in which a cargo containment system is located.

1.2.4 Hazardous areas, gas-dangerous spaces

Hazardous areas or gas-dangerous spaces are areas in which an explosive gas atmosphere is, or may be expected to be, present in quantities such as to require special precautions for the construction, installation and use of electrical apparatus.

Based upon the frequency and the duration of the occurrence of explosive atmosphere, hazardous areas are classified into the following zones:

- Zone 0:

  an area in which an explosive gas atmosphere is present continuously or is present for long periods
- Zone 1:

  an area in which an explosive gas atmosphere is likely to occur in normal operation
- Zone 2:

  an area in which an explosive gas atmosphere is not likely to occur in normal operations and, if it does, is likely to occur infrequently only and will exist for a short period only.

1.2.5 Explosive gas atmosphere

An explosive gas atmosphere is a mixture with air, under atmospheric conditions, of flammable substances in the form of gas, vapour or mist, in which, after ignition, combustion spreads throughout the unconsommed mixture.

2 Units with service notation liquefied gas storage

2.1 Segregation of the cargo area

2.1.1 Hold spaces are to be segregated from machinery and boiler spaces, accommodation spaces, service spaces, control spaces, chain lockers, drinking and domestic water tanks and from stores. The segregation is to be effected as follows:

- For cargo containment systems not requiring a secondary barrier, the segregation is to be effected by cofferdams, fuel oil tanks or single gastight bulkheads of A-60 class, as defined in Pt D, Ch 9, Sec 3 of the Ship Rules. Class A-0 may be accepted if there is no source of ignition or fire hazard in the adjacent spaces. Cofferdams may be used as ballast tanks, subject to special approval by the Society.
- For cargo containment systems requiring a secondary barrier, the segregation is to be effected by cofferdam or fuel oil tanks. Segregation with bulkheads of class A-0 may be accepted if there is no source of ignition or fire hazard in the adjacent spaces.

2.1.2 The thrusters, if any, are not to be located within the cargo area.

2.2 Accommodations, service and machinery spaces and control stations

2.2.1 In addition to the requirements of Pt D, Ch 9, Sec 3, [1.2] of the Ship Rules, the requirements of Sec 13 relating to the accommodations layout and safety principles are to be complied with.

2.2.2 The accommodation spaces, service spaces or control stations are not to be located within the cargo area.

2.2.3 Entrances and openings to service spaces located outside the cargo area may not face such an area.

2.2.4 Doors facing the cargo area or located in prohibited zones in the sides are to be restricted to stores for cargo-related and safety equipment, cargo control stations as well as decontamination showers and eye wash.

Where such doors are permitted, the space may not give access to other spaces covered by Pt D, Ch 9, Sec 3, [1.2.5] of the Ship rules and the common boundaries with these spaces are to be insulated with A-60 class bulkheads, as defined in Pt D, Ch 9, Sec 3 of the Ship Rules.

2.2.5 Bolted plates of A-60 class for removal of machinery may be accepted on bulkheads facing the cargo area, provided signboards are fitted to warn that these plates may be opened only when the unit is in gas-free condition.

2.2.6 For units intended to carry toxic products, Pt D, Ch 9, Sec 3, [1.2.12] of the Ship Rules for fitting air intakes and openings with closing devices operable from inside the space is to apply to spaces used for the unit's radio and main navigating equipment, cabins, mess rooms, toilets, hospitals, galleys, etc., but does not apply to spaces not normally manned, such as deck stores, forecastle stores, engine room casings and workshops. The requirement does not apply to cargo control rooms located within the cargo area.

When internal closing is required, this includes both ventilation intakes and outlets.

The closing devices are to give a reasonable degree of gas-tightness. Ordinary steel fire-flaps without gaskets/seals are normally not considered as satisfactory.

2.3 Cargo pump rooms and cargo compressor rooms

2.3.1 When cargo pump rooms and compressor rooms are permitted to be fitted between the cargo hold and the accommodations, the bulkhead which separates the cargo pump rooms or compressor rooms from accommodation and service spaces, control stations and machinery spaces of category A is to be so located as to avoid the entry of gas to these spaces through a single failure of a deck or bulkhead. The same condition is also to be satisfied when cargo pump rooms and compressor rooms fitted within the cargo area have a bulkhead in common with accommodation and service spaces, control stations and machinery spaces of category A.

2.3.2 In application of the requirements of Sec 12, cargo pump rooms and cargo compressor rooms are to be considered as hazardous area Zone 1 and electrical equipment is to be of a safe type authorized for these dangerous spaces.

2.4 Access to spaces in the cargo area

2.4.1 Access to spaces in the cargo area is to comply with the requirements of Sec 2, [4.4].

2.4.2 Visual inspection is to be possible from at least one side of the inner hull structure, without the removal of any fixed structure or fitting. If the visual inspection is possible only at the outer face of the inner hull, the inner hull is not to be a fuel tank boundary.

2.4.3 Access from open weather deck to gas-safe spaces is to be located in a gas-safe zone, at least 2,40 m above the weather deck unless the access is by means of an air lock.

2.5 Air locks

2.5.1 Air locks are permitted only between gas-dangerous zones on the open weather deck and gas-safe spaces. An air lock consists of two steel gastight doors spaced as follows:

- at least 1,50 m
- not more than 2,50 m.

2.5.2 Air lock doors are to be self-closing and without any holding back arrangement. Door sill is not to be less than 300 mm.

2.5.3 Air locks are to be such as to provide easy passage and are to cover a deck area of not less than 1,50 m^2. Air locks are to be kept unobstructed and may not be employed for other uses, such as storage.

2.5.4 An audible and visual alarm system is to be provided to indicate if more than one door is moved from the closed position. The alarm system is to act on both sides of the air lock.

The alarm systems are to be of the intrinsically safe type. However, signalling lamps may be of a safe type authorised for the dangerous spaces in which they are installed.

2.5.5 The air lock space is to be monitored for cargo vapour.

2.5.6 The air lock space is to be mechanically ventilated from a gas-safe space and maintained to an overpressure to the gas-dangerous zone on the open weather deck.

2.5.7 Electrical equipment which is not of the certified safe type and supplying emergency services is not to be located in spaces protected by air locks.

2.5.8 The following means are considered to be acceptable alternatives to differential pressure sensing devices in spaces having a ventilation rate not less than 30 air changes per hour:

- monitoring of current or power in the electrical supply to the ventilation motors, or
- air flow sensors in the ventilation ducts.

In spaces where the ventilation rate is less than 30 air changes per hour and where one of the above alternatives is fitted, in addition to the alarms required in [2.5.4], arrangements are to be made to de-energise electrical equipment which is not of the certified safe type if more than one air lock door is moved from the closed position.

2.5.9 Lack of overpressure or air flow is not to imply the stopping of the motors driving compressors used for the boil-off system. Therefore, such engines are to be of the certified safe type and the relevant control appliance is to be fitted in a non-gas-dangerous space.

2.5.10 After any loss of the overpressure, the spaces protected by air locks are to be ventilated for the time necessary to give at least 10 air changes prior to energising the non-safe type electrical installations.

2.6 Bilge, ballast and fuel oil arrangements

2.6.1 For cargo containment systems not requiring a secondary barrier, hold spaces are to be provided with suitable drainage arrangements not connected with the machinery spaces. Means of detecting any leakage are to be provided.

2.6.2 For cargo containment systems requiring a secondary barrier, suitable drainage arrangements for dealing with any leakage into the hold or insulation spaces through adjacent structure is to be provided. The drainage is not to be supplied by pumps inside the machinery space. Means of detecting such leakage are to be provided.

2.6.3 The holds or interbarrier spaces of type A independent tank units are to be provided with a drainage system suitable for handling liquid cargo in the event of cargo tank leakage or rupture. Such arrangements are to provide the return of any cargo leakage to the liquid cargo piping.

These arrangements are to be provided with a removable spool piece.

2.6.4 Gas-safe ballast spaces, including wet duct keels used as ballast piping, fuel oil tanks and gas-safe spaces may be connected to pumps in the machinery spaces. Dry duct keels with ballast piping passing through may be connected to pumps in the machinery spaces, provided that the connections are led directly to the pumps and the discharge from the pump is led directly overboard with no valve of manifolds in either line which could connect the line from the duct keel to lines serving gas-safe spaces. Pump vents are not to be open to machinery spaces.

2.6.5 Gas-dangerous spaces within the cargo area are to be fitted with a bilge or drain arrangement not connected to the machinery space.

Spaces not accessible at all times are to be fitted with sounding arrangements.

Spaces without a permanent ventilation system are to be fitted with a pressure/vacuum relief system or with air pipes.

2.6.6 Additional requirements relative to the bilge system from Pt D, Ch 9, Sec 3, [1.7] of the Ship Rules are to be complied with.

2.7 Cargo tank venting system

2.7.1 Protection of interbarrier spaces

a) The relieving capacity of pressure relief devices of interbarrier spaces surrounding independent type B cargo tanks may be determined on the basis of the method given in Pt D, Ch 9, Sec 8, [2] of the Ship Rules; however, the leakage rate is to be determined in accordance with Pt D, Ch 9, Sec 4, [2.5.2] of the Ship Rules.

b) The relieving capacity of pressure relief devices for interbarrier spaces of membrane and semi-membrane tanks is to be evaluated on the basis of specific membrane tank design.

c) The relieving capacity of pressure relief devices for interbarrier spaces adjacent to integral type cargo tanks may, if applicable, be determined as for type A independent cargo tanks.

d) Interbarrier space pressure relief devices in the scope of this interpretation are emergency devices for protecting the hull structure from being unduly overstressed in the event of a pressure rise in the interbarrier space due to primary barrier failure. Therefore such devices need not comply with the requirements of Pt D, Ch 9, Sec 8, [2.1.12] and [2.1.14] of the Ship Rules.

2.7.2 Size of pressure relief devices

The combined relieving capacity Q_{sa} of the pressure relief devices for interbarrier spaces surrounding type A independent cargo tanks where the insulation is fitted to the cargo tanks may be determined by the following formula:

$$Q_{sa} = 3{,}4 \cdot A_C \cdot \frac{\rho}{\rho_V} \cdot \sqrt{h}$$

where:

Q_{sa} : Minimum required discharge rate of air in standard conditions of 273 K and 1,013 bar, in m^3/s

A_C : Design crack opening area, in m^2, equal to:

$$A_C = \frac{\pi}{4} \cdot \delta \cdot l$$

with:

δ : Maximum crack opening width, in m, equal to:

$\delta = 0{,}2\ t$

t being the thickness of tank bottom plating, in m

l : Design crack length, in m, equal to the diagonal of the largest plate panel of the tank bottom (see also Pt D, Ch 9, Sec 8 of the Ship Rules)

h : Maximum liquid height above tank bottom plus 10 × MARVS, in m

ρ : Density of product liquid phase, in kN/m^3, at the set pressure of the interbarrier space relief device

ρ_V : Density of product vapour phase, in kN/m^3, at the set pressure of the interbarrier space relief device and a temperature of 273 K.

2.7.3 Vents

The height of vent exits, as indicated in Pt D, Ch 9, Sec 8, [2.1.12] of the Ship Rules, is also to be measured above storage tanks and cargo liquid lines, where applicable.

Flaring may be accepted by the Society as an alternative solution, provided that:

- the requirements of [2.7.5] relating to pressure drop are complied with
- the availability of flare boom is proven, at the satisfaction of the Society.

2.7.4 Additional requirements on vent location

a) The distances of the vent exits are to be measured horizontally.

b) In the case of carriage of flammable and/or toxic products, the vent exits are to be arranged at a distance of at least 5 m from exhaust ducts and at least 10 m from intake ducts serving cargo pump rooms and/or cargo compressor rooms.

c) The distances are also intended to refer to outlets of ventilation ducts of safe spaces.

2.7.5 Pressure drop in vent lines

The pressure drop in the vent lines from the tank to the pressure relief valve inlet is not to exceed 3% of the valve set pressure. For unbalanced pressure relief valves, the back pressure in the discharge line is not to exceed 10% of the gauge pressure at the relief valve inlet with the vent lines under fire exposure.

2.8 Mechanical ventilation in the cargo area

2.8.1 The relevant requirements of Pt D, Ch 9, Sec 12 of the Ship Rules, relating to the mechanical ventilation in the cargo area, are to be complied with.

Section 12 Equipment and Safety Particulars

1 General

1.1 Application

1.1.1 The equipment is to comply with the applicable National Rules and, for items covered by classification, with the requirements of Part C of the Offshore Rules.

1.1.2 In addition, the units covered by this Rule Note are to comply with the requirements of Pt D, Ch 1, Sec 17 of the Offshore Rules.

1.1.3 Additional requirements for units assigned the service notation **liquefied gas storage** are given in Article [5].

2 Hazardous areas

2.1 General

2.1.1 Article [2] is applicable to hazardous areas due to cargo storage and offloading.

Applicable requirements for hazardous areas due to other causes are given in Pt C, Ch 4, Sec 3 of the Offshore Rules.

Note 1: For interface areas which may be covered by two different standards, the requirements for hazardous areas due to cargo storage and offloading are to be complied with, as applicable.

2.1.2 For the definition of the expressions used in this Article [2], refer to Pt C, Ch 4, Sec 3, [1] of the Offshore Rules.

2.1.3 Attention is drawn on the fact that the provisions of IMO Regulations for hazardous areas of liquefied gas carriers, as well as the provisions of the Ship Rules applicable to the same areas, are applicable.

2.2 Classification of hazardous areas due to storage and offloading

2.2.1 For the purpose of machinery and electrical installations, hazardous areas are classified as indicated in Tab 1.

Table 1 : Description of spaces and hazardous area zones

No.	Space description	Hazardous area zone
1	The interior of cargo tanks, any pipework of pressure-relief or other venting systems for cargo, pipes and equipment containing the cargo or developing flammable gases and vapours	Zone 0
2	Interbarrier spaces, hold spaces where cargo is carried in a cargo containment system requiring a secondary barrier	Zone 0
3	Void spaces adjacent to, above, or below integral cargo tanks	Zone 1
4	Hold spaces where cargo is carried in a cargo containment system not requiring a secondary barrier	Zone 1
5	Cofferdams and permanent (for example, segregated) ballast tanks adjacent to cargo tanks	Zone 1
6	Cargo pump rooms and cargo compressor rooms	Zone 1
7	Enclosed or semi-enclosed spaces, immediately above cargo tanks (for example, between decks) or having bulkheads above and in line with cargo tank bulkheads, unless protected by a diagonal plate acceptable to the Society	Zone 1
8	Spaces, other than cofferdams, adjacent to, and below, the top of a cargo tank (for example, trunks, passageways and holds)	Zone 1
9	Areas on open deck, or semi-enclosed spaces on open deck, within 3 m of any cargo tank outlet, gas or vapour outlet, cargo manifold valve, cargo valve, cargo pipe flange, cargo pump room ventilation outlets, cargo compressor room ventilation outlets and cargo tank openings for pressure release provided to permit the flow of small volumes of gas or vapour mixtures caused by thermal variations **Note 1:** Such areas are, for example, all areas within 3 m of cargo tank hatches, sight ports, tank cleaning openings, ullage openings, sounding pipes, cargo vapour outlets	Zone 1
10	Areas on open deck, or semi-enclosed spaces on open deck above and in the vicinity of any cargo gas outlet intended for the passage of large volumes of gas or vapour mixture during cargo loading and ballasting or during discharging, within a vertical cylinder of unlimited height and 6 m radius centred upon the centre of the outlet, and within a hemisphere of 6 m radius below the outlet	Zone 1

No.	Space description	Hazardous area zone
11	Areas on open deck, or semi-enclosed spaces on open deck, within 1,5 m of cargo pump room entrances, cargo pump room ventilation inlet, openings into cofferdams, cargo compressor room entrances, cargo compressor room ventilation inlets or other zone 1 spaces	Zone 1
12	Areas on open deck within spillage coamings surrounding cargo manifold valves and 3 m beyond these ones, up to a height of 2,4 m above the deck	Zone 1
13	Areas on open deck over the cargo area where structures are restricting the natural ventilation and over the full breadth of the unit plus 3 m fore and aft of the forwardmost and aftermost cargo tank bulkheads, up to a height of 2,4 m above the deck	Zone 1
14	Compartments for cargo hoses	Zone 1
15	Enclosed or semi-enclosed spaces in which pipes containing cargoes are located	Zone 1
16	Spaces separated from a hold space, where cargo is stored in a cargo tank requiring a secondary barrier, by a single gastight boundary	Zone 1
17	Enclosed or semi-enclosed spaces in which pipes containing cargo products for boil-off gas fuel burning systems are located, unless special precautions approved by the Society are provided to prevent product gas escaping into such spaces	Zone 1
18	Areas of 1,5 m surrounding a space of zone 1 defined in No. 9	Zone 2
19	Spaces 4 m beyond the cylinder and 4 m beyond the sphere defined in No. 10	Zone 2
20	Spaces forming an air lock as defined in Sec 11, [2.5]	Zone 2
21	Areas on open deck extending to the coamings fitted to keep any spills on deck and away from the accommodation and service areas and 3 m beyond them up to a height of 2,4 m above the deck	Zone 2
22	Areas on open deck over the cargo area where unrestricted natural ventilation is guaranteed and over the full breadth of the unit plus 3 m fore and aft of the forwardmost and aftermost cargo tank bulkheads, up to a height of 2,4 m above the deck surrounding open or semi-enclosed spaces of zone 1	Zone 2
23	Spaces forward of the open deck areas referred to in 13 and 22, located below the level of the main deck and having an opening onto the main deck or at a level less than 0,5 m above the main deck, unless: • the doors and all openings are in non-hazardous area; and • the spaces are mechanically ventilated	Zone 2
24	Areas within 2,4 m of the outer surface of a cargo tank where such a surface is exposed to the weather	Zone 2

3 Side discharges

3.1 Side discharges below the freeboard deck

3.1.1 Requirements for side discharges below the freeboard deck are given in Sec 10, [3.1.2].

4 Life saving appliances

4.1 Additional requirement

4.1.1 In addition to the requirements of Pt C, Ch 4, Sec 12 of the Offshore Rules applicable to units assigned the additional class notation **LSA**, lifeboats are to be of a totally enclosed fire resistant type.

5 Additional requirements for units assigned the service notation liquefied gas storage

5.1 General

5.1.1 In addition to the requirements referenced in [1.1.1] and [1.1.2], units assigned the service notation **liquefied gas storage** are to comply with Pt D, Ch 9, Sec 11 of the Ship Rules, taking into account the additional interpretations given from [5.2] to [5.6].

5.2 Fire safety

5.2.1 Temperature of steam and heating media within cargo area

The maximum temperature of the steam and heating media within the cargo area is to be adjusted to take into account the temperature class of the cargo.

5.2.2 Segregation of high temperature piping

High temperature pipes are to be thermally isolated from the adjacent structures. In particular, the temperature of pipelines is not to exceed 220°C in gas-dangerous zones.

5.3 Water spray system

5.3.1 Water spray system coverage

The water spray system mentioned in requirement [1.3.2] of Pt D, Ch 9, Sec 11 of the Ship Rules is also to cover the boundaries of:

- spaces containing internal combustion engines and/or fuel treatment units
- store-rooms for flammable liquids having a flashpoint equal to or less than 60°C, and
- paint lockers.

5.3.2 Nozzle arrangement

The number and location of spray nozzles are to be suitable to spread the sprayed water uniformly on areas to be protected.

5.3.3 Protection of accommodation spaces

Stop valves are to be fitted on the water-spray main for the purpose of isolating damaged sections. The location of stop valves is to be such that the accommodation spaces are always protected in case of a spray-main failure.

5.4 Dry chemical powder fire-extinguishing systems

5.4.1 System capacity

Any exposed point of the cargo area, including cargo piping, is to be capable of being reached by powder delivered from at least two hoses or from a fixed monitor and one hose, which are not to be supplied by the same powder unit.

5.4.2 System arrangement

a) Two powder units, even if mutually connected through a common main, may be considered independent on condition that non-return valves or other arrangements suitable to prevent powder from passing from one unit to the other are fitted.

b) The powder units which constitute the system are to contain, in general, the same powder quantity and, when they are not grouped together in a single position, they are to be uniformly located over the area to be protected.

5.5 Cargo compressor rooms and cargo pump rooms

5.5.1 Carbon dioxide system

The cargo compressor rooms and cargo pump rooms are to be provided with a carbon dioxide system, as requested by Pt D, Ch 9 Sec 11, [1.5.2] of the Ship Rules.

Audible alarms fitted to warn of the release of fire extinguishing medium into pump rooms are to be of the pneumatic or electric type:

a) In cases where the periodic testing of pneumatically operated alarms is required, CO_2 operated alarms may not be used owing to the possibility of the generation of static electricity in the CO_2 cloud. Air operated alarms may be used provided the air supply is clean and dry.

b) When electrically operated alarms are used, the arrangements are to be such that the electric actuating mechanism is located outside the pump room, except where the alarms are certified intrinsically safe.

5.6 Portable fire extinguishers

5.6.1 In cargo pump rooms and cargo compressor rooms, at least two portable fire extinguishers of a recognised type are to be fitted.

Section 13 Topside Arrangement and Systems

1 General

1.1 Application

1.1.1 This Section provides requirements applicable either to the overall safety of the unit or to the topside systems covered by specific class notations, as detailed in [1.1.2] and [1.1.3].

1.1.2 All the units are to comply with the topside layout principles and overall safety requirement detailed in Article [2].

1.1.3 Additional requirements for topside systems are detailed in [1.2] to [1.5] and in Articles [3] and [4]. These requirements are applicable to the topside systems covered by each of the following notations, when assigned to the unit:

- additional class notation **PROC-GP**, as defined in Pt A, Ch 1, Sec 2, [8.3.3] of the Offshore Rules
- additional class notation **PROC-GL**, as defined in Pt A, Ch 1, Sec 2, [8.3.3] of the Offshore Rules
- additional class notation **liquefied gas transfer**, as defined in Pt A, Ch 1, Sec 2, [8.3.8] of the Offshore Rules.

Note 1: When one of the notations above is not assigned to the unit, the corresponding topside systems are considered outside the scope of classification.

1.1.4 The Society may accept topside arrangements different from those required in Article [4], based on the principle of equivalence given in Pt A, Ch 1, Sec 1, [2.3] of the Offshore Rules.

1.1.5 The requirements of this Section are based on references to different parts of the in-force Rules of the Society and to miscellaneous recognized codes and standards. When there is a conflict between referenced requirements, the Society is to be consulted for clarification.

1.1.6 For all the pieces of equipment covered by the additional class notation **PROC-GL** or the additional class notation **PROC-GP**, the certification and survey are to be performed in accordance with the requirements of NR266 Requirements for Survey of Materials and Equipment for the Classification of Ships and Offshore Units, Item L27.

1.2 Additional class notation PROC-GP

1.2.1 The following systems are covered by the additional class notation **PROC-GP**:

- pressure vessels, piping systems and mechanical equipment for hydrocarbon processing
- subsystems or plants for gas dehydratation
- subsystems or plants for the removal of acids or mercury
- flaring and venting systems
- control, safety and utility systems for hydrocarbon processing plant.

1.3 Additional class notation PROC-GL

1.3.1 For units assigned the additional class notation **PROC-GL**, the liquefaction plant is to comply with the requirements of this Section. Depending on the liquefaction method used, the liquefaction plant is generally to include the following items:

- pressure vessels and piping for pre-cooling subsystems and fractionation plants
- mechanical equipment relating to the liquefaction plant, such as turbines, compressors, pumps, turbo expanders
- cold boxes (plate fin heat exchangers, spiral wound heat exchangers or printed circuit heat exchangers) for main refrigeration plant
- pressure vessels and/or tanks for the storage of liquefied gas, refrigerants and condensate.

1.4 Additional class notation liquefied gas transfer

1.4.1 For units assigned the additional class notation **liquefied gas transfer**, cargo transfer system is generally to include the following items:

- transfer arms, including structural members, product lines and swivels
- valves and piping systems or cryogenic hoses used for liquefied gas discharge
- main riser of the transfer system
- pumps, compressors and any other equipment used for cargo handling
- vapor return systems
- emergency release systems
- mooring and fendering equipment for transfer operations.

1.5 New technology

1.5.1 Topside systems are to be considered as new technology when based on a novel technology or an existing technology used in a new environment, for which no track record is available.

1.5.2 Prior to the design approval, the qualification of new technology is to be performed. Depending on the criticality levels identified by the qualification process for various equipment, the Society reserves the right to apply provisions other than those in [3], based on engineering judgement and references to recognized codes and standards.

1.5.3 The qualification process required in [1.5.2] is to be carried out in accordance with the methodology and principles of the Guidance Note NI 525 Risk Based Qualification of New Technology - Methodological Guidelines.

2 Unit safety requirements

2.1 Topside layout

2.1.1 Topside layout is to comply with the applicable requirements of Pt C, Ch 4, Sec 2 of the Offshore Rules. Additional requirements are given in this Section.

2.1.2 The requirements relating to topside layout principles and general arrangement of topside systems are coherent with the IGC Code.

The Society may refer to these codes and standards when deemed necessary.

2.2 Risk analysis

2.2.1 Risk analysis is to be performed to validate the topside layout and to determine the critical conditions that the systems are capable to withstand. A detailed report for risk analysis is to be submitted to the Society for information.

Note 1: Risk analysis reports are considered for information only, to ensure that findings and conclusions of the risk analysis are properly taken into account for the design of the unit.

2.2.2 Detailed follow-up report of actions and mitigation measures taken in response to risk analysis findings is to be submitted to the Society for information.

2.3 Cryogenic embrittlement protection

2.3.1 Topside layout is to be so designed as to minimize the risk of cryogenic embrittlement of critical elements (structural members, safety critical equipment, means of escape) due to spillage of cryogenic liquids.

Means are to be provided to collect, and safely dispose of, cryogenic leaks. Flanges, valves and other possible sources of leaks should be minimized on systems containing cryogenic fluids. On high pressure systems, local shielding and drainage of flanges and valves should be considered.

2.4 Temporary refuge

2.4.1 Temporary refuge is a facility where the personnel can muster temporarily and prepare for the evacuation of the unit. The emergency response is to be communicated and controlled from the temporary refuge.

2.4.2 At least one main temporary refuge is to be fitted onboard the unit. Depending on the unit dimensions and arrangements of means of escape, the Society may require a secondary refuge.

2.4.3 The main temporary refuge is to be located in the accommodation area, being generally a part of the living quarters. The whole accommodation building may be designed as temporary refuge.

2.4.4 The main temporary refuge is to include the following facilities:

- central control room including marine systems control, process system control and communication equipment
- main muster area
- medical suite
- standby control room
- emergency response centre.

2.4.5 At least two separate means of escape are to be provided to evacuate from the temporary refuge to the deck level and to the helideck. One of these means of escape may be an emergency escape door, to be used only in the case of emergency.

2.4.6 All the doors used for the normal access to the spaces in the main temporary refuge are to be equipped with positive pressurised air locks.

2.4.7 Medical suite is to be so located as to facilitate the access of casualties and to provide a good access to the muster areas.

2.4.8 When a secondary refuge is fitted, suitable means of communication with the main temporary refuge are to be provided.

2.5 Fire zone

2.5.1 For the purpose of fire protection, topside layout is generally to be divided into fire zones. The fire zones are areas where pieces of equipment are grouped by nature and/or by homogeneous level of risk. The partition into fire zones is such that the consequence of a fire, a flammable gas leak, or an explosion corresponding to the credible event likely to occur in the concerned zone, is not to impact other fire zones to an extent where their integrity could be put at risk.

Simultaneous independent hazardous events in two separate fire zones are not to be considered.

2.5.2 The extent of a fire zone is defined by the application of an extinguishing agent, by a drainage common to several items of equipment or by a natural segregation. Generally, the boundaries of the fire zones are to be defined as the edge of the unit and/or physical boundaries (fire and blast bulkheads).

2.6 Fire protection

2.6.1 External bulkheads and walls of the living quarters and temporary refuge facing the process area are to be rated at least as H-60 class.

Bulkheads of a lower class may be accepted, provided that a risk analysis or a fire load analysis, showing that the bulkheads are acceptable, is performed and submitted to the Society for review.

3 Topside systems requirements

3.1 Application

3.1.1 The requirements of this Article are applicable only in the case of the use of one of the additional notations defined in [1.1.3].

3.2 Topside systems and components

3.2.1 Except when otherwise specified in this Section, topside systems and components are to comply with the relevant requirements in Part C of the Offshore Rules or other recognized standards such as:

- ASME VIII, Div 1 and 2 “Rules for the Construction of Pressure Vessels”
- AD Merkblater “Technical Rules for Pressure Vessels”
- CODAP 80 “Code des Appareils à Pression”
- BS 5500 “Unfired Fusion Welded Pressure Vessels”
- API RP 14E “Design and Installation of Offshore Production Platform Piping Systems”
- ASME B31.3 “Chemical Plant and Petroleum Refinery Piping”.

The acceptance of other national and/or international standards may be considered by the Society on a case-by-case basis.

Note 1: On a case-by-case basis, the Society may refer to the relevant requirements of IGC Code, as amended, and of Part D, Chapter 9 of the Ship Rules in case specific topics are not properly addressed by the applied recognized standards.

3.2.2 For the approval of pieces of equipment or components not covered by the requirements of [3.2.1], the Society refers to recognized standards such as:

- EN 1473 “Installations and equipment for liquefied natural gas - Design of onshore installations”
- NFPA 59A “Standard for the production, storage and handling of Liquefied Natural Gas (LNG)”
- NFPA 59 “Standard for the storage and handling of Liquefied Petroleum Gases at utility gas plants”.

3.3 Process systems and components (PROC-GP and PROC-GL)

3.3.1 General

Systems and components covered by the additional class notation **PROC-GP** or **PROC-GL** are to comply with the requirements of NR459 Process Systems Onboard Offshore Units and Installations, covering the following classification items:

- design requirements
- certification of components
- construction survey and testing.

3.3.2 Liquefaction plant (PROC-GL)

In addition to the requirements of [3.2], the Society may require studies and risk analyses showing that the equipment of liquefaction plant is safe in offshore environment, taking into account the motions and accelerations during operations on site.

The following plans and documents are to be submitted to the Society for approval:

- piping and instrumentation diagram
- hazardous areas
- details of pumps, compressors and gas process vessels
- ventilation systems
- fire protections systems
- gas detection systems.

3.4 Cargo transfer systems (liquefied gas transfer)

3.4.1 Cargo transfer systems covered by the additional class notation **liquefied gas transfer** are to comply with the requirements of Sec 14.

3.4.2 Parts of the transfer systems which are not covered by Sec 14 are to comply with [3.2].

4 Topside layout

4.1 Application

4.1.1 The requirements of this Article are applicable only in the case of the use of one of the additional notations defined in [1.1.3].

4.2 General

4.2.1 General

In addition to requirement given in [2.1], the requirements relating to topside layout principles and general arrangement of topside systems are coherent with the following codes and standards:

- API RP 14J “Recommended Practice for Design and Hazards Analysis for Offshore Production Facilities”
- EN ISO 13702 “Control and Mitigation of Fires and Explosions on Offshore Production Installations”
- NORSOK standard S-001

4.2.2 Risk analysis

In addition to requirements given in [2.2], the assessment through risk analysis is to be performed based on standards recognized by the Society, such as:

- API RP 14J “Recommended Practice for Design and Hazards Analysis for Offshore Production Facilities”
- EN ISO 17776 “Guidelines on tools and techniques for hazard identification and risk assessment”.

4.3 Safety principles

4.3.1 Topside layout is to be so designed as to reduce the probability and the consequence of accidents through location, separation and orientation of areas, equipment and functions.

4.3.2 Topside arrangement is to be divided into main areas, such as:

- accommodations
- utilities
- process equipment
- liquefaction plant
- transfer system, offloading
- revaporization plant
- hydrocarbon storage.

As a rule, the main areas are to be separated by means of physical barriers, such as fire and blast bulkheads or suitable distances, in order to prevent the escalation of an accident from one main area to another.

4.3.3 Hydrocarbon and hazardous material handling areas are to be as separated as practicable from safe areas as:

- emergency services
- main safety equipment
- accommodations, living quarters
- means of escape.

4.3.4 A risk grading principle is to be applied: areas with low risk (such as utilities areas) are to be located between high risk areas and living quarters and control stations.

4.3.5 Means of access are to be designed to provide:

- a safe transfer of the personnel to/from transportation points (helideck, vessel)
- a safe access for operations, maintenance and material handling.

4.3.6 Means of escape are to be designed, based on the following principles:

- means of escape are to be provided between all the areas and the designed muster area
- means of escape are to be so designed as to maximize the availability of safety equipment.

4.3.7 The location of topside pieces of equipment is to take into account the prevailing wind direction, in order to avoid impairment from smoke or flammable/toxic products. The following principles are to be considered:

- the living quarters and the helideck are to be located as far as possible from the flaring system
- exhausts from fired equipment, turbines and vents are to be so located as not to disturb the helideck approach
- air inlets for air compressors, diesel engines, air handling units and gas turbines are to be located upwind (toward free air)
- exhaust are to be located downwind.

4.4 Fire zones

4.4.1 Where the fire zones contain hydrocarbons, it should be possible to completely isolate the hydrocarbon inventory by emergency shutdown valves and depressurize the isolated hydrocarbon inventory by blowdown valves.

4.4.2 For fire zone breakdown and location of different pieces of equipment for fire protection purpose, reference is made to API RP 14J “Recommended Practice for Design and Hazards Analysis for Offshore Production Facilities”.

4.5 System arrangement

4.5.1 Risers and flow lines

Hydrocarbon risers and flow lines are to be so designed, located and protected as to minimize the likelihood of damage due to collisions and dropped objects.

4.5.2 Pipings

a) Routing of piping containing hydrocarbon to or through utility areas is to be avoided, except for fuel lines of utility systems.

b) Piping conveying liquefied gases (cryogenic lines) are to be located at the lowest level of the topside module.

c) Routing of hydrocarbon pipings is not allowed within:
   - the living quarter areas, and
   - the electrical room, the instrument room and the control room.

d) Routing of hydrocarbon pipings within areas where emergency equipment is located is to be limited to fuel supply lines for the emergency pieces of equipment.

4.5.3 Process area

a) Cryogenic equipment is generally to be located at the lowest level of the topside module.

b) The vertical distribution of equipment is to follow the process stream.

c) Pressure equipment containing large amounts of liquids is to be so located and arranged that the exposure to jet fires is minimized.

d) Vessels containing liquids are to be located lower than gas equipment.

e) Equipment containing hydrocarbon is to be protected from external impact from dropped objects or missiles due to disintegration of rotating machinery.

4.5.4 Explosion mitigation

In order to minimize explosion effects due to overpressure and drag forces, the topside modules are to be designed based on the following principles:

a) horizontal vessels are to be so arranged that the largest dimension is in the direction of the main vent flow

b) congestion is to be minimized

c) long narrow modules are to be avoided

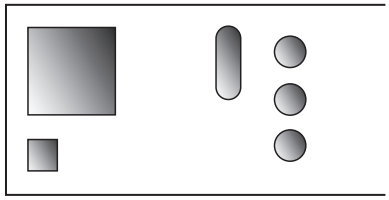
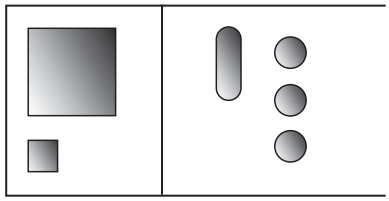
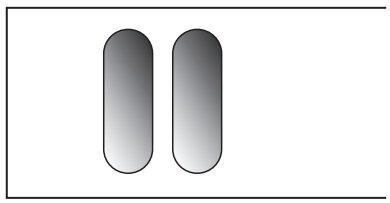
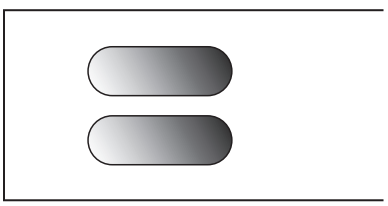
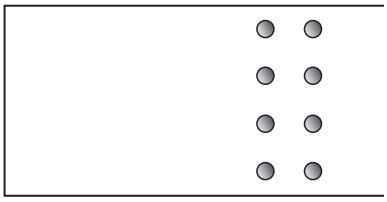
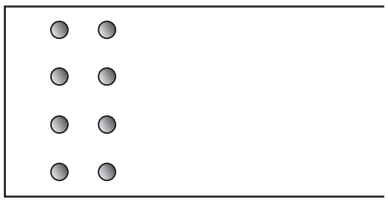
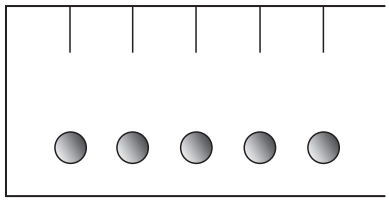
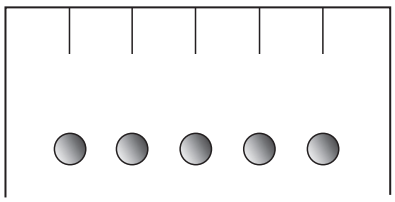
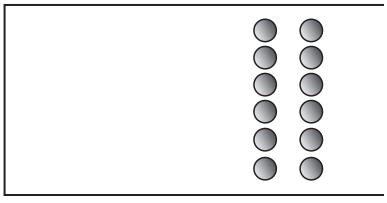
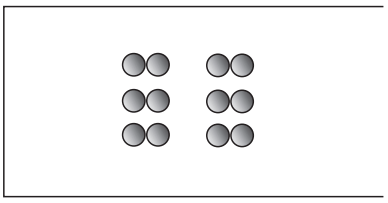
d) openings in the module structure are to be maximized as far as possible, particularly in floors and ceilings

e) openings in the module boundaries are not to be obstructed

f) module design is to be such that the failure due to explosion occurs first in the less critical directions (collapse in cascade fashion).

Recommendations for module arrangements relating to explosion mitigation are given in Tab 1.

Table 1 : Recommendations for topside module arrangement (based on ISO 13702)

To be avoided	Typical recommendation	Main advantages
		Volume reduced
		Blockage ratio reduced Number of obstacles reduced
		Obstacles moved to the inner part of the module
		Sideway venting
		Blockage ratio reduced Transverse spacing increased

4.5.5 Laydown and lifting areas

a) Crane coverage and laydown areas are to be arranged to promote safe crane operations with free visibility from crane cabin, in order to minimize the risk of dropped objects. Special consideration is to be given to sidewise movement of crane load.

b) Laydown areas are not to be located in hazardous areas.

c) When deemed necessary as a result of risk analysis, equipment and pipings containing hydrocarbons, flammable or toxic gas liquids, are to be protected against dropped objects within the lifting areas.

4.5.6 Transfer system (loading/offloading)

The transfer system arrangement is to be such as to maximize the distance between the living quarter of the shuttle tanker or gas carrier and the flare equipment of the unit, in berthed configuration.

4.6 Means of escape

4.6.1 At least two different escape routes are to be provided between any accessed location of topside modules and the temporary refuge.

4.6.2 Main escape routes are to be arranged in the longitudinal direction of the unit and are to remain as straight as possible. The main escape routes are to be designed to permit the transfer of injured persons, including the transport by stretcher.

4.6.3 Escape routes are to be clear of any green water effects.

4.6.4 Change in elevation along the escape routes is to be made by stairs. Vertical ladders are to be avoided, as much as possible. Ladders are accepted only for the access to infrequently accessed areas or for zones where installation of stairs is not practicable.

4.6.5 Escape routes are to be bridged over the gaps between topside modules.

4.6.6 Topside modules are to be equipped with at least two stairwells running from the uppermost process deck to the main deck of the unit. Access is to be provided to each deck of the module.

4.7 Fire protection

4.7.1 Reference is done to the relevant requirements of Part C, Chapter 4 of the Offshore Rules.

4.7.2 For fire zones (as defined in [4.4]) limited by fire bulkheads or decks, these divisions are to be of class A or H (see Pt C, Ch 4, Sec 1 of the Offshore Rules). Class H is required for zones where the heat load is significantly above 107 kW/m^2.

Section 14 Transfer Systems

1 General

1.1 Application

1.1.1 Classification, class notation

The requirements of this Section are applicable for units assigned the additional class notation **liquefied gas transfer**, as defined in Pt A, Ch 1, Sec 2, [8.3.8] of the Offshore Rules.

The general principles of the classification process are defined in Part A of the Offshore Rules.

The scope and limits of the additional class notation **liquefied gas transfer** are defined in [1.2].

Additional information about the classification procedure, with identification of different steps of classification process, is given in Article [2].

1.1.2 Other approval processes

The provisions of this Section are also applicable, as relevant, for other approval processes relating to transfer systems for liquefied gas, such as:

- concept approval
- basic design approval
- Front End Engineering Design (FEED) approval.

These approval processes provide, previous to the classification process, a confirmation of the technical feasibility of the project at each planning stage, taking into account both the current state of art and the applicable rules and standards.

1.1.3 Types of transfer systems

This Section covers the following types of transfer system:

- transfer arms applied in a side-by-side configuration
- transfer arms applied in a tandem configuration
- transfer systems using transfer hoses.

Transfer systems applying new or unproven technology are also considered.

1.1.4 Reference documents

When deemed necessary, the Society may refer to the requirements of the following ISO/EN documents:

- ISO 16904:2016 Petroleum and natural gas industries - Design and testing of LNG marine transfer arms for conventional onshore terminals
- EN 1474-2 Installation and equipment for liquefied natural gas - Design and testing of marine transfer systems - Part 2: Design and testing of transfer hoses
- EN 1474-3 Installation and equipment for liquefied natural gas - Design and testing of marine transfer systems - Part 3: Offshore transfer systems

Sec 14 provides interpretations and clarifications of the ISO16904 and EN 1474 requirements, from the Society point of view, which are also mandatory class requirements.

1.1.5 Deviations from Section 14

Deviations from this Section may be accepted by the Society, based on the principle of equivalence given in Pt A, Ch 1, Sec 1, [2.3] of the Offshore Rules. This equivalence involves that:

- a gap analysis of the transfer system design compared to Sec 14 is performed and submitted to the Society
- each identified deviation is justified by a review of the safety philosophy and a risk based approach.

1.2 Scope of the additional class notation liquefied gas transfer

1.2.1 Classed transfer systems – Additional class notation liquefied gas transfer

The additional class notation **liquefied gas transfer** may be assigned to the units having a transfer system for liquefied gas fitted onboard. This notation covers the classification of the transfer system (as defined in [1.3.1]) and all the mooring and fendering equipment relating to offloading operations. The presentation flange of the transfer system is to be considered as the limit of the classification scope.

Manifolds, connecting devices and other related pieces of equipment fitted onboard the gas carrier are not included in the scope of the classification. However, documentation including a general description of, and the operational procedures relating to, these items is to be submitted to the Society for information.

Note 1: Equipment and devices fitted onboard the gas carrier may be considered through a concept approval process (see [1.1.2]) and covered by the related Concept Approval Certificate.

1.2.2 Additional class notation liquefied gas transfer not requested

When the additional class notation **liquefied gas transfer** is not requested by the Owner, the classification is limited to the transfer system foundations and the attachments of all the related equipment to the hull structure. Depending on the configuration of the transfer system, the Society may extend the scope of the classification to other items of transfer system which influence the global safety of the unit, on a case-by-case basis.

Documentation of the estimated loads on foundations and attachments to the hull are to be submitted to the Society for information.

1.3 Definitions

1.3.1 Transfer system

A transfer system is a system allowing the transfer of liquefied gas between the unit and the gas carrier. The transfer system comprises the transfer lines and all their supporting structure on both the gas carrier and the unit, including all their accessories, control/detection systems and energy supply.

1.3.2 Transfer line

A transfer line is an articulated piping, a transfer hose and a swivel if any, or a combination of piping and hose, allowing the transfer of liquefied gas between the unit and the gas carrier.

1.3.3 Transfer arm

A transfer arm is an articulated piping, including the base riser fixed on its supporting structure, and all its accessories.

1.3.4 Swivel

A swivel is a swing joint contained in the transfer arm allowing the transfer of liquid between the arm parts. It enables the arm to freely follow the relative motions of the unit and the gas carrier.

1.3.5 Manifold

A manifold is a pipe assembly to which the outboard flanges of the transfer system are connected.

1.3.6 Emergency release coupling (ERC)

An ERC is a device providing a means of quick release of the transfer system and used only when such release is required as an emergency measure.

1.3.7 Emergency release system (ERS)

An ERS is a system providing a positive means of quick release of the transfer system and safe isolation of the gas carrier and transfer system. An ERS normally contains one or several ERC.

1.3.8 Emergency shut down (ESD)

An ESD is a method that stops, in a safely way, the transfer of liquefied gas between the unit and the gas carrier.

1.3.9 Operating envelope

The operating envelope of a transfer system is the volume in which the presentation flange of the transfer line is required to operate.

1.3.10 Technology qualification

A technology qualification is a confirmation by examination that a new technology meets the specified requirements for the intended use. The qualification process is carried out through a set of documented activities to prove that the technology is fit for service.

1.3.11 Presentation flange

A presentation flange is a transfer system's flange for connection to the gas carrier manifold or spool piece.

1.3.12 Spool piece

A spool piece is a reducer or an enlarger fitted on the gas carrier manifold for the purpose of matching the flanges of transfer system and gas carrier.

2 Classification procedure

2.1 General

2.1.1 Classification steps

The classification process related to the additional class notation **liquefied gas transfer** is to be performed through a risk assessment approach based on the requirements of EN 1474-3, [4]. The steps of the procedure are given in Tab 1.

Table 1 : Definition of acceptance criteria for risk analysis and performance standards

No.	Classification step	Performed by the	See
1	Definition of the transfer system	Party applying for classification	[2.2]
2	Definition of Owner's acceptance criteria and performance standards	Owner	[2.3]
3	Definition of limiting conditions for loading/offloading operations	Owner Party applying for classification	[2.4]
4	Risk assessment	Party applying for classification	[2.5]
5	Identification of new technology Qualification program of new technology	Party applying for classification	[2.6]
6	Design studies and/or model tests	Party applying for classification	[2.7]
7	Elaboration of the approval scheme for classification	Society	[2.8]
8	Verification of all approval tasks from the approval scheme	Society	[2.9]
9	Issuance of certificate for the additional class notation **liquefied gas transfer**	Society	–

2.2 Definition of the transfer system

2.2.1 The party applying for classification is to provide a description of the transfer system covering the design, arrangement and operating procedures. Previous applications of the technology, if relevant, are also to be specified.

2.2.2 Available certificates

The Society may accept, for the purpose of the classification, previous certificates relating to the transfer system and/or its components, upon the request of the party applying for classification. These certificates are to be submitted to the Society for examination. Additional documentation and gap analysis may be requested for acceptance. The following types of certificates are generally concerned:

- Concept Approval Certificates of the transfer system or equivalent
- Type Approval Certificates of parts and components of the transfer system.

2.3 Definition of Owner's acceptance criteria and performance standards

2.3.1 Acceptance criteria for risk analysis

The Owner is to define the acceptance criteria establishing the basis for identification of safety critical elements of the transfer system. The criteria are to take into account the probability (or frequency) and consequences of significant major hazards.

The acceptance criteria are to be stated in the Design Criteria Statement.

2.3.2 Performance standards

The Owner is to define the performance standards relating to the transfer system, taking into account the following items:

- applicable legislation and regulations
- industry standards intended to be considered for the classification of transfer system
- overall functional targets and requirements covering different operational phases (see EN 1474-3, [4.3]).

The performance statements may be expressed in both qualitative and quantitative terms.

2.4 Definition of limiting loading conditions for loading/offloading operations

2.4.1 The party applying for classification is to specify the list of limiting conditions for loading/offloading operations, based on the following items:

- Owner requirements
- technological limits defined by the Designer and the manufacturer of the offloading system
- issues of the risk analysis (see [2.5]).

The following parameters are to be defined as a minimum:

- maximum allowable significant wave heights
- limiting specific metocean conditions (wind, current, ice and snow)
- limiting air temperatures for offloading operations
- limiting configurations of gas carrier (manifold position is to be taken into account)
- limiting draughts of the unit for loading/offloading operations
- operating envelopes of the transfer system.

The parameters defining the limiting conditions for loading/offloading operations are to be stated in the Design Criteria Statement.

2.5 Risk assessment

2.5.1 A risk assessment study is to be carried out, as a part of overall assessment of the transfer system. The risk assessment report, complying with the requirements of [2.5.2], is to be submitted to the Society for information.

Generally, the risk assessment study has the following objectives:

- evaluation of the design, taking into account the operational procedures
- determination of limiting conditions for loading/ offloading operations
- assessment of safety and operability of the transfer system through risk assessment techniques.

2.5.2 Risk assessment report

The risk assessment report is to cover at least the following items:

- hazard identification with documentation of techniques
- critical failure mode identification, major hazard accidents
- risk ranking of identified hazards
- identification and categorization of safety critical elements
- definition of performance standards for safety critical elements; Owner's performance standards as per [2.3.2] are to be taken into account
- listing of measures for risk control and mitigation
- risk calculation methodology and assumptions
- record of limiting conditions for loading/offloading operations, to be added to the list of [2.4.1].

2.5.3 Risk assessment methodology

Risk assessment methodology is to be based on the provisions of EN 1474-3, [4.6]. The Society accepts risk analysis based on other recognized standards, such as EN ISO 17776 "Guidelines on tools and techniques for hazard identification and risk assessment".

2.5.4 Detailed follow-up report of actions and mitigation measures taken in response to risk analysis findings is to be submitted to the Society for information.

2.6 Identification and qualification program of new technology

2.6.1 Identification of new technology

The transfer systems covered by the additional class notation **liquefied gas transfer** are generally a combination between known or proven technology and new or unproven technology. The new technology is to be subject to a qualification process.

The identification of new technology is to be carried out based on the provisions of EN 1474-3, [4.4]. A documentation containing the list of the transfer system components categorized as new technology and requiring a qualification process is to be submitted.

2.6.2 Qualification program of new technology

The party applying for classification is to establish and submit a qualification program of new technology. This program is to be performed through a risk approach based on the principles stipulated in EN 1474-3, [5]. Methodological guidelines are provided in NI 525 Risk Based Qualification of New Technology.

Based on the qualification program, the Society is to set-up a list of approval activities, to be included in the approval scheme for classification.

The main tasks of the qualification program are to be clearly identified and documented.

The documentation of the qualification program is to include:

- design description and proposed criteria
- test procedures and reports
- calculation procedures and reports
- correlation analysis reports.

2.7 Design studies and/or model tests

2.7.1 The party applying for classification is to perform and document the technical studies and model tests requested for the approval scheme. The following types of studies and tests are concerned:

- studies and model tests requested by the qualification plan of new technologies
- studies and model tests requested by the design requirements in Article [3]
- studies and model tests requested for the evaluation of performance standards defined for risk analysis.

A detailed documentation is to be submitted to the Society for information.

2.8 Elaboration of approval scheme for classification

2.8.1 The approval scheme for classification is to be established by the Society, based on the documentation provided by the party applying for classification.

The approval scheme is to include the following items:

- approval tasks identified through the risk analysis, in order to check that the performance standards are achieved for each safety critical element
- approval tasks from the design requirements (see Article [3]
- tasks relating to the construction survey, inspections and testing (see Article [4])
- on-site requested inspections, at installations and in service.

2.9 Verification of approval scheme for classification

2.9.1 The Society is to perform the tasks defined through the approval scheme, including the examination of documents, inspections, attendance to tests. The additional class notation **liquefied gas transfer** is assigned to the unit when all the approval tasks are satisfactory fulfilled. Any exception and/or limitation is/are to be stated in the Certificate of Classification.

3 Design requirements

3.1 Dimensions and clearance

3.1.1 Stowed position of side-by-side loading arms

In stowed position, side-by-side loading arms are to be arranged such as no part of the arm extends transversely beyond unit's deck at side.

3.1.2 Clearance study report

The party applying for Classification is to provide a clearance study report, indicating the investigated checkpoints. These ones are to be chosen taking into account the deck and topside layout. The Society may require clearance check in additional checkpoints, based on the examination of the general arrangement drawings.

The clearance study is to take into account the fabrication and erection tolerances specified by the party applying for classification. These tolerance values are to be stated in the Design Criteria Statement.

The clearance study is also to take into account the maximum deformation of the structural elements (see [3.5.10]).

3.1.3 Minimum clearance

The minimum allowable clearances applicable for transfer arms are indicated in Tab 2.

Minimum clearances different from those in Tab 2 may be accepted by the Society, provided a detailed documentation of these values, covering different operating conditions of the transfer system, is submitted to the Society and agreed by the Owner.

For transfer systems other than transfer arms, the Society is to establish the minimum allowable clearances on a case-by-case basis, depending on the system configuration.

Table 2 : Minimum allowable clearances

Description	Minimum clearance
• Between counterweights of operating arms • Between any part of an operating arm and a stowed arm	150 mm
Between any part of an operating arm and any adjacent structure, piping, equipment or part of an adjacent operating arm	300 mm

3.2 Materials

3.2.1 Design temperature

Design temperature of the transfer system elements is to be calculated based on the local environmental conditions (air temperature ranges) and cargo temperature.

A calculation report is to be submitted to the Society. The methods, software and assumptions used for the design temperature calculation are to be documented.

3.2.2 Supporting structures

Steel grades of the supporting structures are to comply with the requirements of Sec 2, [2], applicable for the elements belonging to offshore areas.

3.2.3 Piping and others elements in contact with cargoes

Materials used for piping and other elements conveying cargoes are to comply with the applicable requirements of Ship Rules, Pt D, Ch 9 Sec 6, taking into account the design temperature defined in [3.2.1].

3.3 Model tests and hydrodynamic analysis

3.3.1 In addition to the hydrodynamic analysis required in Sec 3, the combined motions of the unit and gas carrier are to be assessed. This assessment is to be based on the offloading procedure, which is to be submitted to the Society for review.

Generally, model tests are to be performed. The model is to include the unit and the gas carrier, as well as the mooring and fendering system and the anchoring system.

For side-by-side configuration, model tests are requested to determine the shielding effect for wind and current coefficients and the damping due to the close proximity of the units.

Direct calculations through numerical methods may be accepted by the Society provided that the following items are at the satisfaction of the Society:

- model of area between the unit and the gas carrier
- model of mooring lines, anchoring and fenders
- choice of heave damping and roll damping parameters.

3.3.2 Reporting

A detailed report is to be submitted to the Society for review. The testing procedures and the methods used for the extrapolation to full scale data are to be documented. In case of numerical calculations, the software, methodology and choice of the parameters are to be documented.

3.3.3 Design conditions

The design conditions for model tests and/or hydrodynamic analysis are to consider the maximum allowable significant wave heights and the specific metocean conditions beyond which any transfer of the cryogenic product is to be stopped.

Design conditions are to be established based on the limiting conditions for loading/offloading operations specified by the Owner.

All mooring configurations are to be investigated.

At least three loading configurations are to be investigated, as given in Tab 3.

Table 3 : Minimum loading configurations

Floating gas unit	Gas carrier (shuttle carrier)
Full loaded	Ballasted
Ballasted	Full loaded
Relevant intermediate filling	Relevant intermediate filling

3.3.4 Design parameters

Model tests and/or hydrodynamic analysis are/is to result in the following parameters, relevant for the assessment of the transfer system and the mooring and anchoring system:

- relative motions between unit and gas carrier
- absolute accelerations in the three directions
- tension in mooring lines
- tension in anchoring lines
- general motions of the coupled system (unit and gas carrier).

3.4 Design loads for the structural elements

3.4.1 Lightweight

The lightweight is to include the weight of the components with all their permanently attached equipment.

The lightweight of all the components of the transfer system is to be calculated based on the material densities specified by the Designer.

3.4.2 Cargo load

The cargo load is the weight of cargo conveyed by the transfer system in operating conditions. The cargo load is to be calculated based on the density of cargo specified by the Designer.

3.4.3 Design pressure

The design pressure for each component conveying cargoes or cargo vapours is to be specified by the Designer. When the design pressure is obtained through calculations or a model test, the corresponding calculation or test report is to be submitted to the Society for information.

3.4.4 Ice accumulation

Ice accumulation on components of the transfer system is to be taken into account for the calculation of weight and wind loads. The following amounts of ice accumulation are to be considered:

- 25 mm on components conveying cargoes, in operating conditions
- 6 mm on components not conveying cargoes, in operating conditions and for transfer systems operating in cold regions
- 6 mm on all components in stowed condition, for transfer systems operating in cold regions.

3.4.5 Wind loads

The wind loads acting on the transfer system are to be calculated for the worst directions.

The wind velocity is to be taken as the design wind speed at 10 m above the sea level, as a 3-second gust speed.

For stowed condition, a 100-year return period wind velocity is to be considered for calculations.

For operating conditions, the wind velocity is to correspond to the probability level of limiting conditions for loading/offloading operations (see [2.4]).

The wind force may be determined through wind tunnel tests on a representative model of the transfer system. When tunnel tests are not available, the wind force is to be calculated using the methodology given in ISO 16904, [5.2.3.8].

3.4.6 Thermal loads

The thermal loads caused by material temperature differences are to be taken into account for the assessment of structural elements. The temperature differences for each structural element are to be established by the Designer and approved by the Society. The following data are to be taken into account:

- design temperature, as defined in [3.2.1]
- ambient air temperature
- cargo liquid or vapour temperature, when relevant
- ice accumulation, when relevant
- solar radiation.

These temperatures are to be applied in the most extreme combination.

3.4.7 Accelerations and relative motions

The accelerations and relative motions between the unit and the gas carrier during loading/offloading operations are to be applied on structural elements of the transfer system in the most severe combination.

The values of accelerations and relative motions are to be obtained through model tests and/or hydrodynamic analysis, as required in [3.3].

3.4.8 Pressure load test

Structural elements conveying cargoes or cargo vapours are to be subject to hydrostatic testing. The test pressure is to be taken as 1,5 times the design pressure defined in [3.4.3].

3.5 Structural design assessment

3.5.1 Load conditions

The following types of load conditions are to be investigated through a structural analysis:

- stowed condition
- operating conditions (see [3.5.2])
- maintenance conditions
- hydrostatic test
- accidental conditions (see [3.5.3]).

Additional load conditions may be requested by the Society, based on the issues of the risk analysis report.

3.5.2 Operating conditions

For transfer systems using transfer arms, the operation conditions include:

- luffing and slewing for normal operations and manoeuvring into the maintenance position
- free wheel mode
- control mode during connection
- control mode after connection
- connection and disconnection of quick connect/disconnect coupler (QCDC)
- operation of the ERS including automatic raise and retract of the arms behind the berthing line
- manoeuvring following ERS operation taking into account:
  - full outboard arm just above the horizontal position, for draining
  - full and empty transfer arm in stowed position
  - full and empty transfer arm at the connected position, for ERC reconnection.

3.5.3 Accidental load conditions

The accidental load conditions are to be identified based on the issues of the risk analysis report and taking into account the major hazard accidents relating to the transfer system and the risk assessment of each hazard.

3.5.4 Load combinations

For transfer systems using transfer arms, the load cases and combinations to be considered, as a minimum, through the structural analysis are given in Tab 4. The Society may require the analysis of additional load cases, taking into account the specificities of design and operation of the loading/offloading system under investigation.

For transfer systems other than those based on transfer arms, the load cases are to be established on a case-by-case basis, taking into account the operational procedure.

3.5.5 Structural criteria

The assessment of structural members of the transfer system is to be carried out as follows:

- calculation of equivalent stresses using linear elastic material behaviour, for all the load cases defined in [3.5.4]; the equivalent stress is defined in Pt B, Ch 3, Sec 3, [5.3] of the Offshore Rules.

  Calculation methods are to be at the satisfaction of the Society.

- the equivalent stress σ_c, in N/mm^2, is to satisfy the following condition:

  $\sigma_c \leq K\, R_f$

  where:

  K : Factor of allowable stress, as given in Tab 4

  R_f : Reference allowable stress, in N/mm^2, as defined in [3.5.6].

3.5.6 Reference allowable stress

The reference allowable stress of material R_f, in N/mm^2, is defined by:

$$R_f = \mathrm{Min}\left(\frac{R_{eG}}{1,5}\,;\frac{R}{f_m}\right)$$

where:

R_{eG} : Minimum specified yield stress of the material, in N/mm^2

R : Ultimate tensile strength of the material, in N/mm^2

f_m : Material factor to be taken equal to:

- 3,0 for austenitic steels
- 2,5 for ferritic steels.

Table 4 : Load cases and associated factor of allowable stress

Load case No.	Loading condition	Load combination	Factor K of allowable stress
1	Stowed condition	• Lightweight • Wind load in stowed position (10 years) • Maximum accelerations from unit's motions at 100-year return period, in the worst directions • Ice accumulation for cold regions, in stowed position	1,2 **(1)**
2	Stowed condition	• Lightweight • Wind load in stowed position (100 years) • Maximum accelerations from unit's motions at 10-year return period, in the worst directions • Ice accumulation for cold regions, in stowed position	1,2 **(1)**
3	Operations - Manoeuvring **(2)**	• Lightweight • Wind loads in operating positions, as requested in [3.4.5] • Maximum accelerations from unit's motions for limiting operation conditions, in the worst directions • Ice accumulation for cold regions, in operating conditions	0,9
4	Operations - Connected, empty	• Lightweight • Wind loads in operating positions, as requested in [3.4.5] • Maximum accelerations from unit's motions for limiting operation conditions, in the worst directions • Ice accumulation for cold regions, in operating conditions	0,8
5	Operations - Connected, with cargo transfer	• Lightweight • Wind loads in operating positions, as requested in [3.4.5] • Maximum accelerations from unit's motions for limiting operation conditions, in the worst directions • Cargo load, as stated in [3.4.2] • Design pressure on elements conveying cargoes and cargo vapours • Ice accumulation for elements conveying cargoes and for cold regions, in operating conditions	0,8
6	Operations - Connected, with cargo transfer	• Lightweight • Wind loads in operating positions, as requested in [3.4.5] • Maximum accelerations from unit's motions for limiting operation conditions, in the worst directions • Cargo load, as stated in [3.4.2] • Design pressure on elements conveying cargoes and cargo vapours • Ice accumulation for elements conveying cargoes and for cold regions, in operating conditions • Thermal loads, as stated in [3.4.6]	1,5
7	Operations - Emergency release, empty **(3)**	• Lightweight • Wind loads in operating positions, as requested in [3.4.5] • Maximum accelerations from unit's motions for limiting operation conditions, in the worst directions • Ice accumulation for elements conveying cargoes and for cold regions, in operating conditions	1,1

(1) The Society may accept, on a case-by-case basis, different return periods for the combination of wind and wave loads, based on the examination of metocean data relating to the unit's site.

(2) This load case is to be applied for all the relevant positions (attitudes) of the transfer system during manoeuvring.

(3) All the positions (attitudes) for emergency release are to be considered.

(4) This load case is to be considered only when the full outboard position just above the horizontal, for draining, is stated in the emergency release procedure.

(5) When the hydrostatic test is performed with a testing fluid different from the cargo, the testing fluid density is to be used for the load calculations.

Load case No.	Loading condition	Load combination	Factor K of allowable stress
8	Operations - Emergency release, full **(3)**	• Lightweight • Wind loads in operating positions, as requested in [3.4.5] • Maximum accelerations from unit's motions for limiting operation conditions, in the worst directions • Cargo load, as stated in [3.4.2] • Design pressure on elements conveying cargoes and cargo vapours • Ice accumulation for elements conveying cargoes and for cold regions, in operating conditions	1,1
9	Operations - Manoeuvring after emergency release, full outboard arm just above horizontal for draining **(4)**	• Lightweight • Wind loads in operating positions, as requested in [3.4.5] • Maximum accelerations from unit's motions for limiting operation conditions, in the worst directions • Cargo load, as stated in [3.4.2] • Ice accumulation for elements conveying cargoes and for cold regions, in operating conditions	1,1
10	Operations - Manoeuvring after emergency release, full transfer arm in stowed position	• Lightweight • Wind loads calculated for limiting operation conditions, for stowed position of the transfer system • Maximum accelerations from unit's motions for limiting operation conditions, in the worst directions • Cargo load, as stated in [3.4.2] • Design pressure on elements conveying cargoes and cargo vapours • Ice accumulation for elements conveying cargoes and for cold regions, in operating conditions	1,1
11	Maintenance	• Lightweight • Wind loads for maintenance conditions • Maximum accelerations from unit's motions for limiting maintenance conditions, in the worst directions	0,9
12	Hydrostatic test	• Lightweight • Wind loads for testing position, for limiting operation conditions • Maximum accelerations from unit's motions for limiting operation conditions, in the worst directions • Cargo load, as stated in [3.4.2] **(5)** • Pressure load test, as stated in [3.4.8] • Ice accumulation, if relevant	1,3

(1) The Society may accept, on a case-by-case basis, different return periods for the combination of wind and wave loads, based on the examination of metocean data relating to the unit's site.

(2) This load case is to be applied for all the relevant positions (attitudes) of the transfer system during manoeuvring.

(3) All the positions (attitudes) for emergency release are to be considered.

(4) This load case is to be considered only when the full outboard position just above the horizontal, for draining, is stated in the emergency release procedure.

(5) When the hydrostatic test is performed with a testing fluid different from the cargo, the testing fluid density is to be used for the load calculations.

3.5.7 Local stress

The local stresses obtained through finite element models with very fine mesh or local thermal stresses are to be examined by the Society on a case-by-case basis.

In any case, the local equivalent stress σ_{c-L}, in N/mm^2, is to comply with the following criterion:

$$\sigma_{c-L} \leq 2\, R_{eG}$$

where:

σ_{c-L} : Local equivalent stress from stress concentration regions, obtained with very fine meshes or local thermal stresses

R_{eG} : As defined in [3.5.6].

More stringent requirements may be requested by the Society, based on the examination of the related structural details.

3.5.8 Buckling

The structural elements under predominantly compressive stress are to be checked, as needed, using recognized methods to the satisfaction of the Society.

The stresses in structural elements are to satisfy the following criteria:

a) When the relevant mode of failure can be described by a single stress component, the stress σ, in N/mm^2, is not to exceed the critical stress for the load case considered, according to the following formula:

$\sigma \leq 0,5\ R_c$

where:

R_c : Critical stress, in N/mm^2, for the relevant mode of failure.

b) When the failure can result from the combination of several modes, the stress components σ_i are to satisfy the following criteria:

$\sigma_i \leq 0,5\ R_{ci}$

and, simultaneously:

$f\ (\sigma_i / 0,5\ R_{ci}) \leq 1$

where:

R_{ci} : Critical stress for the stress component σ_i, in N/mm^2

f : Suitable interaction equation.

3.5.9 Fatigue behaviour

Fatigue behaviour of the structural elements is to be verified as requested in EN 1474-3, [6.6]. The fatigue analysis is to be performed in compliance with the relevant requirements of Pt B, Ch 3, Sec 3, [7] of the Offshore Rules.

Except when otherwise specified by the party applying for classification, the design fatigue life is to be taken at least equal to the design service life of the unit.

3.5.10 Maximum deformation

Maximum deformations of structural elements obtained through the structural analysis are to be taken into account for the clearance study, as requested in [3.1.2] and [3.1.3].

3.5.11 Alternative criteria

The structural criteria given in NR526 Rules for the Classification and the Certification of Cranes onboard Ships and Offshore Units may be used for the purpose of transfer system assessment, on a case-by-case basis, provided that:

- the structural elements of the transfer system are similar to the lifting appliances covered by NR526
- the loading patterns of the transfer system are similar to those defined in NR526 for lifting appliances.

3.6 Mooring and fendering equipment

3.6.1 General

As specified in [1.2.1], for units assigned with notation **liquefied gas transfer**, the mooring and fendering equipment related to the offloading operation between the unit and the gas carrier are in the scope of classification.

The description and structural arrangement of the mooring and fendering equipment are to be submitted to the Society.

3.6.2 Design loads

The design conditions to be investigated are stated in [3.3.3].

For calculations of the wave drift loads, the interaction with the gas carrier is to be considered in the calculation of the Quadratic Transfer Function, through model tests or hydrodynamic analysis.

3.6.3 Mooring analysis

Time domain mooring analysis is to be performed in order to assess the design of mooring lines and fendering system. The anchoring system is to be a part of the analysis.

Regarding the methods of evalutation to be used for the design, a great care is to be paid to the compliance with the required assumptions. The NR493 Classification of Mooring Systems for Permanent and Mobile Offshore Units describes the different available methods and their assumptions.

The design conditions to be investigated are stated in [3.3.3].

3.6.4 Hawser minimum breaking load

In this Article, the minimum breaking load (MBL) to be used for hawser is the certified new wet breaking load.

3.6.5 Side-by-side configuration

As stated in [3.3], model tests are to be performed in order to determine the shielding effect for wind and current coefficients and the damping due to the close proximity of the units. Both intact and damaged conditions of the mooring system are to be assessed.

The safety factors for hawsers are to be as per NR493 Classification of Mooring Systems for Permanent and Mobile Offshore Units, Sec 3.

3.6.6 Tandem configuration

The mooring system for tandem configuration is to comply with the relevant requirements regarding hawser mooring system and line attachment structures of NR494 Rules for the Classification of Offshore Loading and Offloading Buoys.

3.7 Release mooring hooks

3.7.1 When quick release mooring hooks are provided, gravity-based release mechanisms are not acceptable.

3.7.2 In case a remote release system is provided, the failure of a single component or of electrical power is not to result in the release of the mooring hooks.

3.7.3 Release mooring hooks are to be designed to be able to move in both vertical and horizontal planes.

3.7.4 Release mooring hooks are to be designed to release independently of each other.

3.7.5 The safe working load (SWL) of a quick release hook is defined as being equal to 60% of the minimum breaking load (MBL) of the mooring line.

3.7.6 The quick release hooks are to be capable of releasing the mooring lines, whether slack or under full SWL.

3.7.7 Release mooring hooks are to be tested to the following loads:

- proof load test: at 1,25 times the SWL
- release test: at the SWL.

3.7.8 Release mooring hooks are to be designed to withstand the mooring lines when loaded to the SWL and to the proof load.

3.7.9 The hook strength is to be documented by appropriate calculations, in accordance with the provisions of the Offshore Rules, Pt B, Ch 3, Sec 3.

Release mooring hooks are to be designed to withstand the loads specified in [3.7.7], and the allowable stress factor α to be considered for the strength criteria is as follows:

- for the safe working load ("static"): $\alpha = 0,6$
- for the proof load ("testing"): $\alpha = 0,9$

3.7.10 The SWL of the quick release hooks, expressed in tonnes, is to be clearly marked on each hook by weld bead outline, in such a location that it is always easily readable by the unit operators during any operation of the hook.

3.8 Winches

3.8.1 On-board winches may be of different drive type (hydraulic, electric, or steam) and of different control type (automatic or manual tensioning).

This sub-article gives specific strength requirements.

Note 1: Additional guidance regarding the winch design is provided in the OCIMF Mooring Equipment Guideline 4th Edition (MEG4).

3.8.2 Rated pull

The rated pull is the pull that the mooring winch is able to develop at the rated speed on the outer layer.

The rated speed is the speed able to be maintained with the rated pull applied to the mooring line. The rated speed in combination with the rated pull determines the power requirement for the winch drive.

3.8.3 Brake holding load

The brake holding load is to be taken equal to 60% of the line MBL.

3.8.4 Winch components

Winch frames, foundations, drums, shafts, bearings and brakes are to be designed to withstand the line when loaded at the design loads defined in Tab 5.

Strength of the winch components is to be documented by appropriate calculations, in accordance with the provisions of the Offshore Rules, Part B, Chapter 3.

The basic allowable stress factors to be considered (see the Offshore Rules, Pt B, Ch 3, Sec 3, [5.4.2] are defined in Tab 5.

Table 5 : Design loads and strength criteria

Mooring winch components	Design loads	Allowable stress factor α
Frames and foundations	MBL	0,8
Drums, shafts and bearings	MBL	0,8
Brakes	80% of MBL	0,8

3.8.5 Marking of winch

The MBL of the mooring line, expressed in tonnes, is to be clearly marked on each winch by weld bead outline, in such a location that it is always easily readable by the unit operators during any operation of the winch.

3.9 Mooring fittings

3.9.1 Fittings, such as fairleads, bitts or bollards (list not exhaustive), may also be part of the mooring system.

Design specifications and documentation of these fittings, if any, are to be submitted to the Society for review.

3.9.2 The fittings are to be designed to withstand a load corresponding to the mooring line MBL, taking account of the mooring line entry and exit directions, as defined in Fig 1.

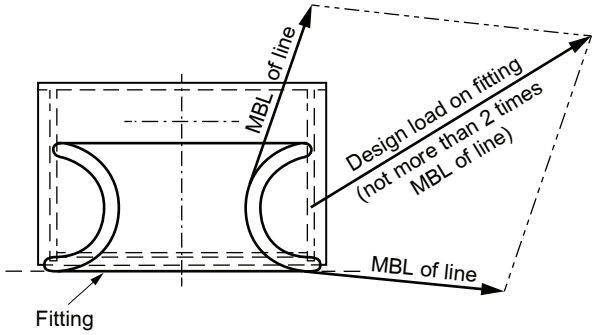
In case several mooring line arrangements are possible for a fitting, the one leading to the maximum resultant load on the fitting is to be considered.

Fitting strength is to be documented by appropriate calculations, in accordance with the provisions of Offshore Rules, Pt B, Ch 3, Sec 3.

Note 1: Additional guidance regarding strength of the mooring fittings is provided in the OCIMF Mooring Equipment Guideline 4th Edition (MEG4).

3.9.3 Each mooring fitting is to be marked with the MBL of the mooring line.

Figure 1 : Example of mooring component arrangement



3.10 Transfer line

3.10.1 Unless otherwise specified by the Owner, the transfer line conveying cargo is to be sized for a maximum cargo speed of 12 m/s. Local higher speeds may be accepted, provided the cavitation and vibration effects are acceptable, at the satisfaction of the Society.

3.10.2 Pressure loss curves for cargo line and return vapour line are to be assessed and accepted by the Owner.

3.10.3 For transfer system using flexible hoses, the transfer line is to be designed in accordance with the requirements of EN 1474-2, [5].

3.11 Swivel joints and structural bearings

3.11.1 The swivel joints and structural bearings are to comply with the relevant requirements of ISO 16904. The relative motions between the fixed parts of the transfer system, on the unit, and the gas carrier manifold are to be considered for the assessment of the structural bearings.

3.12 Embrittlement protection

3.12.1 The piping and structural elements which could be affected by cargo leakage are to be protected from brittle fracture. The protection is to be achieved by:

- an appropriate material selection
- an insulation with a material protecting the equipment or element from the cold shock.

3.13 Other design requirements

3.13.1 References

As stated in [1.1.4], the design requirements stated in ISO 16904 and EN 1474 are adopted for the purpose of the classification. References to the relevant requirements of ISO 16904 and EN 1474 are given in Tab 6.

Table 6 : Design requirements

Design aspect	Reference
Connecting/disconnecting devices	EN 1474-3, [6.9]
Communications, evacuation and rescue	EN 1474-3, [6.11]
Safety systems	EN 1474-3, [7] ISO 16904, [6] **(1)**
Flexible hoses	EN 1474-2
Pipework and fittings	ISO 16904, [5.6]
Welding	ISO 16904, [5.7]
Accessories	ISO 16904, [5.5]
Monitoring, alarm and shut-down systems	EN 1474-3, [7.4] ISO 16904, [6.3]
Electrical safety	ISO 16904, [6.5.2]
Hydraulic and electric control system	ISO 16904, [8]
QCDC system	ISO 16904, [7] EN 1474-3, [8]
Corrosion protection and embrittlement protection	ISO 16904, [5.8] EN 1474-3, [6.12]
(1) See also Sec 13	

4 Inspections and testing

4.1 General

4.1.1 The following types of inspection and testing are requested for the purpose of the classification of the transfer systems using transfer arms:

- prototype testings
- manufacturing
- factory acceptance tests
- site acceptance tests.

For each of them, the Society will issue relevant inspection certificates or release notes.

4.2 Prototype testing

4.2.1 Prototype testing requested for the classification of the transfer systems using transfer arms is given in Tab 7.

Table 7 : Prototype testing

Item	Test and reference
Swivels	ISO 16904, [9.2.2]
ERS	ISO 16904, [9.2.3]
QCDC	ISO 16904, [9.2.4]

4.3 Manufacturing

4.3.1 Tests relating to manufacturing are given in Tab 8.

Table 8 : Manufacturing tests

Item	Test and reference
Materials	ISO 16904, [9.3.2]
Non-destructive testing	• radiographic examination of welds: ISO 16904, [9.3.4.1] • penetrant inspection of welds: ISO 16904, [9.3.4.2] • pressure testing: ISO 16904, [9.3.6]
Insulation flange	ISO 16904, [9.3.9]

4.4 Factory acceptance tests

4.4.1 Factory acceptance tests are to be performed in accordance with ISO 16904, [9.4].

4.5 Site acceptance tests

4.5.1 Site acceptance tests are to be performed in accordance with ISO 16904, [9.5].

4.6 Additional requirements

4.6.1 Additional requirements for inspection and testing of transfer systems are given in EN 1474-3, [10].

4.7 Inspection and tests of transfer systems using flexible hoses

4.7.1 Inspection and tests of the transfer systems using flexible hoses are given in EN 1474-2, [6]. The following types of tests are covered by the referenced requirements:

- laboratory testing
- prototype hose testing
- factory acceptance tests
- system testing.

Section 15 Piping Systems

1 General

1.1 Application

1.1.1 For all the units covered by this Rule Note, piping systems are to comply with:

- the relevant requirements of, and other documents referred to in, Pt C, Ch 1, Sec 7 of the Offshore Rules
- the relevant requirements of Pt D, Ch 1, Sec 18 of the Offshore Rules.

1.1.2 In addition, production piping systems are to comply with the applicable requirements of NR459 Process Systems Onboard Offshore Units and Installations.

1.1.3 For units assigned the service notation(s) **liquefied gas storage**, the relevant requirements of IGC Code relating to process and cargo piping are also to be complied with.

Interpretations of IGC Code and additional requirements mandatory for class are given in Article [2].

1.2 Definitions

1.2.1 Cargo piping

Cargo piping means:

- all the piping components downstream of the last flange from production equipment (liquefaction plant, if applicable, is considered as production equipment)
- piping components for gas loading/offloading, if applicable

1.2.2 Production piping

Production piping means all the piping components upstream of the last flange from production equipment (liquefaction plant included).

1.3 Alternative requirements

1.3.1 As an alternative to the requirements of [1.1], the Society may accept recognized codes and standards, as listed in [1.3.2], based on the principle of equivalence specified in Pt A, Ch 1, Sec 1, [2.3] of the Offshore Rules.

1.3.2 Examples of recognized codes and standards:

- EN 1473 “Installations and equipment for liquefied natural gas - Design of onshore installations”
- NFPA 59A “Standard for the production, storage and handling of Liquefied Natural Gas (LNG)”
- NFPA 59 “Standard for the storage and handling of Liquefied Petroleum Gases at utility gas plants”
- API RP 14E “Design and Installation of Offshore Production Piping Systems”
- API RP 521 “Pressure-Relieving and Depressuring Systems”
- API Spec. 6H “End Closures, Connectors and Swivels”
- ASME B31.3 “Chemical Plant and Petroleum Refinery Piping”
- BS 3351 “Piping Systems for Petroleum Refineries and Petrochemical Plants”.

1.4 Separation of systems

1.4.1 Piping systems carrying non-hazardous fluids are generally to be separate from piping systems which may contain hazardous fluids. Cross connection of the piping systems may be permitted where means for avoiding possible contamination of the non-hazardous fluid system by the hazardous fluid are provided.

2 Cargo pipings of units with service notation liquefied gas storage

2.1 General

2.1.1 Cargo pipings are to comply with the applicable requirements of Pt C, Ch 1, Sec 7 of the Offshore Rules for class I pressure piping, unless otherwise specified in IGC Code or in this Article.

2.1.2 Provisions for protection of piping against thermal stress

Expansion joints are to be protected from extensions and compressions greater than their allowable limits and the connected piping is to be suitably supported and anchored. Bellow expansion joints are to be protected from mechanical damage.

2.1.3 Pressure relief valve setting

Pressure relief valves are to be set to discharge at a pressure not greater than the design pressure such that the overpressure during discharge does not exceed 110% of the design pressure.

2.1.4 Protection against leakage

Where the piping system is intended for liquids having a boiling point lower than –30°C, permanent means to avoid possibility of contact between leaks and hull structures are to be provided in all those locations where leakage might be expected, such as shore connections, pump seals, flanges subject to frequent dismantling, etc.

2.1.5 Means to detect the presence of liquid cargo

The means to detect the presence of liquid cargo in the vent system, as required in Pt D, Ch 9, Sec 5 [2.2.4] of the Ship Rules, may be constituted by electrical level switches with intrinsically safe circuit. The alarm signals given by the level switches are to be transmitted to the cargo control station.

2.1.6 Connections of relief valve discharges to cargo tanks

The connections, if any, between the cargo tanks and the relief valve discharges fitted on the liquid phase cargo piping are not to be fitted with shut-off valves, but are to be provided with non-return valves in the proximity of the tanks.

2.1.7 Centrifugal pumps

Overpressure relief valves on cargo pumps may be omitted in the case of centrifugal pumps having a maximum delivery head, the delivery valve being completely closed, not greater than the one permitted for the piping.

2.1.8 Type approval

The piping components mentioned in Article [2] are subject to a type approval by the Society.

2.2 Design pressure

2.2.1 The definition of design pressure for piping is provided in Offshore Rules Pt C, Ch 1, Sec 7, [1.3.2], item a).

The design pressure P is to be taken as per the requirements of Ship Rules, Pt D, Ch 9, Sec 5, [4].

2.3 Scantlings based on internal pressure

2.3.1 Piping subjected to green seas

For piping subjected to green seas, the design pressure P, as defined in [2.2], in the formula given in Pt D, Ch 9, Sec 5, [4] of the Ship Rules is to be replaced by an equivalent pressure P' taken equal to:

$$P' = \frac{1}{2}\left(P + \sqrt{P^2 + 6R'K\frac{D_C}{D}}\right)$$

where:

R' : Drag, in N/mm^2, corresponding to the effect of green seas, as given in Tab 1, and depending on the location of the pipes and their height H above the deepest load line. Intermediate values are to be determined by linear interpolation

K : Allowable stress, in N/mm^2, equal to:

$K = \text{Min}\ (R/2{,}7\ ;\ R_e/1{,}8)$

with:

R : Specified minimum tensile strength at room temperature, in N/mm^2

R_e : Specified minimum yield stress at room temperature, in N/mm^2. If the stress-strain curve does not show a defined yield stress, the 0,2% proof stress applies

D : External pipe diameter, in mm

D_C : External pipe diameter taking into account the insulation, in mm, the thickness of which is to be taken at least equal to:

- 40 mm if $D \leq 50$ mm
- 80 mm if $D \geq 150$ mm

Intermediate values are to be determined by linear interpolation.

2.4 Flanges not complying with standards

2.4.1 For flanges not complying with a standard, the dimensions and type of gaskets are to be to the satisfaction of the Society.

2.5 Stress analysis

2.5.1 Calculations in accordance with recognised standards

When required, the stress analysis is to be carried out according to this sub-article. Subject to this condition, calculations in accordance with recognised standards are admitted by the Society.

Table 1 : Drag R', in N/mm^2, corresponding to the effect of green seas

External pipe diameter **(1)**	Aft of the quarter of the unit's length			Forward of the quarter of the unit's length		
	H ≤ 8 m	H = 13 m	H ≥ 18 m	H ≤ 8 m	H = 13 m	H ≥ 18 m
≤ 25 mm	0,015	0,0025	0,0015	0,022	0,0035	0,0015
50 mm	0,014	0,0025	0,0015	0,020	0,0035	0,0015
75 mm	0,011	0,0025	0,0015	0,016	0,0035	0,0015
100 mm	0,007	0,0025	0,0015	0,007	0,0035	0,0015
≥ 150 mm	0,005	0,0025	0,0015	0,007	0,0035	0,0015

(1) To be taken equal to D_C if the pipe is insulated, D otherwise.

Note 1:

H : Pipe height, in m, above the deepest load line.

2.5.2 Calculation cases

The calculations are to be made for every possible case of operation, but only those leading to the most unfavourable results are required to be submitted.

2.5.3 Loads to be taken into consideration

The calculations are to be carried out taking into account the following loads:

a) for piping not subjected to green seas:
- pressure
- weight of the piping and of the internal fluid
- contraction

b) for piping subjected to green seas:
- pressure
- weight of the piping and of the internal fluid
- green seas
- contraction
- unit motion accelerations.

2.5.4 Green sea directions

When green seas are considered, their effects are to be studied, unless otherwise justified, in the following three directions:

- the longitudinal axis of the unit
- the vertical direction
- the horizontal direction, perpendicular to the longitudinal axis of the unit. The load on the pipes is the load R' defined in [2.3.1].

2.5.5 Thermal stress

The stress intensity is to be determined from the formulae given in Pt C, Ch 1, Sec 7, [2.4.2] of the Offshore Rules for pipes intended for high temperatures:

a) for primary stresses, resulting from:
- pressure
- weight
- green seas

b) for primary stresses and secondary stresses, resulting from:
- contraction.

2.5.6 Stress intensity limits

The stress intensity is to be limited to:

- for item a) of [2.5.5]: the lower of 0,8 R_e and 0,4 R_m
- for item b) of [2.5.5]: the lower of 1,6 R_e and 0,8 R_m.

2.5.7 Piping with expansion devices

The characteristics of piping fitted with expansion devices are to be submitted to the Society. Where these characteristics are such that the forces and moments at the ends of the devices are negligible for the contraction they are to absorb, the calculation of the loads due to contraction in the corresponding piping is not required. However, it is to be checked that the stress intensity corresponding to the primary stresses does not exceed the limits given in [2.5.6].

2.5.8 Local stresses

Particular attention is to be paid to the calculation of local stresses in the assemblies subjected to axial forces and bending moments. The Society reserves the right to request additional justifications or local strengthening where considered necessary.

2.6 Aluminised pipes

2.6.1 Aluminised pipes may be fitted in ballast tanks, in inerted cargo tanks and, provided the pipes are protected from accidental impact, in hazardous areas on open deck.

2.7 Cargo system valving

2.7.1 Cargo tank connections for gauging

The requirements in Pt D, Ch 9, Sec 5, [5.3.2] of the Ship Rules, relevant to cargo tank connections for pressure gauges and measuring devices, do not apply to tanks with an MARVS not exceeding 0,07 MPa.

2.7.2 Emergency shutdown - Clarification on location of fusible elements

The cargo stations, in way of which the fusible elements mentioned in Pt D, Ch 9, Sec 18, [3.3.2] of the Ship Rules are to be fitted, are to be intended as the loading and unloading manifolds.

2.8 Cargo transfer methods

2.8.1 Discharge into common header

When two or more pumps located in different cargo tanks are operating at the same time, discharging into a common header, the stopping of the pumps is to activate an alarm at the centralised cargo control location.

2.9 Bonding

2.9.1 Static electricity

To avoid the hazard of an incentive discharge due to the build-up of static electricity resulting from the flow of the liquid/gas/vapours, the resistance between the hull of the unit and any point on the surface of the cargo and slop tanks, piping systems and equipment is not to be greater than 10^6 Ω.

3 Production piping intended to carry liquefied gas or liquefied gas vapours

3.1 General

3.1.1 Production piping intended to carry liquefied gas or liquefied gas vapours are to comply with the requirements from [2.1.2] to [2.1.4].

3.1.2 Stress analysis

When the design temperature is –110°C or less, a complete stress analysis, taking into account all the stresses due to the weight of pipes, including acceleration loads if significant, internal pressure, thermal contraction and loads induced by hogging and sagging of the unit is to be submitted to the Society for each branch of the piping system.

For temperatures above –110°C, the Society may require a stress analysis in relation to matters such as the design or stiffness of the piping system and the choice of materials.

In any case, consideration is to be given to the thermal stresses, even though calculations are not submitted. The analysis may be carried out according to a recognized standard.

Section 16 Use of Cargo as Fuel

1 General

1.1 Application

1.1.1 This Section addresses the design of machinery fuelled with process gas, as well as the arrangement of the spaces where such machinery is located.

1.2 General references

1.2.1 The requirements of documents referenced in Tab 1 are to be complied with. For any conflict between referenced requirements, the Society is to be consulted for clarification.

Table 1 : General references

Reference	Comments
Pt C, Ch 1, App 2 of Ship Rules	Addresses the design and installation of dual fuel engines using low pressure gas
Pt D, Ch 1, Sec 19 of the Offshore Rules	Provides additional requirements for the use of gas as fuel
Relevant requirements of IGC Code, as amended	The interpretations of IGC Code given in Pt D, Ch 9, Sec 16 of the Ship Rules are also to be taken into account

Section 17 Electrical Installations

1 General

1.1 Application

1.1.1 The requirements of this Section apply in addition to the relevant requirements of Part C, Chapter 2 of the Offshore Rules.

1.1.2 For units assigned the service notation(s) **liquefied gas storage** and/or **gas liquefaction**, the requirements of IGC Code, as amended, relating to electrical installations are to be complied with.

This Section supplements generally the requirements of IGC Code, including additional requirements and interpretations of IGC Code, which are to be considered mandatory for class.

1.1.3 In case of conflict between the rules, codes and standards referenced in this Section, the Society is to be consulted for clarification.

1.2 Documentation to be submitted

1.2.1 In addition to the documentation requested in Pt C, Ch 2, Sec 1, Tab 1 of the Offshore Rules, the following documents are to be submitted for approval:

a) plan of hazardous areas

b) document giving details of cable types and safety characteristics of the equipment installed in hazardous areas

c) diagrams of tank level indicator systems, high level alarm systems and overflow control systems, where requested.

1.3 Earth detection

1.3.1 Monitoring of circuits in hazardous areas

The devices intended to continuously monitor the insulation level of all the distribution systems are also to monitor all the circuits, other than the intrinsically safe circuits, connected to the apparatus in hazardous areas or passing through such areas. An audible and visual alarm is to be given, at a manned position, in the event of an abnormally low level of insulation.

1.4 Mechanical ventilation of hazardous spaces

1.4.1 Electric motors driving fans of the ventilating systems of hazardous spaces are to be located outside the ventilation ducting.

1.4.2 Motors driving ventilating fans may be located within the ventilation duct, provided they are of a certified safe type and arranged with an additional enclosure (having a degree of protection of at least IP 44) which prevents the impingement of the ducted air stream upon the motor casing.

1.4.3 The materials used for the fans and their housing are to be in compliance with Pt C, Ch 4, Sec 1, [3.6.9] of the Offshore Rules.

1.4.4 Cargo compressor rooms and other enclosed spaces which contain cargo-handling equipment, and similar spaces in which work is performed on the cargo, may be fitted with mechanical ventilation systems, capable of being controlled from outside such spaces.

1.4.5 Provisions are to be made to ventilate the spaces defined in [1.4.4] prior to entering the compartment and operating the equipment.

1.5 Electrical installation precautions

1.5.1 Precautions against inlet of gas or vapours

Suitable arrangements are to be provided, to the satisfaction of the Society, so as to prevent the possibility of gas or vapours passing from a gas-dangerous space to another space through runs of cables or their conduits.

2 Hazardous locations and types of equipment

2.1 Electrical equipment permitted in gas-dangerous spaces and zones

2.1.1 In order to facilitate the selection of appropriate electrical apparatus and the design of suitable electrical installations, hazardous areas are divided into zones (0, 1 and 2) according to the definitions given in Sec 11, [1.2.4]. The different spaces are to be classified according to Sec 12, Tab 1.

The types of electrical equipment permitted, depending on the zone where they are installed, are specified in Pt C, Ch 2, Sec 15 of the Offshore Rules.

2.1.2 A space separated by a gastight boundary from an hazardous area may be classified as zone 0, zone 1, zone 2 or considered as non hazardous space, taking into account the sources of release inside that space and its conditions of ventilation.

2.1.3 Access doors and other openings are not to be provided between an area intended to be considered as non-hazardous and an hazardous area, or between a space intended to be considered as zone 2 and a zone 1 area, except where required for operational reasons.

2.1.4 In enclosed or semi-enclosed spaces having a direct opening into any hazardous space or area, electrical installations are to comply with the requirements for the space or area to which the opening leads.

2.1.5 Where a space has an opening into an adjacent, more hazardous space or area, it may be considered as a less hazardous space or a non-hazardous space, taking into account the type of separation and the ventilation system.

2.1.6 A differential pressure monitoring device or a flow monitoring device, or both, is/are to be provided for monitoring the satisfactory pressurisation functioning of spaces having an opening into a more hazardous zone.

In the event of loss of protection, by overpressure or loss of ventilation, in spaces classified as zone 1 or zone 2, protective measures are to be taken.

2.2 Submerged cargo pumps

2.2.1 Exceptions

Submerged cargo pumps are not permitted in connection with the following cargoes:

- diethyl ether
- vinyl ethyl ether
- ethylene oxide
- propylene oxide
- mixtures of ethylene oxide and propylene oxide.

2.2.2 Submerged electric motors

a) Where submerged electric motors are used, means are to be provided, e.g. by the arrangements specified in Pt D, Ch 9, Sec 17, [6] of the Ship Rules, to avoid the formation of explosive mixtures during loading, cargo transfer and unloading.

b) Arrangements are to be provided to automatically shut down the motors in the event of low liquid level. This may be fulfilled by detection of low pump discharge pressure, low motor current, or low liquid level. The shutdown is to be alarmed at the cargo control station. Cargo pump motors are to be capable of being isolated from their electrical supply during gas-freeing operations.

3 Product classification

3.1 Temperature class and explosion group

3.1.1 Tab 1 specifies temperature class and explosion group data for the products indicated in Pt D, Ch 9, Sec 19 of the Ship Rules. The data given between brackets are derived from similar products.

Table 1 : Temperature class and explosion group of some typical products

Product name	Temperature class	Explosion group	Product name	Temperature class	Explosion group
Acetaldehyde	T4	II A	Isopropylamine	T2	II A
Ammonia anhydrous	T1	II A	Methane	T1	II A
Butadiene	T2	II B	Methyl acetylene propadiene mixture	T4	II A
Butane	T2	II A	Methyl bromide	T3	II A
Butane/propane mixture	T2	II A	Methyl chloride	T1	II A
Butylenes	T3	II A	Monoethylamine	T2	II A

Product name	Temperature class	Explosion group	Product name	Temperature class	Explosion group
Carbon dioxide	NF	NF	Nitrogen	NF	NF
Chlorine	NF	NF	Pentane (all isomers)	(T2)	(II A)
Diethyl ether	T4	II B	Pentene (all isomers	(T3)	(II B)
Dimethylamine	T2	II A	Propane	T1	II A
Dimethyl ether	T3	II B	Propylene	T2	II B
Ethane	T1	II A	Propylene oxide	T2	II B
Ethyl chloride	T2	II A	Refrigerant gas	NF	NF
Ethylene	T2	II B	Sulphur dioxide	(T3)	(II B)
Ethylene oxide	T2	II B	Vinyl chloride	T2	II A
Ethylene oxide propylene oxide mixture (max. 30% w/w ethylene oxide)	T2	II B	Vinyl ethyl ether	T3	II B
Isoprene	T3	II B	Vinylidene chloride	T2	II A

Section 18 Swivels and Turrets Compartments

1 Swivels

1.1 Pressure swivels

1.1.1 The pressure parts of a pressure swivel are to be designed and manufactured according to the requirements of Pt C, Ch 1, Sec 3 of the Offshore Rules or other recognised pressure vessel code.

1.1.2 A pressure swivel is to be isolated from the structural loads due to the anchoring systems.

1.1.3 Piping loads on swivel are to be minimised (e.g. by means of an expansion joint).

1.1.4 Materials of swivel and seals are to be compatible with the transported products.

1.1.5 Bearings are to be protected against internal fluids and marine environment. Bearings are to be designed for the rated life of the swivel.

1.1.6 If necessary, pressure seals are to be protected against mechanical aggression.

1.1.7 The sealing system of flammable or toxic products is to constitute, at least, a double barrier against leakage to environment or, for multiple product swivels, leakage between the different products.

Means are to be provided to allow the checking of the sealing system integrity while the swivel is in operation. A leak detection and alarm system is to be provided.

1.1.8 Means are to be provided to collect and safely dispose of liquid leaks of flammable products.

1.2 Electrical swivels

1.2.1 Electrical swivels are to be designed and manufactured according to the applicable requirements of Part C, Chapter 2 of the Offshore Rules.

1.2.2 Where relevant, the electrical swivels are to be suitable for the hazardous area in which they are located.

1.3 Test of pressure swivels

1.3.1 Static resistance tests

A pressure swivel is to be subjected to a pressure resistance static test, according to its design code.

1.3.2 Dynamic tests

Rotation and oscillation tests including rest periods are to be performed at design pressure with measurement of starting and running moments.

At least two complete rotations, or equivalent, in each direction are to be performed. The rotation speed is to be about 1°/s.

2 Turret compartments

2.1 General

2.1.1 Definition

Turret compartments are those spaces and trunks that contain equipment and machinery for retrieval and release of the disconnectable turret mooring system, high-pressure hydraulic operating systems, fire protection arrangements and cargo transfer valves.

2.1.2 Application

Turret compartments are to comply with the requirements of Part D, Chapter 9 of Ships Rules as defined in Tab 1.

Table 1 : Applicable requirements for turret compartment, with reference to Ship Rules

Topic	Reference in the Ship Rules
Arrangements	Pt D, Ch 9, Sec 3, [1.1.6] Pt D, Ch 9, Sec 3, [1.3] Pt D, Ch 9, Sec 3, [1.5.8]
Process pressure vessels and liquids, vapour and pressure piping systems	Pt D, Ch 9, Sec 5, [2.2.1] Pt D, Ch 9, Sec 5, [3.3] Pt D, Ch 9, Sec 5, [10.2]
Fire protection and extinction	Pt D, Ch 9, Sec 11, [1.5.5]
Instrumentation and automation systems	Pt D, Ch 9, Sec 13, [6.1.2]
Special requirements **(1)**	Pt D, Ch 9, Sec 17, [5.1.7]
(1) Only applicable for cargoes requiring type 1G ship.	

BUREAU VERITAS MARINE & OFFSHORE

Tour Alto
4 place des Saisons
92400 Courbevoie - France
+33 (0)1 55 24 70 00

marine-offshore.bureauveritas.com/rules-guidelines

BUREAU VERITAS
1828
BUREAU
VERITAS

Shaping a World of Trust