Introduction

In 2009, ClassNK introduced specific rules for Floating Production Storage and Offloading Systems (FPSO) as Part PS of the Rules for the Survey and Construction of Steel Ships.

At that time, almost all of the FPSO in service were involved in the production, storage and offloading of petroleum. Therefore, Part PS of the Rules was primarily established to target crude oil/petroleum oil FPSO.

On the other hand, the research into the development of FPSO specifically designed to handle LNG and LPG (LNG/LPG FPSO) has been going on since the 1990 because such FPSO would not need a pipeline system to deliver their products to shore, thus making the development of offshore gas fields more economically feasible. Moreover, in recent years, the matters including the delays in the development of land-based gas fields (due to difficulty negotiating rights with local governments, manpower shortages, environmental concerns, etc.) have led to increased interest in LNG/LPG FPSO.

Currently, the requirement in PS1.1.1-1, Part PS of the Guidance specifies that Gas FPSO are individually dealt with based on the principal concept of the applicable requirement given in Part PS of the Rules and Part N (SHIPS CARRYING LIQUIFIED GASES IN BULK) of the Rules. However, accordingly, ClassNK has developed a new set of guidelines in order to clarify more specific technical requirements for Gas FPSO this time.

Finally, it is anticipated that, in the future, we’ll continue to review the various technical requirements, corresponding to the technological development of Gas FPSO, and appropriately add the detailed requirement for Gas FPSO.

February 2011
Preface for the Second Edition

In February 2011, ClassNK introduced a new set of guidelines, called the “Guidelines for Floating Offshore Facilities for LNG/LPG Production, Storage and Offloading”, which laid out specific technical requirements for Gas FPSOs.

Since this guidelines can also be applied to LNG floating and regasification units (FSRUs), which in recent years has increasingly become the focus of attention of the relevant industry members, ClassNK decided to revise the guidelines in order to clarify its application to FSRUs. In addition, specific requirements related the impact of tsunamis on FSRUs have been added since such units are, for the most part, located in waters relatively close to shore. Furthermore, to reflect these revisions, the guidelines has been renamed and is being released as the “Guidelines for Floating Offshore Facilities for LNG/LPG Production, Storage, Offloading and Regasification (Second Edition)”.

Finally, ClassNK intends to continue reviewing the various technical requirements found in this guidelines and add or revise the requirements as deemed necessary in order to ensure that it corresponds to the latest developments in gas handling floating facility technology.

February 2015
Preface for the Third Edition

In February 2011, ClassNK introduced its “Guidelines for Floating Offshore Facilities for LNG/LPG Production, Storage and Offloading”: a new set of guidelines which laid out specific technical requirements for Gas FPSOs.

A second edition of the Guidelines was released as “Guidelines for Floating Offshore Facilities for LNG/LPG Production, Storage, Offloading and Regasification (Second Edition)” in February 2015. This new edition not only clarified its application to floating storage regasification units (FSRUs), but also added requirements related to the impact of tsunamis.

Not too long after the release of the Second Edition, the Maritime Bureau of Japan’s Ministry of Land, Infrastructure, Transport and Tourism (MLIT) established a committee to develop guidelines to ensure the safe design of LNG FPSOs (FLNG). ClassNK played a role in the establishment of the resulting MLIT’s “Guidelines for FLNG Design Requirements”. The main differences between the MLIT Guidelines and the Second Edition of the ClassNK Guidelines are that the former specifies the specific requirements of mooring analysis, and the requirements for fire protection, extinction, means of escape and personnel protection specified in IMO MODU Code.

As a result of the above, ClassNK conducted a review of its own Guidelines and amended it accordingly to ensure consistency with the MLIT Guidelines. This new version is being released as “Guidelines for Floating Offshore Facilities for LNG/LPG Production, Storage, Offloading and Regasification (Third Edition)”.

Finally, ClassNK intends to continue reviewing the various technical requirements found in this guidelines and add or revise the requirements as deemed necessary in order to ensure that it corresponds to the latest developments in gas handling floating facility technology.

December 2015
Guidelines for Floating Offshore Facilities for LNG/LPG Production, Storage, Offloading and Regasification

CONTENTS

Chapter 1  GENERAL ................................................................. 1
  1.1 General ......................................................................... 1
  1.2 Definitions ..................................................................... 3

Chapter 2  DESIGN CONDITIONS ........................................ 7
  2.1 General ......................................................................... 7
  2.2 Design Conditions ......................................................... 7
  2.3 Design Environmental Condition .................................... 7
  2.4 Accidental Damage ....................................................... 11

Chapter 3  HULL CONSTRUCTION AND EQUIPMENT .......... 12
  3.1 General ......................................................................... 12
  3.2 Materials and Welding .................................................... 12
  3.3 Stability ........................................................................ 13
  3.4 Hull Construction .......................................................... 13
  3.5 Structural Strength for Ship-Type Gas Floating Offshore Facility ................................................. 14
  3.6 Structural Strength for Other Type Gas Floating Offshore Facilities .................................................. 15
  3.7 Fatigue Strength for Hull Structure Excluding Cargo Tanks ............................................................ 15
  3.8 Corrosion Control Means and Corrosion Margins ........................................................................... 16
  3.9 Hull Equipment, etc. ......................................................... 18
  3.10 Cargo Containment Systems .......................................... 18
  3.11 Cargo Tank Vent Systems .............................................. 19
  3.12 Protections of Deck ...................................................... 19

Chapter 4  POSITIONING SYSTEMS .................................... 20
  4.1 General ......................................................................... 20
  4.2 Mooring Analysis ............................................................ 21
  4.3 Design of Mooring Lines, etc. ......................................... 25
  4.4 Mooring Equipment ....................................................... 27
  4.5 Single Point Mooring Systems ........................................ 28
  4.6 Dynamic Positioning Systems ........................................ 29

Chapter 5  HAZARDOUS AREAS ........................................ 30
  5.1 General ......................................................................... 30
5.2 Hazardous Areas

Chapter 6  FIRE PROTECTION, EXTINCTION, MEANS OF ESCAPE AND PERSONNEL PROTECTION

6.1 General
6.2 Location and Separation of Spaces
6.3 Construction for Fire Protection
6.4 Fire Extinction
6.5 Environmental Controls
6.6 Means of Escape

Chapter 7  MACHINERY INSTALLATIONS

7.1 General
7.2 Cargo Pressure/Temperature Control
7.3 Dual Fuel Diesel Engines, Boilers and Gas Turbines
7.4 Monitoring and Remote Control Systems
7.5 Emergency Shutdown (ESD) Systems
7.6 Machinery Installations in Hazardous areas

Chapter 8  ELECTRICAL INSTALLATIONS

8.1 General
8.2 Main Source of Electrical Power and Lighting Systems
8.3 Emergency Source of Electrical Power
8.4 Emergency Alarm Systems and Internal Means of Communication

Chapter 9  PRODUCTION SYSTEMS

9.1 General
9.2 Recognized Codes and Standards
9.3 Drawings and Data
9.4 General Requirements for the Design of Production System Components
9.5 General Requirements for the Design of Production Systems
9.6 Emergency Shutdown Systems and Process Shutdown Systems of Production Systems
9.7 Production System Components
9.8 Gas Processing Facilities
9.9 Liquefaction Facilities
9.10 Regasification Facilities

Chapter 10  SPECIAL REQUIREMENTS

10.1 General
Chapter 11 SURVEYS

11.1 General

11.2 Classification Surveys

11.3 Class Maintenance Surveys
GUIDELINES FOR FLOATING OFFSHORE FACILITIES FOR LNG/LPG PRODUCTION, STORAGE, OFFLOADING AND REGASIFICATION

Chapter 1 GENERAL

1.1 General

1.1.1 Application

1. The Guidelines apply to floating offshore facilities (hereinafter referred to as the “Gas Floating Offshore Facility” defined in 1.2.1), not primarily intended for the transport of cargo, which are also either of the following (1) or (2):

(1) Facilities positioned at specific gas producing sea areas permanently or for long periods of time which are also fitted with systems for the production, storage and offloading of gases drawn up from the seabed; or

(2) Facilities positioned at specific sea areas permanently or for long period of times which are also fitted with systems for the storage, regasification and offloading of gases from ships carrying liquefied gases in bulk or other liquefied gas production facilities.

2. Where a Gas Floating Offshore Facility has a tank to store condensates, the Gas Floating Offshore Facility is to comply with relevant requirements given in Part PS of the “Rules for the Survey and Construction of Steel Ships” (hereinafter referred to as “Rules”) according to the properties of the condensates in addition to the requirements given in these Guidelines.

3. Attention is to be paid to complying with any relevant statutory requirements of the National Authority of the coastal state in which the Gas Floating Offshore Facility is located and of the flag state.

4. In cases where ships carrying liquefied gases in bulk are converted to Gas Floating Offshore Facilities, relevant requirements given in these Guidelines are to apply with given to consideration with the following items:

(1) Design environmental conditions are to be established in accordance with 2.2.1.

(2) In the cases of scantlings (net scantlings) obtained by subtracting the corrosion margins specified in Table 3.3 or proposed by applicants from the scantlings obtained from thickness measurement data, structural strength is to be estimated in accordance with 3.4 to 3.6. In such cases, main structural arrangements are to indicate scantlings and net scantlings or adopted corrosion margins.

(3) Fatigue strength assessments are to comply with the following:

(a) Cumulative fatigue damage ratios at the time of conversion are to be estimated by methods deemed appropriate by the Society based on service records before conversion.

(b) Fatigue strengths after conversion are to be estimated by the cumulative fatigue damage ratio according to 3.7.

(c) The sum of the cumulative fatigue damage ratio obtained from (a) and (b) above is to be confirmed to meet the requirements given in 3.7. In such cases, the design life of Gas Floating Offshore Facilities specified in 3.7.1-3 is the period that the Gas Floating Offshore Facility age at the time of conversion adds to the assumed service period after conversion or 25 years, whichever is longer.

5. Where the production systems defined in 1.2.3 are to be certified by the Society, such systems are to be in accordance with relevant requirements given in these Guidelines as well as the statutory requirements of the National Authority having jurisdiction in the waters where Gas Floating Offshore Facilities are located during operation or codes/standards deemed appropriate by the Society. In such cases, relevant documents for reference are to be submitted to the Society. In cases where classification applications for the production systems are submitted, such production systems may be classified separately from Gas Floating Offshore Facilities.

6. In the case of the periphery facilities for positioning defined in 1.2.5, it is to be indicated that a Gas Floating Offshore Facility can be adequately moored in accordance with relevant requirements given in these Guidelines as well as the statutory requirements of the National Authority having jurisdiction in the waters where Gas Floating
Offshore Facilities are located during operation or codes/standards deemed appropriate by the Society. In such cases, relevant documents for reference are to be submitted to the Society. In cases where classification applications for periphery facilities for positioning are submitted, such periphery facilities for positioning may be classified separately from Gas Floating Offshore Facilities.

1.1.2 Equivalency
Gas Floating Offshore Facilities which do not comply with some of the requirements given in these Guidelines may be accepted provided that they are deemed by the Society to be equivalent to those specified in these Guidelines.

1.1.3 Hazards (with reference to IGC Code 1.2)
Hazards of gases covered by these Guidelines include fire, toxicity, corrosivity, reactivity, low temperature and pressure.

1.1.4 Gas Floating Offshore Facilities with Novel Design Features
With respect to Gas Floating Offshore Facilities of different types or with different systems from those specified in these Guidelines, the required hull construction, equipment, and installation are to be specified respectively based upon the fundamental concepts found in the requirements given in these Guidelines.

1.1.5 Class Notations
1 For Gas Floating Offshore Facilities complying with additional requirements and/or those exempted from requirements related to the subjects specified in the following paragraphs in accordance with the provisions of these Guidelines, an appropriate notation is affixed to the Classification Characters in accordance with the provisions of Chapter 2 of the Regulation for the Classification and Registry of Ships as follows;

<table>
<thead>
<tr>
<th>NS* (1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Areas of restricted services specified in -2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) Purpose of Gas Floating Offshore Facilities specified in -3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3) Type of production systems specified in -4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4) Type of positioning systems specified in -5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2 For Gas Floating Offshore Facilities approved by the Society in accordance with the provisions given in these Guidelines, the notation of "Designated Service Area" (abbreviated to DSA) is affixed to the Classification Characters and the details of the designated service area are entered as descriptive notes in the Classification Register.

3 For Gas Floating Offshore Facilities approved by the Society in accordance with the provisions given in these Guidelines, appropriate notation corresponding to the purpose of the Gas Floating Offshore Facility is affixed to the Classification Characters in accordance with the following provisions:

(1) For LNG FPSO or LPG FPSO defined in 1.2.1-1:
Floating Offshore Facility for LNG Production, Storage and Offloading (abbreviated to LNG FPSO) or Floating Offshore Facility for LPG Production, Storage and Offloading (abbreviated to LPG FPSO)

(2) For LNG FPO or LPG FPO defined in 1.2.1-2:
Floating Offshore Facility for LNG Production and Offloading (abbreviated to LNG FPO) or Floating Offshore Facility for LPG Production and Offloading (abbreviated to LPG FPO)

(3) For LNG FSO or LPG FSO defined in 1.2.1-3:
Floating Offshore Facility for LNG Storage and Offloading (abbreviated to LNG FSO) or Floating Offshore Facility for LPG Storage and Offloading (abbreviated to LPG FSO)

(4) For LNG FSRU defined in 1.2.1-4:
Floating Offshore Facility for LNG Storage and Regasification (abbreviated to LNG FSRU)

4 Where production systems approved by the Society in accordance with the provisions given in these Guidelines are installed on a Gas Floating Offshore Facility, appropriate notations corresponding to the type of the installed production systems are affixed to the Classification Characters in accordance with the following provisions:

(1) For Gas processing Facility defined in 1.2.3-1:
Gas Processing Facility (abbreviated to GPF)

(2) For Liquefaction Facility defined in 1.2.3-2:
Liquefaction Facility (abbreviated to LF)

(3) For Regasification Facility defined in 1.2.1-3:
Regasification Facility (abbreviated to RGF)

For Gas Floating Offshore Facilities with positioning systems approved by the Society in accordance with the provisions given in these Guidelines, appropriate notation corresponding to the type of the positioning system is affixed to the Classification Characters in accordance with the following provisions:

1. For Catenary Mooring defined in 1.2.4-2(1):
   Catenary Mooring (abbreviated to CM)

2. For Taut Mooring defined in 1.2.4-2(2):
   Taut Mooring (abbreviated to TAM)

3. For CALM defined in 1.2.4-3(1):
   Catenary Anchor Leg Mooring (abbreviated to CALM)

4. For SALM defined in 1.2.4-3(2):
   Single Anchor Leg Mooring (abbreviated to SALM)

5. For Turret Mooring defined in 1.2.4-3(3):
   Turret Mooring (abbreviated to TRM)

6. For Dynamic Positioning System defined in 1.2.4-4:
   Dynamic Positioning System (abbreviated to DPS)

1.1.6 Record of Design Criteria

Key design conditions such as water depth, wave height, etc. which serve as the basis for Society approval of the operation sites of Gas Floating Offshore Facilities are to be recorded in the Classification Register.

1.1.7 Operating Booklets

An appropriate operating booklet corresponding to the particular use of the Gas Floating Offshore Facility is to be on board.

1.2 Definitions

Unless otherwise specified in Chapter 2, Part A , 1.1.6, Part D, 1.1.5, Part H, 1.1.4, Part N, 1.2, Part P and Chapter 3, Part R of the Rules for the Survey and Construction of Steel Ships, the definitions of the terms given in these Guidelines are as specified below:

1.2.1 Purpose of Gas Floating Offshore Facilities

1. LNG FPSO or LPG FPSO
   LNG FPSO or LPG FPSO is the Gas Floating Offshore Facility positioned at specific gas producing sea areas either permanently or for long period of times which is also fitted with systems for the production, storage and offloading of gas drawn up from the seabed.

2. LNG FPO or LPG FPO
   LNG FPO or LPG FPO is the Gas Floating Offshore Facility positioned at specific gas producing sea areas either permanently or for long periods of time which is also fitted with systems for the production and offloading of gas drawn up from the seabed.

3. LNG FSO or LPG FSO
   LNG FSO or LPG FSO is the Gas Floating Offshore Facility positioned at specific gas field sea area either permanently or for long periods of time which receives liquefied gases from ships carrying liquefied gases in bulk or other liquefied gas production facilities, and which is also fitted with systems for the storage and offloading of liquefied gases.

4. LNG FSRU
   LNG FSRU is the Gas Floating Offshore Facility positioned at specific sea areas either permanently or for long period of times, which receives liquefied gases from ships carrying liquefied gases in bulk or other liquefied gas production facilities, and which is also fitted with systems for the storage, regasification and offloading of gas to onshore facilities.

1.2.2 Type of Gas Floating Offshore Facilities

1. Ship type
Ship type is the Gas Floating Offshore Facility in the shape of an ordinary ship having a displacement hull.

2 Other type
Other type is the Gas Floating Offshore Facility not specified in -1.

1.2.3 Production Systems
1 Gas Processing Facility
A gas processing facility is a facility for acid gas removal, dehydration and mercury removal from the raw gas drawn up from the seabed.

2 Liquefaction Facility
A liquefaction facility is a facility to liquefy the gas refined by the gas processing facility by heat exchange with a refrigerant.

3 Regasification Facility
A regasification facility is a facility to gasify liquefied gas loaded in the cargo containment systems by heating with water, air or steam, etc.

4 Production support systems
Production support systems are systems to support the drawing up and processing of gas, which includes power generation and distribution systems, instrument and service air systems, potable water systems, fuel oil systems, instrument systems, communication systems, fire fighting systems, etc.

1.2.4 Positioning Systems
1 Positioning systems are such systems to keep Gas Floating Offshore Facility at a specific position of designated service area permanently or for long periods of time, which are specified in -2 through -5.

2 Spread mooring systems
Spread mooring systems consist of mooring lines connected to piles, sinkers, etc., which are firmly embedded into the seabed, the other end of which is individually connected to winches, or stoppers which are installed on board Gas Floating Offshore Facilities, the definitions of each category being as given in (1) and (2) below. Here, the term “mooring line” means an integration of chains, wire ropes, fibre ropes or their combination, except periphery facilities for positioning such as piles, sinkers, etc. which are laid onto the seabeds.

(1) Catenary Mooring
Catenary Mooring is defined as mooring forces obtained mainly from the net weight of catenary mooring lines (in the case of those provided with intermediate buoys or intermediate sinkers, their net weight or buoyancy).

(2) Taut Mooring
Taut Mooring is defined as mooring lines arranged straight and adjusted by high initial mooring forces, and the mooring forces obtained from the elastic elongation of these lines.

3 Single point mooring system
Single point mooring system is a system that allows Gas Floating Offshore Facility to weathervane so that the Gas Floating Offshore Facility changes its heading corresponding to wind and wave directions. Typical single point mooring systems are as shown below:

(1) CALM (Catenary Anchor Leg Mooring)
CALM consists of a large buoy connected to mooring points at the seabed by catenary mooring lines. The Gas Floating Offshore Facility is moored to the buoy by mooring lines or a rigid yoke structure.

(2) SALM (Single Anchor Leg Mooring)
SALM consists of the mooring structure with buoyancy which is positioned at or near the water surface, and is connected to the seabed. The Gas Floating Offshore Facility is moored to the buoy by mooring lines or a rigid yoke structure.

(3) Turret mooring
The Gas Floating Offshore Facility itself is fitted with a turret which allows only its angular movement relative to the turret so that it may be weathervane. The turret may be fitted internally within the Gas Floating Offshore Facility, or externally at the stern/bow of the Gas Floating Offshore Facility. The turret is generally connected to the seabed using a spread mooring system.

4 Dynamic Positioning system
Dynamic positioning system is a positioning system that the Gas Floating Offshore Facility is kept a specific
position by automatically control of thruster systems such as thruster or propeller provided with the Gas Floating Offshore Facility.

5 Other Type of Positioning System

Other type of positioning systems are positioning systems other than those specified in -2 and -4 above.

1.2.5 Periphery Facility for Positioning

Periphery facilities for positioning are independent separate floating structures connected to the mooring installations of Gas Floating Offshore Facility, and consist of large buoys for CALM, the mooring structures for SALM, fixed structures (dolphins, jackets, etc.) and sinkers/piles laid onto the seabed.

1.2.6 Cargo Area

Cargo area means that part of the Gas Floating Offshore Facility which contains the cargo containment system, cargo pump, compressor rooms and production system, and includes deck areas over the full length and breadth of the part of the Gas Floating Offshore Facility over the above-mentioned 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.

1.2.7 Cargo Containment System

Cargo containment system means 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.

1.2.8 Cargoes

Cargoes means LNG, LPG and condensates processed, stored and offloaded by Gas Floating Offshore Facility subject to the requirements in these Guidelines.

1.2.9 Design Conditions

1 Environmental design condition

Environmental design condition means the combination of extreme environmental conditions such as wind, wave, current, etc. at the operation site of operation, for which the Gas Floating Offshore Facility is to be designed.

2 Design operating condition

Design operating condition means limiting environmental conditions which would require the suspension of normal operation.

1.2.10 Operating Booklets

Operating Booklets are to include the following information, as applicable to the particular unit, so as to provide suitable guidance to the operating personnel with regard to the safe operation of the Gas Floating Offshore Facility:

(1) General description of the Gas Floating Offshore Facility;
(2) Pertinent data for each approved mode of operation, including design and variable loading, environmental conditions, draught, etc.;
(3) The lowest atmospheric and sea water temperatures assumed at the design stage;
(4) General arrangements showing watertight compartments, closures, vents, allowable deck loadings, etc.;
(5) Hydrostatic curves or equivalent data;
(6) Capacity plans showing the capacities of tanks, centres of gravity, free surface corrections, etc.;
(7) Instructions for operation, including any precautions to be taken in adverse weather, changing modes of operation, any inherent operational limitations, etc.;
(8) Plans and descriptions of the ballast system and instructions for ballasting. If permanent ballast is to be used, the weight, location and substance used are to be clearly indicated;
(9) Piping diagrams of fuel oil transfer systems;
(10) Hazardous area plan;
(11) Fire control plan;
(12) Arrangements of life-saving appliances together with escape routes;
(13) Light ship data based on the results of inclining experiments, etc.;
(14) Stability information
(15) Representative examples of loading conditions for each approved mode of operation together with a means for the evaluation of other loading conditions;
(16) Diagrams of the main and auxiliary wiring systems;
(17) Details of the emergency shut-down procedures for electrical equipment;
(18) Identification of the helicopter assumed in the design of the helicopter deck;
(19) Instructions for the operation of mooring systems together with information regarding the maximum offset and maximum tension of such systems. In cases where a mooring system can be isolated, the procedures for isolating and re-mooring are also to be included.
(20) Instructions for the operation of loading and unloading, transfers and offloading of cargo and ballast.
(21) Other instructions deemed necessary by the Society

1.2.11 Emergency Operation Manuals

Emergency operation manual means such that includes all of the elements of the ordinary systems and emergency systems of the Gas Floating Offshore Facility, and such that shows all necessary instruments/equipment, the functions necessary for them, emergency shut-off valves, emergency shut-down devices as well as all supporting arrangement used in emergency situations.
Chapter 2 DESIGN CONDITIONS

2.1 General

2.1.1 General
1 The environmental conditions (air and sea temperature, tide and current, swell, wave, ice and snow, wind, tsunami, submarine slide, seiche in closed areas, abnormal compositions of air and sea water, air humidity, salinity, ice drift, collapse of iceberg, etc.), the operational limitations of the Gas Floating Offshore Facility and the design loads acting on the Gas Floating Offshore Facility, etc. on the basis of design are to be clearly shown in drawings submitted for approval.
2 The information clearly shown in such submitted drawings (meteorological and sea states data for the specific site of operation, statistical distributions, estimation approach, experimental data, data and analyses supplied by qualified consultants or design standards as deemed appropriate by the Society, etc.) on the basis of environmental conditions are to be submitted to the Society for reference.

2.2 Design Conditions

2.2.1 Design Environmental Condition
1 The design environmental condition for a Gas Floating Offshore Facility is to be based on statistics, and is to be of the most severe condition in the return period, which is to be three times as long as the design specified employment period but not less than 100 years, of the facility. When it is expected that the relevant design environmental conditions are not able to be evaluated by the return period, e.g. tsunamis, etc. the maximum tsunami that can occur at the specified operation site is to be taken account.
2 The design environmental condition of a Gas Floating Offshore Facility is to be of the most severe loading conditions with a combination of winds, waves, etc. based on meteorological and sea state data. However, accidental events such as tsunamis need not be considered as part of the most severe loading condition.
3 The operational limitations of a Gas Floating Offshore Facility are to be specified by designers. In such cases, the capability of positioning systems, the operating conditions of production systems, the conditions of offloading, etc. (specified in Chapter 4) with the combination of winds, waves and currents based on meteorological and sea state data for the specified site of operation are to be taken into account.
4 When being towed, the design environmental conditions of a Gas Floating Offshore Facility are to be decided taking into consideration the navigation route and are to be approved by the Society.

2.2.2 Fatigue Design Condition
1 The design fatigue life to be taken into consideration for fatigue design is to be of the specified design service life of the Gas Floating Offshore Facility and is not to be less than 25 years.
2 Repeated loads mainly due to waves are to be taken into consideration in fatigue design. In cases where the repeated loads due to heat, wind, current, etc. are considered not to be negligible, or in cases where the change of static loads for loading is big, they are to be taken into account.

2.3 Design Environmental Condition

2.3.1 General
This Section gives the requirements for the methods used to calculate representative design loads. Design loads for which the calculating method is not specified in this Section may be estimated through model tests, the wind tunnel experiments, tank tests or analytical methods as deemed appropriate by the Society. In such cases, data relative to the calculation of design loads is to be submitted to the Society.
2.3.2 Current

1. The current forces on mooring lines, risers or any other submerged objects associated with the system are to be calculated using an upright distribution of current profiles based on the return period specified in 2.2.1-1.

2. Current force $F_{\text{current}}$ on the submerged part of any structure is to be calculated by the following equation. In cases where analysis programs designed to simultaneously calculate the load due to waves and current force $F_{\text{current}}$ is adopted, it is to comply with provisions specified otherwise.

$$ F_{\text{current}} = \frac{1}{2} \rho_{\text{water}} C_D A_{\text{current}} u_c^2 $$

- $\rho_{\text{water}}$: Density of water = 1.025
- $C_D$: Drag coefficient in steady flow based on data obtained from model tests or reliable coefficients
- $u_c$: Current velocity vector (m/s) normal to the plane of the projected area. In cases where wave particle velocity is considered to be not negligible, the current velocity is to be added to the wave particle velocity.
- $A_{\text{current}}$: Projected area ($m^2$) exposed to current. In cases where the underwater projected area varies according to the changing of the draft, the area is to be on the maximum draft. In the case of slender structures such as pipes in which the influence of an increase of the projected area due to marine growth is considered to be not negligible, maximum marine growth for one year is to be taken into account.

3. In the case of slender structures such as pipes in which flutters of structural members due to vortex shedding occur, vortex shedding is to be taken into account.

4. In the case of slender structures such as pipes in which the lifting force is considered to be not negligible, lifting force is to be calculated by a suitable method.

5. In cases where the length or breadth of a structure exceeds 50 times its draft, friction force due to flows is to be calculated by a suitable method.

2.3.3 Wind

1. The wind velocity for the design environmental condition is to be based on the statistical measurement wind data for the specific operation site or the analysis and interpretation of wind measurement data for the specific operation site by weather consultants. It is to include tables showing the frequency distribution of wind velocity and direction and tables or graphs showing the return period of extreme winds.

2. The design operation condition is to identify the percentage of time which the wind velocity is expected to exceed the design operating wind velocity throughout the year and the term.

3. Wind load are to be considered as described below:

   (1) In cases where wind velocity is considered to be constant, the wind velocity for 1 minute is to be used in calculating the wind load.

   (2) In cases where wind loads are calculated using a wind velocity which is a combination of constant wind velocity and a time-varying component calculated from a suitable wind spectrum, the effect of the wind gust spectrum is to be taken into account.

   (3) In cases where the wind velocity for over 1 minute (the wind velocity for 10 minutes or 1 hour) is used for the wind load, the dynamic effect of wind is to be additionally taken into account.

4. Wind pressure $P_{\text{wind}}$ (N/m$^2$) is to be calculated as follows:

$$ P_{\text{wind}} = 0.611 C_s C_h v_{\text{wind}}^2 $$

- $C_s, C_h$: Shape coefficient and Height coefficient given in Table 2.1, Table 2.2.
### Table 2.1 Shape Coefficient $C_s$

<table>
<thead>
<tr>
<th>Structural members</th>
<th>$C_s$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spherical structures</td>
<td>0.40</td>
</tr>
<tr>
<td>Cylindrical structures</td>
<td>0.50</td>
</tr>
<tr>
<td>Main Hulls</td>
<td>1.00</td>
</tr>
<tr>
<td>Deckhouses</td>
<td>1.00</td>
</tr>
<tr>
<td>Independent structural members (cranes, shapes, beams, etc.)</td>
<td>1.50</td>
</tr>
<tr>
<td>Under-deck parts (smooth surface)</td>
<td>1.00</td>
</tr>
<tr>
<td>Under-deck parts (exposed beams, girders, etc.)</td>
<td>1.30</td>
</tr>
<tr>
<td>Working towers (each surface)</td>
<td>1.25</td>
</tr>
</tbody>
</table>

### Table 2.2 Height Coefficient $C_h$

<table>
<thead>
<tr>
<th>Height ($m$)</th>
<th>$C_h$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not less than</td>
<td>Less than</td>
</tr>
<tr>
<td>15.3</td>
<td>15.3</td>
</tr>
<tr>
<td>15.3 - 30.5</td>
<td>15.3 - 30.5</td>
</tr>
<tr>
<td>30.5 - 46.0</td>
<td>30.5 - 46.0</td>
</tr>
<tr>
<td>46.0 - 61.0</td>
<td>46.0 - 61.0</td>
</tr>
<tr>
<td>61.0 - 76.0</td>
<td>61.0 - 76.0</td>
</tr>
<tr>
<td>76.0 - 91.5</td>
<td>76.0 - 91.5</td>
</tr>
<tr>
<td>91.5 - 106.5</td>
<td>91.5 - 106.5</td>
</tr>
<tr>
<td>106.5 - 122.0</td>
<td>106.5 - 122.0</td>
</tr>
<tr>
<td>122.0 - 137.0</td>
<td>122.0 - 137.0</td>
</tr>
<tr>
<td>137.0 - 152.5</td>
<td>137.0 - 152.5</td>
</tr>
<tr>
<td>152.5 - 167.5</td>
<td>152.5 - 167.5</td>
</tr>
<tr>
<td>167.5 - 183.0</td>
<td>167.5 - 183.0</td>
</tr>
<tr>
<td>183.0 - 198.0</td>
<td>183.0 - 198.0</td>
</tr>
<tr>
<td>198.0 - 213.5</td>
<td>198.0 - 213.5</td>
</tr>
<tr>
<td>213.5 - 228.5</td>
<td>213.5 - 228.5</td>
</tr>
<tr>
<td>228.5 - 244.0</td>
<td>228.5 - 244.0</td>
</tr>
<tr>
<td>244.0 - 259.0</td>
<td>244.0 - 259.0</td>
</tr>
<tr>
<td>259.0</td>
<td>259.0</td>
</tr>
</tbody>
</table>

5 The wind force $F_{wind}$ ($N$) exerted on each structural member is to be calculated as follows. The total wind force is to be obtained by summing up the wind forces exerted on each structural member.

$$ F_{wind} = P_{wind} A_{wind} $$

$A_{wind}$ : Projected area ($m^2$) of windage on a plane normal to the direction of the wind. In cases where the atmospheric projected area varies according to the changing of drafts, the area is to be on the minimum draft. When a girder is wholly or party protected from wind by another girder, the areas of the superposed portions may be multiplied by the reduction factor ($\eta$) obtained from Fig. 2.1. The distance $b$ between girders is to be as given in Fig. 2.2.

In cases where structural members may be affected by the shadow effect in which data and calculations are submitted to the Society and considered appropriate, wind forces may not conform to the above-mentioned formula.

6 In cases where the length or breadth of a structure exceeds 50 times its draft, the friction force due to wind is to be calculated by a suitable method.
2.3.4 Wave

1. The wave for the design environmental condition is to be based on the statistical measurement wave data for the specific operation site of operation or the analysis and interpretation of wave measurement data for the specific operation site of operation by weather consultants. It is to include tables or graphs showing the wave energy spectra, the significant wave height, the average wave periods, the wave duration, the wave height, the wave direction, the frequency distribution of wave period, the return period of the extreme wave, etc.

2. Waves are to be considered as coming from any direction relative to structures. However, in cases where the directions of waves are to be specified by taking into account the data analysis of the specific operation site, it may comply with provisions specified otherwise.

3. The dynamic response due to a wave is to be estimated, in principle, by using numerical simulation. The dynamic response estimation of a structure is to be done within the limits of the wave period that have effective energy in the wave spectrum by analysis programs that appropriately model the structures and their positioning systems.

4. Wave force is to be divided into the following three classes and to be estimated respectively by analysis programs that take into account the effects of water depth.
   (1) First order force at the wave period of the incident wave
   (2) Second order force at a period that is longer than the wave period of the incident wave
   (3) Steady part of the second order force (Wave drifting force)

5. For the wave force of structures comprised of slender members with diameters (or equivalent diameters giving the same cross-sectional areas parallel to the flow) less than 20% of the wave lengths, the application of semi-empirical equation such as Morison’s equation may be used. In general, the application of Morison’s equation may be used for structures comprised of slender members with diameters (or equivalent diameters giving the same cross-sectional areas parallel to the flow) less than 20% of the wave lengths.

6. Wave force may be estimated by model tests or the results of real ship experiments from similar ships as deemed appropriate by the Society.

2.3.5 Directionality of Design Environmental Condition

In cases where the dependency of environmental condition on direction can be confirmed by detailed environmental condition data or it is verified that the environmental loads acting on a Gas Floating Offshore Facility
have special characteristics depending on direction (like weathervane) by model tests, special considerations may be
given to the directionality of design environmental condition based on environmental condition data or the results of
model tests.

2.3.6 Soil Condition

The characteristics of the soil condition of the seabed that is used for the mooring point design of the seabed are
to be submitted for reference. A report prepared by qualified geotechnical consultants is acceptable.

2.3.7 Other Environmental Conditions
1 In the case of a Gas Floating Offshore Facility moored to the fixed structure of periphery facilities for
positioning, forces due to earthquakes which is transmitted via the periphery facilities for positioning is to be taken
into account.
2 Force due to earthquakes on fixed structures is to be estimated by analysis programs using maximum earthquake
waves that have occurred in the past and the soil conditions for the specific operation site.
3 Tsunamis which occurred at the past for the specified operation site are to be investigated as much as possible,
and the maximum tsunami which can occur at the specified operation site is to be taken into consideration based on
the topography, geology, etc. of the site. Wave conditions such as wave height, wave period, wave velocity, etc. of
the maximum tsunami are to be determined from an appropriate method approved by the Society. However, in cases
where water depth is deemed to be sufficiently deep by the Society, the effects of tsunamis may be deemed as
changes of tidal level and current.
4 In cases where earthquakes and tsunamis are taken into consideration, the load is to be of a combination of the
winds, waves and currents in a 1-year return period.

2.4 Accidental Damage

2.4.1 General

Risk assessment for accidental damage (e.g. collision, dropped objects, fire, explosions and leak of cargo, etc.)
are to be provided when designing a Gas Floating Offshore Facility and examination sheets for reference is to be
submitted to the Society.
Chapter 3  HULL CONSTRUCTION AND EQUIPMENT

3.1  General

3.1.1  Application

The requirements given in this section apply to all types of Gas Floating Offshore Facilities.

3.1.2  Load Line

1. A mark designating the maximum allowable draught for loading is to be located in easily visible positions on Gas Floating Offshore Facilities as deemed appropriate by the Society or in positions easily distinguishable by the person in charge of liquid transfer operations.


3.1.3  Loading Manual, Stability Information and Instruction for Operation

1. In order to avoid the occurrence of unacceptable stress in Gas Floating Offshore Facility structures corresponding to all cargo and ballast loading conditions and to enable the master or the person-in-charge of loading operations to adjust the loading of cargo and ballast, Gas Floating Offshore Facilities are to be provided with loading manuals approved by the Society. Such loading manuals are to at least include the following items as well as relevant provisions given in Chapter 34, Part C of the Rules for the Survey and Construction of Steel Ships.

   (1) The loading conditions on which the design of a Gas Floating Offshore Facility has been based, including the permissible limits of longitudinal still water bending moments and still water shearing forces.

   (2) The calculation results of longitudinal still water bending moments and still water shearing forces corresponding to the loading conditions.

   (3) The allowable limits of local loads applied to decks, double bottom construction, etc., in cases where deemed necessary by the Society.

   (4) The limit values of the loads of mooring lines and riser loads.

2. In addition to -1 above, a loading computer that is capable of readily computing longitudinal still water bending moments and still water shearing forces working on Gas Floating Offshore Facilities corresponding to all cargo and ballast loading conditions and the operation manual for such a computer is to be provided on board.

3. The capability of the loading computer specified in -2 above to function as specified in the location where it is installed is to be confirmed.

4. A stability information booklet approved by the Society is to be provided on board in accordance with Part U of the Rules for the Survey and Construction of Steel Ships. This booklet is to include the results of stability evaluations in representative operating conditions and assumed damage conditions as well as the damage condition of any mooring system equipment as necessary.

5. Instructions for the loading and unloading, and transfer and offloading operations of cargo and ballast are to be provided on board. In cases where mooring systems can be isolated, the procedures for isolating and re-mooring are also to be included.

3.2  Materials and Welding

3.2.1  General

1. The materials used for important structural members are to be those that comply with the requirements specified in Part K of the Rules for the Survey and Construction of Steel Ships. The steel used for parts supporting heavy loads such as plant facilities, etc. and those parts under tensile loads in the direction across the plate thickness such as the crossing parts of column and braces are to be made of material complying with the requirements given in 3.11,
3.3 Stability

3.3.1 General

1. Intact stability criteria and damage stability criteria are to be in accordance with the requirements specified in Chapter 4, Part P of the Rules for the Survey and Construction of Steel Ships under the environmental conditions specified in Chapter 2. When calculating wind overturning moments, in cases where Gas Floating Offshore Facilities are designed to be under wind from a specified direction, the overturning moment induced by wind from a specified direction may be accepted.

2. The arrangements of watertight compartments, watertight bulkheads, and closing devices are to be in accordance with the requirements specified in Chapter 5, Part P, and Chapter 4 and Chapter 13, Part C of the Rules for the Survey and Construction of Steel Ships.

3. In addition to -1 and -2 above, the survival capability and the location of cargo tanks for Gas Floating Offshore Facilities are to be in accordance with the requirements specified in Chapter 2, Part N of the Rules for the Survey and Construction of Steel Ships.

3.4 Hull Construction

3.4.1 General

1. The categories of structural members and application of steel are to be in accordance with the requirements specified in 6.2, Part P of the Rules for the Survey and Construction of Steel Ships.

2. The designs of welded joints are to be in accordance with the requirements specified in 1.2, Part C of the Rules for the Survey and Construction of Steel Ships. In cases where consideration is given to the welded joints of parts where the stresses may concentrate and the shapes of welded joints for fatigue strength design, data relative to them is to be submitted for Society approval.

3. Gas Floating Offshore Facilities which operate in icy sea areas are to comply with the requirements given in Chapter 5, Part P of the Rules for the Survey and Construction of Steel Ships.

4. In cases where large openings such as moonpools, turret mooring systems, etc. are provided, Gas Floating Offshore Facility structures are to be suitably reinforced and possess strength continuity.

5. The strength of Gas Floating Offshore Facilities during towing is to be as deemed appropriate by the Society.

3.4.2 Structural Arrangements

1. Tank sizes are to be sufficient enough to avoid any motion due to resonance of the natural period of oscillation of liquid in the tanks with the natural periods of rolling and pitching of Gas Floating Offshore Facilities. In case where such motion is not avoidable, swash bulkheads are to be provided inside tanks. However, in cases where the structural member of tanks possess sufficient strength against loads caused by the motion of liquids in such tanks in accordance with the requirements specified in 3.5.2-3; or, such structural members comply with relevant requirements specified in Part CSR-T of the Rules for the Survey and Construction of Steel Ships, the above requirements need not apply.

2. The arrangement of fuel oil tanks and other structural arrangements are to be in accordance with relevant requirements given in Part C and Chapter 3, Part N of the Rules for the Survey and Construction of Steel Ships.
3.4.3 Overall Strength Analysis

1 Overall strength analysis is to be performed for the loading conditions specified in the following (1) and (2) in all modes of operation. The scantlings of structural members used for overall strength analysis are to be determined by deducting the corrosion margin specified in 3.8 from their actual scantling.

(1) Static loading

Static loading is a condition in which a Gas Floating Offshore Facility is in still-water and is loaded with static loads such as the loads occurring under operating conditions, the dead load of the Gas Floating Offshore Facility and buoyancy.

(2) Combined loading

Combined loading is a condition in which a Gas Floating Offshore Facility is loaded with the combined loads of the static loads specified in (1), loads induced by the design conditions specified in Chapter 2 such as wind, etc. and loads induced by the accelerate motion of the Gas Floating Offshore Facility due to the above loads and heeling.

3.5 Structural Strength for Ship-Type Gas Floating Offshore Facility

3.5.1 Overall Strength

1 In the case of ship-type Gas Floating Offshore Facilities, longitudinal strength is to comply with the requirements given in Chapter 15, Part C of the Rules for the Survey and Construction of Steel Ships. \( M_{w(+)} \) and \( M_{w(-)} \) given in 15.2.1-1, Part C of the Rules for the Survey and Construction of Steel Ships may be taken as wave induced longitudinal bending moments based on the environmental condition of the specific installation site.

2 In addition to (1) above, longitudinal bending moments and wave induced shearing forces calculated by the requirements specified in Chapter 2 for all loading conditions are to be evaluated based on the beam theory. In such cases, allowable stress is not to exceed 0.8 times the yield strength of the material.

3 In cases where large openings such as moonpools, etc. are provided and the width of their openings is more than 70% of the breadth of the ship, the strength due to horizontal/-twisting moments is to be evaluated. In such cases, the overall strength of hull constructions in cases where the scantlings of structural members are determined by deducting the corrosion margin specified in 3.8 from their actual scantling is to be calculated using analytical methods deemed appropriate by the Society, and it is to be confirmed that the requirements given in Table P7.1, Part P of the Rules for the Survey and Construction of Steel Ships relating to allowable stress are satisfied.

4 With respect to the neighborhood of openings such as moonpools, etc. and those areas designed by the Society, fine mesh structural strength analysis in accordance with the requirements specified in Appendix B.3, CSR-T of the Rules for the Survey and Construction of Steel Ships is to be carried out to assess and verify any stress. Such stress is not to be more than the criteria of allowable stress specified in Part CSR-T of the Rules for the Survey and Construction of Steel Ships.

3.5.2 Local Strength

1 Shell plating, decks, tank bulkheads, helicopter decks and the stiffeners which support them are to be in accordance with the relevant requirements of 7.3 and 7.6, Part P, Part C, or Part CSR-T of the Rules for the Survey and Construction of Steel Ships. In such cases, corrosion margins are to be in accordance with 3.8.3.

2 The structural strength of the parts which support mooring systems is to be capable of withstanding the breaking loads of mooring lines.

3 In cases where the difference between the natural periods of rolling and pitching of a Gas Floating Offshore Facility and the period of oscillation of the liquid in tanks is less than 20% of the natural periods of oscillation of such liquid, an estimation of the dynamic loads due to sloshing and structural analysis are to be carried out applying the provisions specified in 3.4.2-1. In such cases, the stress of internal tank structures such as bulkheads, etc. is not to be greater than the allowable stress specified in 7.2.2 and 7.2.3, Part P of the Rules for the Survey and Construction of Steel Ships.

3.5.3 Structural Redundancy

1 Gas Floating Offshore Facilities are to be of such structural redundancy that their overall structures do not collapse even in cases where the external environmental forces for the 1-year return period specified in Chapter 2 act
on the Gas Floating Offshore Facility under the conditions that the following plates or girders which are one of the structural members related to overall strength becomes ineffective due to damage:
1. Plates enclosed by supporting stiffeners and girders (elementary plate panels of local strength evaluation)
2. One of the stiffeners fitted to an elementary plate panel
3. Girders fitted to elementary plate panels
   In cases where the assumed extent of damage in accordance with 2.4 is larger than the extent mentioned in (1) to (3), it is to be used.

2 In -1 above, the following parts are assumed to be damage and the stress of the surrounding structures is to be less than the yield stress of the materials used to make them:
1. Parts on which high loads are expected through overall strength analysis
2. Strengthened parts for large openings
3. Parts supporting mooring systems
4. Parts expected to reach a severe condition in the case of flooding
5. Parts liable to fatigue fractures
6. Parts expected to suffer damage in cases where the possibility of accidents occurring is high according to the examination sheet specified in 2.4.1.

3 Structural members assumed to be damages in -2 above are to be arranged so that they can be appropriately examined and monitored.

3.6 Structural Strength for Other Type Gas Floating Offshore Facilities

3.6.1 General
1. Overall Strength is to be in accordance with the requirements specified in Part P of the Rules for the Survey and Construction of Steel Ships.
2. Local Strength is to be in accordance with relevant requirements specified in Part P, Part C, or Part CSR-T of the Rules for the Survey and Construction of Steel Ships. In such cases, applied corrosion margins are to be in accordance with 3.8.3.

3.7 Fatigue Strength for Hull Structure Excluding Cargo Tanks

3.7.1 General
1. Structural members subject to repeated stress are to have sufficient fatigue strength, taking the value and number of cycles of the repeated stress, mean stress, the shape of members, etc. into consideration.
2. Fatigue analysis is to be performed in a site-specific manner based on the operation style and the environmental condition of the specific installation site considered in the design of the Gas Floating Offshore Facility.
3. Design fatigue life of a structure is equal to the design service life of the Gas Floating Offshore Facility but not less than 25 years.

3.7.2 Fatigue Strength Evaluation
1. Fatigue strength assessments are to be carried out for the connections of longitudinal stiffeners fitted to watertight plates, to web frames and transverse bulkheads within cargo areas, areas subject to reaction forces from mooring systems and the connections of plates to plates required by the Society.
2. In fatigue strength evaluations, the cumulative fatigue damage ratio is to be calculated based on the assumption of linear cumulative damage. The results of any evaluation and information regarding methods used in such evaluation such as the method of stress analysis, applied S-N Diagram, the consideration of mean stress, etc. are to be submitted to the Society.
3. Fatigue Strength may be estimated using cumulative fatigue damage ratio in correspondence to Appendix P1, Part P of the Rules for the Survey and Construction of Steel Ships or one of the following requirements. However, the reference stresses of stiffeners are to be calculated in accordance with the $10^{-4}$ probability level of design loads specified in Chapter 2.
1. In the case of longitudinal stiffeners
   (a) Annex C1.1.23-1, Part C of the Guidance for the Survey and Construction of Steel Ships, in cases where
(b) Appendix C, Part CSR-T of the Rules for the Survey and Construction of Steel Ships

(2) In the case of the members, excluding longitudinal stiffeners, of ship-type Gas Floating Offshore Facilities, Appendix C, Part CSR-T of the Rules for the Survey and Construction of Steel Ships

3.7.3 Criteria for Fatigue Strength Evaluation

1 The cumulative fatigue damage ratio \(D\) divided by Usage Factor \(\eta\) taking into account the criticality of structural members and the accessibility to structural members is not to exceed 1.0. The Usage Factor \(\eta\) is to be as given in Table 3.1.

\[
\frac{D}{\eta} \leq 1.0
\]

<table>
<thead>
<tr>
<th>Criticality of the structural members</th>
<th>Accessibility</th>
<th>Usage Factor, (\eta)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>High</td>
<td>1.0</td>
</tr>
<tr>
<td>Normal</td>
<td>Low</td>
<td>0.5</td>
</tr>
<tr>
<td>High</td>
<td>High</td>
<td>0.33</td>
</tr>
<tr>
<td>High</td>
<td>Low</td>
<td>0.1^1</td>
</tr>
</tbody>
</table>

Note) *1: For the structural members whose criticality is high and accessibility is low, special design consideration is to be taken into account in order to provide appropriate measures for inspection and condition monitoring in principle.

2 The criticality of structural members is to be considered from the viewpoints of strength and function. Highly critical structural members from a strength viewpoint signify members whose structural damage is connected to catastrophic accidents such as overturning, fires, explosions, etc. Highly critical structural members from a functional viewpoint signify, for example, members such as the shell plating of oil tanks and stiffeners fitted to outer shell plating whose cracks due to fatigue are connected to marine pollution.

3 The accessibility of structural members is to be judged based on whether there is a means of access for inspections and repairs. It is to be considered that the accessibility of members in splash zone and in-water parts is low unless special design considerations are taken.

3.8 Corrosion Control Means and Corrosion Margins

3.8.1 General

1 Corrosion control means for Gas Floating Offshore Facilities are to be provided in accordance with the relevant provisions specified in Part C of the Rules for the Survey and Construction of Steel Ships and taking design service life, maintenance, corrosive environment, etc. into account.

2 Corrosion control means and corrosion margins for a cargo containment system are to be in accordance with the requirement specified in 3.10.1.

3.8.2 Corrosion Control Means

The standard corrosion control means to be provided according to the corrosive environment to which structural members are exposed are specified in the following Table 3.2.
### Table 3.2 Standard Corrosion Control Means

<table>
<thead>
<tr>
<th>Structural members to be provided with corrosion control means</th>
<th>Means of corrosion control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above the light draught</td>
<td>Coating with rust-resistant and weather-resistant paint.</td>
</tr>
<tr>
<td>External shell</td>
<td></td>
</tr>
<tr>
<td>Upper deck, side-shell plating of hull</td>
<td></td>
</tr>
<tr>
<td>Below the light draught</td>
<td>Coating with sea water corrosion resistant paint, installation of cathodic protection or use two means at the same time.</td>
</tr>
<tr>
<td>structural members</td>
<td></td>
</tr>
<tr>
<td>Side-shell plating and bottom shell plating of hull</td>
<td></td>
</tr>
<tr>
<td>In ballast tank</td>
<td>Coating with sea water corrosion resistant paint or use coating and cathodic protection together.</td>
</tr>
<tr>
<td>Primary members such as bulkheads, floors, girders</td>
<td></td>
</tr>
<tr>
<td>Stiffeners such as longitudinals</td>
<td></td>
</tr>
<tr>
<td>Primary structural members other than those shown above</td>
<td>Coating with rust-resistant paint.</td>
</tr>
<tr>
<td>(excluding cargo containment systems)</td>
<td></td>
</tr>
</tbody>
</table>

3.8.3 Corrosion Margin

1. Corrosion margins according to the corrosive environment to which structural members are exposed are to be in accordance with the values given in Table 3.3. In cases where a corrosive environment is clearly severer than assumed, values that are bigger than the values given in Table 3.3 or additional corrosion control means considered appropriate will be required as deemed necessary by the Society.

2. In cases where the scantlings of structural members are to comply with the requirements given in Part C of the Rules for the Survey and Construction of Steel Ships, they are to follow (1) or (2) below:

   (1) In cases where the scantling is determined by plate thickness
   The value for \( + \alpha \) specified in the end of the formula is to be provided by the value given in Table 3.3.

   (2) In cases where the scantling is determined by section modulus
   For stiffeners having section modulus obtained by dividing the formula by 1.2, each scantling of web and face plates may be determined, and the values given in Table 3.3 are to be added to the determined thickness of each web and face plate.

3. In cases where the scantlings of structural members are to comply with the requirements given in Part CSR-T of the Rules for the Survey and Construction of Steel Ships, they are to follow (1) or (2) below:

   (1) In cases where the scantling is determined by plate thickness
   The values given in Table 3.3 are to be added to the value calculated by the formula and rounded up to the nearest 0.5mm.

   (2) In cases where the scantling is determined by the section modulus
   For stiffeners having section modulus given in the formula, each scantling of web and face plates may be determined, and the values given in Table 3.3 are to be added to the determined thickness of each web and face plate and rounded up to the nearest 0.5mm.

4. In the application of -2 and -3 above, loads calculated in accordance with Chapter 2 may be able to be used instead of those loads specified in Part C and Part CSR-T of the Rules for the Survey and Construction of Steel Ships.

### Table 3.3 One Side Corrosion Margin for Structural Members

<table>
<thead>
<tr>
<th>Corrosive environment</th>
<th>One Side Corrosion Margin (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Period intended to operate: 20 years</td>
</tr>
<tr>
<td>In ballast tank</td>
<td>Face of girder: 1.0</td>
</tr>
<tr>
<td></td>
<td>Other than those shown above: 0.8</td>
</tr>
<tr>
<td>Exposed to air</td>
<td>1.0</td>
</tr>
<tr>
<td>Exposed to sea water</td>
<td>0.5</td>
</tr>
<tr>
<td>Other than those shown above (excluding cargo containment systems)</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Note)
In cases where the period intended to operate assumes an intermediate value of Table 3.3, the period intended to operate is to be determined by linear interpolation and rounded up to one decimal place. In cases where the period intended to operate exceeds 30\ years, the period intended to operate is to be determined by linear extrapolation using the values equal to those in cases where the period intended to operate is 20\ years and 30\ years and rounded up to one decimal place.

3.9 Hull Equipment, etc.

3.9.1 Mooring Systems for Temporary Mooring, etc.
1 The mooring systems for temporary mooring specified in 9.2, Part P of the Rules for the Survey and Construction of Steel Ships need not be fitted. In cases where the Society deems such necessary in consideration of the form of Gas Floating Offshore Facility operations, the mooring systems for temporary mooring specified in 9.2, Part P of the Rules for the Survey and Construction of Steel Ships are required.
2 In the case of single-point mooring systems to moor shuttle tankers and deemed appropriate by the Society, the chafing chain used ends for mooring lines are to be fitted and are to comply with the following:
   (1) The chafing chain is to be the offshore chain specified in 3.2, Part L of the Rules for the Survey and Construction of Steel Ships, and the chain standard is short lengths (approximately 8m) of 76mm diameter.
   (2) The arrangement of the end connections of chafing chains is to comply with any standards deemed appropriate by the Society.
   (3) Documented evidence of satisfactory tests of similar diameter mooring chains in the prior six month period may be used in lieu of breaking tests subject to agreement with the Society.
3 Equipment used in mooring systems to moor at jetty etc. in order to install plant or mooring equipment for the mooring support ships and shuttle tankers, except for the equipment specified in -2 above, is to be as deemed appropriate by the Society.

3.9.2 Guardrails, Fenders, etc.
1 The guardrails or bulwarks specified in Chapter 23, Part C of the Rules for the Survey and Construction of Steel Ships are to be provided on weather decks. In cases where guardrails will become hindrances to the taking-off and landing of helicopters, means to prevent falling such as wire nets, etc. are to be provided.
2 Suitable fenders fore contact with the gunwales of other ships such as support ships, tug boats, shuttle tankers, etc. are to be provided.
3 Freeing arrangements, cargo ports and other similar openings, side scuttles, rectangular windows, ventilators and gangways are to be in accordance with the requirements for tankers specified in Chapter 23, Part C of the Rules for the Survey and Construction of Steel Ships.
4 Ladders, steps, etc. are to be provided inside compartments for safety examinations as deemed appropriate by the Society. However, the requirements of permanent means of access (PMA) specified in Regulation 3.6, Chapter II-1 of SOLAS do not apply to Gas Floating Offshore Facilities unless otherwise required by the Administration. In addition, inspection facilities will be regarded as complying with the Rules if the means to carry out inspections of the construction of Gas Floating Offshore Facilities and the means to carry out periodical surveys are judged to be in accordance with the requirements specified in Chapter 13, Part B of the Rules referred to in 14.3.1, Part B of the Rules for the Survey and Construction of Steel Ships.

3.9.3 Helicopter Decks, etc.
   The loads for helicopter decks and decks in helicopter hanger areas are to comply with the requirements specified in 3.2.7, Part P of the Rules for the Survey and Construction of Steel Ships.

3.10 Cargo Containment Systems

3.10.1 Cargo Containment Systems
   Cargo containment systems are to be in accordance with the requirements specified in Chapter 4, Part N of the Rules for the Survey and Construction of Steel Ships.
3.10.2 Filling Limits for Cargo Tanks

Filling of cargo tanks are to be in accordance with the requirements specified in Chapter 15, Part N of the Rules for the Survey and Construction of Steel Ships.

3.11 Cargo Tank Vent Systems

Cargo tank vent systems are to be in accordance with the requirements specified in Chapter 8, Part N of the Rules for the Survey and Construction of Steel Ships.

3.12 Protections of Deck

The deck structures of Gas Floating Offshore Facilities containing production systems are to be protected, as deemed appropriate by the Society, from any leakage of low temperature cargo onto the deck.
Chapter 4 POSITIONING SYSTEMS

4.1 General

4.1.1 General

1 Gas Floating Offshore Facilities are to be provided with positioning systems complying with the requirements given in this Chapter.

2 In the case of positioning systems which keep Gas Floating Offshore Facilities at a specific position by connecting mooring systems installed on the Gas Floating Offshore Facility to any of the periphery facilities for positioning defined in 1.2.5, construction of such periphery facilities for positioning and such mooring systems are to be in accordance with the following requirements:

   (1) Periphery facilities for positioning classified according to 1.1.1-6

   (2) In the case of floating-type periphery facilities for positioning, the construction, compartments, stability, positioning systems and installed equipment of such periphery facilities for positioning are to comply with relevant requirements given in these Guidelines.

   (3) In the case of fixed-type periphery facilities for positioning, the periphery facilities for other structures or the seabed are to be installed in accordance with appropriate codes or standards such as API RP2A. Installed equipment is to comply with relevant requirements given in these Guidelines.

3 The following plans and documents are to be submitted for periphery facilities of positioning:

   (1) General arrangements

   (2) Details of floating structures including the following information:

      (a) Arrangement plans of watertight compartments

      (b) Structural arrangements (shell platings, frames, bulkheads, etc.)

      (c) Details of watertight doors, hatches, etc.

      (d) Details of welding

      (e) Permanent ballast, etc.

      (f) Bilge, sounding and venting arrangements

      (g) Hazardous areas

   (3) Details of fixed structures (dolphins, jackets, etc.)

   (4) Mooring arrangements (including arrangements at the seabed such as anchor legs, piles and bearings for single point mooring systems)

   (5) Electrical system diagrams

   (6) Arrangements for protection against corrosion

   (7) Arrangement of electrical equipment in hazardous areas

   (8) Piping systems (including ancillary systems like swivels, etc.)

   (9) Data, calculations, etc. necessary for strength analysis, mooring analysis

   (10) Tests procedures (including test procedures for the hydrostatic tests of flow-line systems)

   (11) The information regarding the sea areas of operation sites (locations, bottom contour elevations/water depths, navigation routes around the site), sizes of moored floating structures, bottom soil conditions, environmental conditions, etc.

   (12) Other plans and/or documents deemed necessary by the Society

4.1.2 Mooring Systems

1 Mooring systems are to be sufficiently capable of positioning Gas Floating Offshore Facilities at a specific location against all of the design conditions for positioning as well as all of the safety conditions for systems embedded on the seabed and the ships laden with offloaded cargo from such Gas Floating Offshore Facilities.

2 In the case of mooring systems of Gas Floating Offshore Facilities operated in sea areas where low temperature, freezing, ice formation, etc. are predicted, the effects of such things are to be taken into consideration or appropriate countermeasures are to be provided.
4.1.3 Conditions to be Considered for Mooring System Analysis

With respect to the design of mooring systems, all hypothetical conditions including the following are to be considered:

1. **Intact condition**
   - A condition where the structure of the Gas Floating Offshore Facility proper and all mooring system components remain intact.

2. **Damage case with one broken mooring line**
   - A condition with any one mooring line broken at its design environmental condition which causes the maximum mooring line load for the entire system, where, however, the structure of the Gas Floating Offshore Facility proper remains intact. It should be noted that the mooring line subjected to the maximum load in intact conditions when broken may not lead to the worst broken mooring line case. Designers are to determine the worst case by analyzing several cases of broken mooring lines including broken lead line and broken adjacent line cases.

3. **Transient condition with one broken mooring line**
   - A condition with one mooring line broken (in principle, the lead line is to be considered as broken) in which the moored Gas Floating Offshore Facility exhibits transient motion (overshooting) until it has settled at a new equilibrium position.

4. **Damaged condition of Gas Floating Offshore Facilities proper**
   - A condition with the Gas Floating Offshore Facility proper damaged to the extent assumed as specified in Chapter 2, Part N of the Rules for the Survey and Construction of Steel Ships, where, however, all the mooring system components remain intact. However, this condition may not be taken into consideration where deemed unnecessary as a result of risk assessment.

2. The effects of increased line tension, etc. due to overshoot upon failure of one mooring line are to be considered through the analysis of the transient conditions of one broken mooring line. The proper clearances between Gas Floating Offshore Facilities and any near-by structures and ships are to also be verified.

3. In the case of Single Anchor Leg Mooring (SALM), cases considering a loss of buoyancy due to damage of a compartment of the SALM structure should be analyzed for position mooring capability instead of cases with one broken mooring line.

4. Mooring system analysis in combination with the assistance of propulsion systems, thrusters, etc. is to be as deemed appropriate by the Society.

4.2 Mooring Analysis

4.2.1 General

1. Mooring analysis is to be conducted based on the environmental conditions as specified in 2.3. Such analysis is to include the evaluations of the mean environmental forces, the extreme response of the Gas Floating Offshore Facility, and the corresponding mooring line tension.

2. Mooring system analysis as deemed appropriate by the Society is to be carried out for the all prospective mooring conditions. The effects due to the draught changes of the Gas Floating Offshore Facility are to be taken into consideration. In the case of Gas Floating Offshore Facilities mooring to individual periphery facilities, such as CALM, separate from the Gas Floating Offshore Facility, mooring analysis for the total system, including any periphery facilities, is to be carried out.

3. In case of mooring systems using mooring lines, analysis is to be carried out under the awareness that there is no harmful excessive bend of any lines in way of the contact points between mooring lines and mooring equipment (fairleaders, etc.) fitted on board Gas Floating Offshore Facilities.

4. The mooring systems of Gas Floating Offshore Facilities and the seabed mooring points (anchors, sinkers, piles, etc.) of any periphery facilities for positioning are not to be slided, uplifted, overturned, etc. against any envisioned force from the mooring lines. In cases where scouring effects are not considered to be negligible, appropriate consideration is to be taken such as the modification of burial depth, protection against the flow around seabed mooring points, etc.

5. Mooring analysis is to be made under the awareness that the equipment for mooring systems is subjected to steady forces of wind, current and mean wave drift force as well as wind and wave induced dynamic forces.
Maximum line tension is to be calculated considering that wind, wave, and current come from unrestricted directions. However, in cases where the data for the specific positioning area of a Gas Floating Offshore Facility prove a restricted direction of wind, wave and current in that area, calculations under such specific directions may be accepted in cases where deemed appropriate by the Society.

6 For mooring analysis of the single point mooring systems (e.g. turret mooring), the combination of external forces are to be determined based on sea state data of the specific operation site. When the useful data which show directional property of forces of the specific operation site is not available, the following combinations for non-collinear of wave, wind and current is to be considered as a minimum;

(1) Case 1: Wind and current are collinear and both at 30 degrees to waves
(2) Case 2: Wind at 30 degrees to waves and current at 90 degrees to waves
(3) Case 3: Wind at 90 degrees to waves and current at 30 degrees to waves
(4) Case 4: Wind at 30 degrees to waves and current at 45 degrees to waves
(5) Case 5: Wind at 45 degrees to waves and current at 30 degrees to waves

7 In the sea area where local sudden change of sea state (e.g. squall) is expected, that sea condition is also to be specially taken into consideration as environmental condition. The investigation is to be provided taking into consideration that squall, etc. are getting close from any direction and external forces (e.g. wave, wind) shortly change. However, the above investigation for sudden change of sea state may not be provided when heading control systems (e.g. effective thruster during sudden change of sea state) is installed.

8 The maximum offset of a Gas Floating Offshore Facility and maximum tension of a mooring line is to be calculated. Depending on the analysis objectives, a quasi-static analytical method, or dynamic analytical method as deemed appropriate by the Society (e.g. API RP 2SK (American Petroleum Institute (API), Recommend Practice for Design and Analysis of Stationkeeping Systems for Floating Structures, 1996)) may be used for calculations.

9 Either of time history response analysis or frequency response analysis is to be used as analysis method. However, maximum offset of a Gas Floating Offshore Facility and maximum tension of mooring line is to be calculated by time history response analysis or model experiment as for single point mooring system (e.g. turret mooring)

10 In the case of deep water operations with large numbers of production risers, mooring system analysis is to take into account riser loads, stiffness, damping, etc. in cases where the interaction between Gas Floating Offshore Facilities/mooring systems and riser systems are significant.

4.2.2 Mean Environmental Forces, etc.

1 The calculation of steady forces due to wind and current are to be in accordance with 2.3.

2 Mean and oscillatory low frequency drift forces may be determined by model tests or using hydrodynamic computer programs verified against model test results or other data. Mean drift forces may be determined using standards deemed appropriate by the Society.

3 Load information is to be prepared based on appropriate analysis, model tests, etc., and such information is to be provided on board.

4.2.3 Maximum Offset

1 Maximum offset may be calculated as the sum of the offset due to steady components such as wind, current, and wave (steady drift), and dynamic motion offset due to the dynamic components of forces induced by waves (high and low frequency).

2 The following formula is to be adopted as the standard for calculating maximum offset. In the following formula, mean offset and significant single amplitude or maximum amplitude of the maximum offset obtained from model tests or analysis methods deemed appropriate by the Society are used. (Frequency response analysis method)

\[ S_{\text{max}} = S_{\text{mean}} + S_{f(\text{max})} + S_{w(\text{sig})} \]

or

\[ S_{\text{max}} = S_{\text{mean}} + S_{f(\text{sig})} + S_{w(\text{max})} \]

whichever is greater

where

\[ S_{\text{mean}} \]: Mean offset of the Gas Floating Offshore Facility due to wind, current and mean drift
\[ S_{f(\text{sig})} \]: Significant single amplitude low frequency motion
\[ S_{w(\text{sig})} \]: Significant single amplitude wave frequency motion
The maximum values of low frequency motion $S_{lf}^{(max)}$ and wave frequency motion $S_{sw}^{(max)}$ may be calculated by multiplying their corresponding significant single amplitude values by the factor $C$, which is to be calculated as follows:

$$C = 1/2 \cdot \sqrt{2 \ln N}$$

$$N = \frac{T}{T_s}$$

$T$: Hypothetical storm duration (seconds), minimum 10,800 (i.e. 3 hours). In the case of areas with longer storm durations (monsoon areas), $T$ needs to be a higher value.

$T_s$: Average response zero up-crossing period (seconds)

In the case of low frequency components, $T_s$ may be taken as the natural period $nT$ of a Gas Floating Offshore Facility with a mooring system. $nT$ can be calculated as follows using the mass of the Gas Floating Offshore Facility $m$ (including added mass, etc.) and the stiffness of the mooring system $k$ for horizontal motion (port-starboard, fwd-aft, yaw motion) at the Gas Floating Offshore Facility’s mean position and equilibrium heading as follows:

$$nT = 2\pi \sqrt{\frac{m}{k}}$$

In such cases, information about the stiffness of mooring systems, damping forces, and other parameters which may affect the maximum values of low frequency motion are to be submitted to the Society for reference.

3 When time history response analysis is used, duration time of a calculation is to be at least three hours. The standard built-up time at start of the calculation is not to be less than 10% of calculation duration time to prevent excessive numerical motion at start time of calculation.

4 In order to assess the motion of Gas Floating Offshore Facilities in waves in relatively shallow water, shallow water effects are to be taken into account. In cases where the changes in tidal levels in shallow waters are relatively large, the tidal difference affecting Gas Floating Offshore Facility motion and the tension acting on mooring lines is to be considered.

5 In the case of single point mooring systems, the maximum offset for motion in waves is to be calculated using a non-linear time history domain method or model tests. In such cases, wave irregularities and wind variances are to be considered as well.

4.2.4 Calculation of Mooring Line Tensions, etc.

1 In order to calculate the maximum tension acting on the mooring lines, the severest combination of wind, waves and current is to be considered together with a sufficient number of angles of incidence. Although this severest condition generally corresponds to cases where all of the wind, wave and current directions are consistent, in the case of specific sea areas, the combination of wind, waves and current in different directions which are likely to create a higher tension are to be taken into account as needed.

2 In calculating the tension acting on mooring lines, at least items (1) to (3) mentioned below are to be considered. Item (4) may be assessed as necessary. This analytical procedure can be called a quasi-static analytical procedure and is to be adopted as the standard for calculating the tensions acting on mooring lines. The maximum tension of mooring lines calculated by this quasi-static analytical procedure has to have, in principle, a suitable safety factor specified in Table 4.1 corresponding to specific breaking tension.

(1) Static tension of mooring lines due to net weight and buoyancy

(2) Steady tension of mooring lines due to a steady horizontal offset of Gas Floating Offshore Facilities induced by wind, waves and current

(3) Quasi-static varying tension of mooring lines due to Gas Floating Offshore Facility motion induced by waves

(4) Tension of mooring lines in consideration of their elastic elongation in cases where they are used in a moderately taut condition (generally in shallow waters), or in cases where mooring lines with low rigidity such as fibre ropes are used
Table 4.1  Safety Factors for Mooring Lines

<table>
<thead>
<tr>
<th>Condition</th>
<th>Safety factor (Chains or wire ropes)</th>
<th>Safety factor (Synthetic fibre ropes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intact</td>
<td>1.67</td>
<td>2.50</td>
</tr>
<tr>
<td>Dynamic analysis</td>
<td>2.00</td>
<td>3.00</td>
</tr>
<tr>
<td>Quasi-static analysis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>One broken mooring line (at new equilibrium position)</td>
<td>1.25</td>
<td>1.88</td>
</tr>
<tr>
<td>Dynamic analysis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>One broken mooring line (transient condition)</td>
<td>1.43</td>
<td>2.15</td>
</tr>
<tr>
<td>Dynamic analysis</td>
<td>1.05</td>
<td>1.58</td>
</tr>
<tr>
<td>Quasi-static analysis</td>
<td>1.18</td>
<td>1.77</td>
</tr>
</tbody>
</table>

3  The maximum tension in a mooring line \( T_{\text{max}} \) is to be determined as follows:

\[
T_{\text{max}} = T_{\text{mean}} + T_{f(\text{max})} + T_{w(\text{sig})}
\]

or

\[
T_{\text{max}} = T_{\text{mean}} + T_{f(\text{sig})} + T_{w(\text{max})}
\]

whichever is greater

where
- \( T_{\text{mean}} \): Mean mooring line tension due to wind, current and mean steady drift
- \( T_{f(\text{sig})} \): Significant single amplitude low frequency tension
- \( T_{w(\text{sig})} \): Significant single amplitude wave frequency tension

The maximum values of low frequency tension \( T_{f(\text{max})} \) and wave frequency tension \( T_{w(\text{max})} \) are to be calculated by the same procedure as that used for obtaining the motions at low frequency and wave frequency described in 4.2.3-2 above.

4  When time history response analysis is used, tension of mooring line is to be calculated by either of the following method for one load combination case.

(1) calculating the average of maximum value of tension for each calculation in a way that calculation of which duration time is minimum three hours is done for over 20 times by changing random number seed of irregular load. However, the number of calculations may be reduced based on the study about low frequency motion of mooring system, influence on analysis result of wave frequency and low frequency motion component, and influence on analysis result of each parameter such as nonlinear factor at the site.

(2) calculating the expected maximum value of tension statistically based on the calculation of which duration time is minimum three hours.

The following statistical approach methods, which approximate the peak values over threshold based on maximum likelihood method, is recommended.

(a) 3 variable Weibull distribution

\[
F_{\text{weibull}}(y) = 1 - \exp \left( - \left( \frac{y - \mu_w}{\sigma_w} \right)^{\xi_w} \right)
\]

where \( \sigma_w \) is scale parameter, \( \xi_w \) is shape parameter, \( \mu_w \) is positional parameter

(b) Generalized Pareto distribution

\[
F_{\text{GPD}}(y) = 1 - \left( 1 + \frac{\xi_p}{\sigma_p} \right)^{-1/\xi_p} \quad \text{for } \xi_p \neq 0, \text{ where } \left( 1 + \frac{\xi_p}{\sigma_p} \right)^{-1/\xi_p} = \max \left( 0,1 + \frac{\xi_p}{\sigma_p} \right)
\]

\[
F_{\text{GPD}}(y) = 1 - \exp \left( - \frac{y}{\sigma_p} \right) \quad \text{for } \xi_p = 0
\]

where \( \sigma_w \) is scale parameter, \( \xi_w \) is shape parameter

5  Mooring systems are to be designed so that the failure of any one mooring line does not cause the progressive failure of the remaining mooring lines. The tension acting on the remaining mooring lines is to be calculated using
the quasi-static analytical procedure. The safety factors for the tension of such mooring lines are, in principle, not to be less than those specified in Table 4.1 corresponding to their respective specific breaking tension. The period of recurrence of environmental loads such as wind and wave loads, however, may be taken as one year.

6 In the analysis of the one broken mooring line condition given in -5 above, in the case of a Gas Floating Offshore Facility which is moored in the proximity of other Floating Offshore Facilities, the safety factors for any mooring lines arranged on the opposite side of the other Floating Offshore Facilities are to be taken as 1.5 times of those indicated in Table 4.1.

7 In cases where the following items (1) and (2) are taken into account in addition to -2 above, the safety factors required in cases where quasi-static analytical procedures are adopted may be modified to values deemed appropriate by the Society.

(1) Dynamic tension in mooring lines due to damping forces and inertia forces acting on each mooring line in cases where they are generally used in deep water.

(2) Quasi-static low-frequency varying tension of mooring lines due to the low-frequency motion of Gas Floating Offshore Facilities in irregular waves in cases where they are used in a sufficiently slack condition. (in cases where the natural period of motion of a Gas Floating Offshore Facility in a horizontal plane is sufficiently longer than the period of ordinary waves)

8 In the case of Taut Mooring systems, the following are to be complied with in addition to -1 to -7 above:

(1) Such systems are to be designed so that no slack is caused in any mooring line due to changes in line tension.

(2) Changes in the tension of mooring lines due to tidal difference including astronomic tides and meteorological tides are to be considered.

(3) The effects of any changes in the weight and displacements of heavy items carried on board upon the tension of mooring lines are to be sufficiently taken into account.

(4) In cases where the effects of the non-linear behavior of mooring lines on their tension are not negligible, tension due to non-linear behavior is to be considered.

4.2.5 Fatigue Analysis

1 The fatigue life of mooring lines is to be assessed in consideration of the changing tension range, \( T \) and the number of cycles, \( n \). The fatigue life of mooring lines is to be evaluated by estimating the fatigue damage ratio, \( D_i \) in accordance with Miner’s law using a curve relating the changing tension range to the number of cycles to failure. (\( T - N \) curve)

\[
D_i = \frac{n_i}{N_i}
\]

\( n_i \) : Number of cycles of changing tension range, \( T_i \), for a given sea state.

\( N_i \) : Number of cycles to failure at changing tension range, \( T_i \).

The cumulative fatigue damage, \( D \) for all expected number of sea states \( NN \) (identified in a wave scatter diagram) is to be calculated as follows:

\[
D = \sum_{i=1}^{NN} D_i
\]

The value of \( D \) divided by the usage factor (\( \eta \)) specified in 3.7.3-1 is not to be greater than 1. In such cases, the usage factors for the underwater parts of the mooring lines are, in principle, to be taken to be that of an inaccessible and critical area.

2 The fatigue life of each mooring line component is to be considered. \( T - N \) curves for various line components are to be based on fatigue test data and regression analysis.

3 Special consideration is to be given to the fatigue strength of the connections between the mooring lines and hull structures of Gas Floating Offshore Facilities, the connections between the mooring lines and seabed mooring points, and the connections between the mooring lines and other mooring lines.

4.3 Design of Mooring Lines, etc.

4.3.1 Components of Mooring Lines and Seabed Mooring Points

1 Each component of mooring systems is to be designed using design methods by which the severest loading
condition can be verified. The strength of connecting shackles, links, etc. used at the connecting points between the mooring lines and hull structures of Gas Floating Offshore Facilities and between mooring lines and seabed mooring points are, in principle, to have safety factors against the breaking loads of such mooring lines or the ultimate strength of structures not less than those indicated in the Table 4.2.

<table>
<thead>
<tr>
<th>Table 4.2 Safety Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety factor</td>
</tr>
<tr>
<td>Intact condition (unmoored Gas Floating Offshore Facility in storm conditions)</td>
</tr>
<tr>
<td>Intact condition (moored Gas Floating Offshore Facility under operating conditions)</td>
</tr>
</tbody>
</table>

Note) *1: In cases where a safety factor of 2.0 is ensured, even in the any one broken mooring line condition, a safety factor of 2.5 may be accepted.

2 In the case of catenary mooring systems, mooring lines are to be sufficiently long so that no up-lifting forces act on the parts of the mooring line around the mooring point on the seabed under design conditions. In the case of soft clay conditions (like in the Gulf of Mexico), a small angle for the one broken mooring line condition may be considered in cases where deemed acceptable by the Society.

3 Information verifying that the holding power of seabed mooring points is sufficient against the expected tension from the mooring lines in accordance with 4.2.4 is to be submitted to the Society for reference.

4 In the case of seabed mooring points which rely on friction with the seabed surface, if the submerged unit weight of mooring lines is constant, the maximum load at the seabed mooring point $F_{anchor}$ can be calculated as follows:

\[
F_{anchor} = P_{line} - W_{sub}WD - F_{friction}
\]

\[
F_{friction} = f_{sl}L_{bed}W_{sub}
\]

$P_{line}$: Maximum mooring line tension

$WD$: Water depth

$f_{sl}$: Friction coefficient of mooring line on seabed at sliding which is to be determined in consideration of soil conditions, the type of mooring line, etc. In the case of soft mud, sand, and clay, the values of $f_{sl}$ and the coefficient of friction at the start $f_{st}$, indicated in the Table 4.3 may be used.

$L_{bed}$: Length of mooring line on seabed at design storm conditions, not to exceed 20% of the total length of a mooring line

$W_{sub}$: Submerged unit weight of mooring line

In cases where submerged mooring lines are not a single line, or those cases where using intermediate sinkers/buoys, the above equation is to be applied in consideration of such effects.

5 The safety factors for the horizontal holding power capacity of the seabed mooring points of catenary mooring systems and taut mooring systems are, in principle, to be in accordance with Table 4.4. However, the above may not be complied with in cases where required ultimate holding capacity is to be determined based on mooring loads derived from dynamic analysis taking into account mooring line dynamics.

6 The safety factors for the vertical holding power capacity of the seabed mooring points of taut mooring systems are, in principle, to be in accordance with Table 4.5.

<table>
<thead>
<tr>
<th>Table 4.3 Coefficient of Friction $f$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Chain</td>
</tr>
<tr>
<td>Wire rope</td>
</tr>
</tbody>
</table>
Table 4.4 Safety Factor for the Horizontal Holding Capacity of the Seabed Mooring Points of Catenary Mooring Systems and Taut Mooring Systems

<table>
<thead>
<tr>
<th>Safety factor</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Intact</td>
<td>1.50</td>
</tr>
<tr>
<td>One broken mooring line extreme</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Table 4.5 Safety Factor for the Vertical Holding Capacity of the Seabed Mooring Points of Taut Mooring Systems

<table>
<thead>
<tr>
<th>Safety factor</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Intact</td>
<td>1.20</td>
</tr>
<tr>
<td>One broken mooring line extreme</td>
<td>1.00</td>
</tr>
</tbody>
</table>

4.4 Mooring Equipment

4.4.1 General

1 The equipment of positioning systems is to have sufficient redundancy. In cases where any single unit of equipment of positioning systems is fitted on board Gas Floating Offshore Facilities, special consideration is to be given to the reliability of such equipment and its components. In cases where the failure of any single unit of equipment may lead to loss of positioning capability, an additional set of such equipment will be required as deemed necessary by the Society.

2 Means are to be provided whereby the normal operations of positioning systems can be sustained or restored even though one unit of equipment becomes inoperative. In the case of driving units, special consideration is to be given for preventing loss of function.

3 The prime movers used for positioning systems are to be designed to operate under the static conditions given in 7.1.4-2 and -3 as well as under the dynamic conditions given below. Deviation from given values may be permitted, taking into consideration the type, size and service conditions, etc. of the Gas Floating Offshore Facility in cases where deemed appropriate by the Society.

(1) In the case of ship-type and barge-type Gas Floating Offshore Facilities:
   Rolling up to 22.5 degrees and simultaneously pitching up to 7.5 degrees

(2) In the case of other Gas Floating Offshore Facilities:
   Dynamic inclination up to 22.5 degrees in any direction

4.4.2 Chains, Wire Ropes, etc.

1 Chains, wire ropes or fibre ropes used for mooring systems are to comply with the requirements given in Chapter 3 to 5, Part L of the Rules for the Survey and Construction of Steel Ships or any standards deemed appropriate by the Society. In cases where the Grade R4 chains specified in 3.2, Part L of the Rules for the Survey and Construction of Steel Ships or stronger chains are used, special care is to be taken because repairs by welding for any defects, loose studs and corrosion by welding is, in principle, prohibited for such chains.

2 Intermediate sinkers, intermediate buoys and anchors, sinkers, piles, etc. for seabed mooring points are to be as deemed appropriate by the Society.

4.4.3 Chain Stoppers or Windlasses, Winches, etc.

1 Individual equipment of mooring systems is, in principle, to be approved by the Society.

2 Chain stoppers used for mooring systems are to have sufficient strength against the breaking strength of the mooring line as deemed appropriate by the Society. The prototypes of chain stoppers are to be verified to have sufficient strength against the breaking strength of the mooring line. It is to be verified that the stress calculated by structural analysis under the awareness that the mooring line is subjected to design maximum loads does not exceed the specified proof stress of the chain stoppers.

3 Windlasses used for the catenary mooring systems of Gas Floating Offshore Facilities are to comply with the requirements specified in following (1) to (3):

(1) Each windlass is to be provided with two independent power-operated brakes. Each brake is to be capable of holding against a static load of at least 50% of braking strength of mooring lines. In cases where deemed appropriate by the Society, one of the brakes may be replaced by a manually operated brake.
(2) Windlasses are to have sufficient dynamic braking capacity to control the normal combination of loads from anchors, mooring lines and anchor handling vessels during the deployment of anchors at the maximum design pay-out speed of the windlass.

(3) In cases where a power source for a windlass is lost, power-operated braking systems are to be automatically applied and be capable of holding against 50% of the total static braking capacity of the windlass.

4 The means specified in (1) to (4) below are to be provided for controlling catenary mooring systems:

1 Each windlass is to be capable of being controlled from a position which provides a good view of the operation.

2 Means are to be provided at the windlass control position to monitor mooring line tension and windlass power load as well as to indicate the amount of mooring line paid out.

3 Indicators for mooring line tension, wind velocity and wind direction at the control station of each windlass are to be provided at the manned control position.

4 Means of communication are to be provided between essential places for mooring operations (for example, operating position, wheel house, control room, etc.)

5 Means are to be so provided that mooring lines can be released from the Gas Floating Offshore Facility after any loss of the main power supply.

6 In the case of laying taut mooring lines, the initial tension in all mooring lines is to be coordinated to achieve approximate uniformity. Power equipment capable of adjusting the tension of mooring lines is to be provided as necessary.

7 A tension monitoring system is to be provided for each taut mooring line.

4.4.4 Fairleaders

1 In cases where chains are used for mooring lines, the standard length of the part where the chain and fairleader make contact is to be not less than 7 times the chain diameter.

2 In cases where wire ropes or fibre ropes are used for mooring lines, the standard length of the part where the wire rope and fairleader make contact is to be not less than 14 times the wire rope nominal diameter.

3 In the case of arrangements that do not comply with the standards given in -1 or -2 above, detailed analysis in which the effects of bending loads acting on mooring lines is taken into account is to be carried out. Otherwise, mooring analysis is to be carried out modifying the values of the safety factors given in Table 4.1 up to those values deemed appropriate by the Society.

4.5 Single Point Mooring Systems

4.5.1 Design Loads for Structures

1 The design of the structure and equipment of single point mooring systems is to consider the severest combination of various loads including at least the following. A detailed report about such designs is to be submitted to the Society for reference.

1) Dead loads

2) Dynamic loads due to motion (including rotating motion around turn tables)

3) Mooring loads

4) Fatigue loads

2 In order to consider the design loads acting on turret systems, the loads from mooring lines or risers due to gravity, buoyancy, inertia, and hydraulic forces, etc. are to be taken into account.

4.5.2 Structural Components

1 Structural components are, in principle, to be in compliance with the codes or standards deemed appropriate by the Society and structural strength is to be evaluated by suitable methods such as FEM, etc.

2 When performing the analysis mentioned in -1 above, the allowable stress for von Mises stress is to be 60% of the specified yield strength (not to exceed 72% of the specified tensile strength) of the material used for the part in concern. In the case of transient conditions in the one broken mooring line condition, however, the value of allowable stress may be increased up to but not exceeding 80% of specified yield strength.

3 Structural components are to have sufficient strength against buckling in consideration of their shape, size, surrounding conditions, etc.

4 A fatigue life evaluation is to be carried out for those parts among essential components designated by the
Society, such as turret systems, yokes, etc. In such cases, a usage factor of 0.33 (0.1 for inaccessible areas) is to be used for such evaluations.

5 The structures of the periphery facilities for positioning, the connections between such periphery facilities for positioning and mooring systems and the connections between such periphery facilities for positioning and seabed mooring points are to be those complying recognized standards/codes.

6 The parts of the hull structures of Gas Floating Offshore Facilities which transmit and dissipate the loads from turrets and yokes (turret bearing parts, etc.) are to be capable of withstanding such loads and are to be suitably reinforced.

4.5.3 Mechanical Components

1 The mechanical components of single point mooring systems (turret bearings, driving mechanisms, various connecting attachments, etc.) are to be in accordance with standards/codes deemed appropriate by the Society in addition to relevant requirements given in Chapter 7.

2 The bearings which carry the loads from rotation structures and mooring lines (turret bearings, etc.) are to be designed with a safety factor of not less than 2 against the destructive yielding of the bearing surface.

3 Notwithstanding above, bearings which do not carry loads may be designed in accordance with standards/codes deemed appropriate by the Society.

4.6 Dynamic Positioning Systems

4.6.1 General

Dynamic positioning systems are to comply with the requirements in 10.2.3 and 10.7, Part P of the Rules for the Survey and Construction of Steel Ships.
Chapter 5  HAZARDOUS AREAS

5.1  General

5.1.1  Application
The requirements given in this Chapter apply to the categorization of hazardous areas.

5.2  Hazardous Areas

5.2.1  General
Hazardous areas for a Gas Floating Offshore Facility are to be categorized in accordance with those requirements given in 4.2.3-3, -4 and -5, Part H of the Rules for the Survey and Construction of Steel Ships and API RP500 and 505.
Chapter 6  FIRE PROTECTION, EXTINCTION, MEANS OF ESCAPE AND PERSONNEL PROTECTION

6.1  General

6.1.1  Application
1  For all Gas Floating Offshore Facilities handling cargoes subject to the application of these Guidelines, fire protection, means of escape, fire extinguishing systems and personnel protection are to comply with the requirements in Chapters 11 and 14, Part N of the Rules for the Survey and Construction of Steel Ships, unless otherwise especially specified in this Chapter.
2  Attention is to be given to any statutory requirements of the National Authority having jurisdiction in the waters where the Gas Floating Offshore Facility is located during operation.
3  Risk assessment for fire and explosions, etc. is to be provided and this result is to be taken into consideration appropriately.
4  Where deemed appropriate by the Society, the requirements in this Chapter may be appropriately modified according to to the condition of to a Gas Floating Offshore Facility.

6.1.2  Definitions
1  “H” class divisions
“H” class divisions are those divisions formed by bulkheads and decks which comply with the following criteria:
(1) they are constructed of steel or other equivalent material;
(2) they are suitably stiffened;
(3) they are constructed to be capable of preventing the passage of smoke and flame and keeping standing to the end of 120-minute hydrocarbon fire tests (“keeping standing” means that they are not to collapse under their own weight, be damaged or collapse under ordinary usage after 120-minute hydrocarbon fire tests);
(4) they are insulated with approved non-combustible materials such that the average temperature of unexposed sides will not rise more than 140°C above the original temperature, nor will the temperature, at any one point, including any joint, rise more than 180°C above the original temperature, within the time listed below during 120-minute hydrocarbon fire tests:
   class “H - 120”  120 minutes
   class “H - 60”   60 minutes
   class “H - 0”    0 minutes
(5) they are ensured by through tests of prototype bulkheads or decks that the specimen is subjected to the temperature corresponding to the curve of hydrocarbon fire time versus temperature described in “Interim Hydrocarbon Fire Resistance Test for Elements of Construction for Offshore Installations” given by U.K. Department of Energy or Norwegian Petroleum Directorate to ensure that it meets the above requirements for integrity and temperature rise, and to be approved by the Society or organizations deemed appropriate by the Society.

6.2  Location and Separation of Spaces

6.2.1  Location and Separation of Production System
1  Relevant hazards are to be considered in cases where locating production systems relative to areas for accommodation, control stations, alleyways and life-saving equipment.
2  Production systems and cargo tanks are to be separated from accommodation, service and machinery spaces. In cases where production systems are arranged, secure separation will normally require that no accommodation or combustion equipment is to be located in areas defined as hazardous. In cases where adequate separation of accommodation and life saving equipment cannot be applied, the use of fire resisting divisions and cofferdams may be accepted after special consideration.
3 Entrances, air inlets and openings to accommodation spaces are normally not to face production areas.
4 Control stations are to be located in non-hazardous areas.
5 Areas which contain production systems, gas flare, cold vent, cargo storage and cargo offloading systems are to be arranged in order to provide:
   (1) Easy access for operation and maintenance
   (2) Easy access for fire fighting
   (3) Adequate ventilation
   (4) Minimized explosion overpressure in the case of ignited gas release
6 The outlets of gas disposal systems, e.g. flares, cold vents or pressure relief valves or from large engine exhausts are to be led to areas where radiation, heat or gases will not be a hazard to Gas Floating Offshore Facilities, personnel or equipment.
7 Flare and vent systems are to be in accordance with the standards deemed appropriate by the Society such as API RP521 (American Petroleum Institute, Guide for Pressure-Relieving and Depressurizing Systems, 4th Edition, March 1997). The radiant heat intensities or emissions from flares and vents are not to exceed the following limits:
   (1) In areas where emergency action lasting up to 1 minute may be required by personnel without shielding, but with appropriate clothing: 6.3 $kW/m^2$
   (2) In areas where emergency action lasting several minutes may be required by personnel without shielding, but with appropriate closing: 4.7 $kW/m^2$
   (3) At any location where personnel are continuously exposed: 1.6 $kW/m^2$
   (4) Temperature rating of electrical and mechanical equipment
   (5) At any point on Floating Offshore Facilities where the gas plumes from vents could be ignited or personnel could come into contact with such gas: 60% LEL

6.2.2 Location and Separation of Cargo Areas
1 Cargo areas are to be appropriately located and segregated in accordance with the requirements in Chapter 3, Part N of the Rules for the Survey and Construction of Steel Ships.
2 Mooring systems with combustion machinery are to be located outside of hazardous areas unless special precautions to avoid any risks of ignition during normal operations and emergency releases are provided.
3 Chain lockers and chain pipes are to be arranged in non-hazardous areas.

6.2.3 Location of Cofferdams
1 In case where cofferdams are provided in accordance with 6.2.2-1, cofferdams are to have breadths not less than 600mm.
2 Ballast tanks will be accepted as cofferdams.

6.3 Construction for Fire Protection

6.3.1 General
The portions of the exterior boundaries of superstructures and deckhouses enclosing accommodation spaces, service spaces and control stations, including any overhanging decks which support accommodation spaces, that face cargo areas, including 3m of side boundaries, are to be protected against heat by Class A-60 insulation. In cases where the relevant deckhouses, etc. are facing production areas, exterior boundaries of those portions facing production areas, including 3m of side boundaries, are to be protected against heat by Class H-60 insulation. In cases where there is a minimum of 30m separation from cargo areas and the production areas, however, respectively Class A-0 and Class H-0 insulation or Class A insulation deemed appropriate by the Society may be applied.

6.3.2 Bulkheads within Accommodation Spaces and Service Spaces and Details of Construction
In applying the requirements given in 5.3 and 9.2.3, Part R of the Rules to Gas Floating Offshore Facilities, only method IC as defined in 9.2.2-1, Part R of the Rules for the Survey and Construction of Steel Ships is to be used.
6.3.3 Fire Integrity of Bulkheads and Decks

1 The fire integrity of bulkheads and decks which separate adjacent spaces is to be in accordance with the requirements given Table 6.1 and Table 6.2 instead of 9.2.4-2, Part R of the Rules for the Survey and Construction of Steel Ships.

In application of the standards of fire integrity, the respective spaces are classified into the following categories (1) to (13) in accordance with their risk of fire. The title of each category is intended to be typical rather than restrictive.

(1) Control stations
   (a) Spaces containing emergency sources of power and lighting
   (b) Wheelhouses and chart rooms
   (c) Radio rooms
   (d) Spaces containing fire indicating equipment, fire alarm equipment and fire control equipment
   (e) Control stations for propulsion machinery provided outside machinery spaces
   (f) Central production control stations

(2) Corridors and lobbies

(3) Accommodation spaces (excluding corridors and lobbies)

(4) Stairways
   Interior stairways, lifts and escalators (excluding those wholly contained within machinery spaces) and enclosures thereto

(5) Service spaces with low risk of fire
   Locker rooms and store rooms not used for the storage of flammable liquids and having areas less than 4 \( m^2 \), drying rooms and laundries

(6) Machinery spaces of Category A
   Spaces as defined in 3.2.31, Part R of the Rules for the Survey and Construction of Steel Ships

(7) Other machinery spaces
   Machinery spaces excluding machinery spaces of Category A

(8) Cargo areas
   Spaces as defined in 1.2.6 (excluding spaces as containing production systems)

(9) Production areas
   Spaces containing production systems, spaces for extracting gas and manifolds

(10) Hazardous areas
   Areas defined in 5.2.1

(11) Service spaces with high risk of fire
   Galleys, pantries containing appliances, paint rooms, lamp rooms, and locker rooms and store rooms having areas of 4m\(^2\) or more, spaces for the storage of flammable liquids, and workshops which are not included in machinery spaces

(12) Spaces on open decks
   Spaces on open decks, enclosed promenades without risk of fire and spaces outside superstructures and deckhouses

(13) Sanitary spaces
   Spaces containing sanitary and similar accommodations

2 Continuous B class ceilings or linings, in association with relevant decks or bulkheads, may be accepted as contributing, wholly or in part, to the required insulation and integrity of a division.

3 In approving structural fire protection details, the risk of heat transmission at intersections and terminal points of required thermal barriers is to be considered. The insulation of a deck or bulkhead is to be carried past the penetration, intersection or terminal point for a distance of at least 450 \( mm \) in the case of steel and aluminium structures. If a space is divided with a deck or a bulkhead of “A” class standard having insulation of different values, the insulation with the higher value is to continue on the deck or bulkhead with the insulation of the lesser value for a distance of at least 450 \( mm \).

4 Windows and side scuttles, with the exception of navigating bridge windows, are to be of the non-operating type. Navigating bridge windows may be of the opening type provided the design of such windows would permit rapid closure.
5 The fire resistance of doors are, as far as practicable, to be equivalent to that the division in which they are fitted. External doors in superstructures and deckhouses are to be constructed to “A-0” Class divisions and, where applicable, be self-closing.

6 Self-closing doors in fire rated bulkheads are not to be fitted with hold-back hooks. However, hold-back arrangements incorporating remote release fittings of the fail-safe type may be utilized.

7 Protection of accommodation spaces, service spaces and control stations (except the space where the emergency source of electric power is installed, the same being applied hereinafter in 6.3.3), is to be in accordance with the requirements in the following (1) to (14):

   (1) In general, accommodation spaces, service spaces and control stations are not to be located adjacent to hazardous areas. However, where this is not practicable, an engineering evaluation is to be performed to ensure that the level of fire protection and blast resistance of the bulkheads and decks separating these spaces from the hazardous areas are adequate for the likely hazard.

   (2) All bulkheads that are to be “A” class divisions are to extend from deck to deck and to the deckhouse side or other boundaries.

   (3) All bulkheads required to be “B” Class divisions are to be extend from deck to deck and to the deckhouse side or other boundaries, unless continuous “B” Class ceilings or linings are fitted on both sides of the bulkhead, in which case the bulkhead may terminate at the continuous ceiling or linings.

   (4) In corridor bulkheads, ventilation openings may be permitted only in and under the doors of cabins, public spaces, offices and sanitary spaces. The openings are to be provided only in the lower half of the door. Where such an opening is in or under a door, the total net area of any such opening or openings are not to exceed 0.05 m². When such an opening is cut in a door it is to be fitted with a grille made of non-combustible material. Such openings are not to be provided in a door in a division forming a stairway enclosure.

   (5) Stairs are to be constructed of steel or other material equivalent thereto.

   (6) Stairways which penetrate only a single deck are to be protected at least at one level by “A” or “B” Class divisions and self-closing doors so as to limit the rapid spread of fire from one deck to another. Personnel lift trucks are to be protected by “A” Class divisions. Stairways and lift trucks which penetrate more than a single deck are to be surrounded by “A” Class divisions and protected by self-closing doors at all levels. Self-closing doors are not to be fitted with hold-back hooks.

   (7) Air spaces enclosed behind ceilings, panellings or linings are to be divided by close fitting draught stops spaced not more than 14 m apart. In the vertical direction, such enclosed air spaces, including those behind linings of stairways, trunks, etc., are to be closed at each deck.

   (8) Except for insulation in refrigerated compartments, insulation material, pipe and vent duct lagging, ceiling, lining and bulkheads are to be of non-combustible material. Insulation of pipe fittings for cold service systems and vapour barriers and adhesives used in conjunction with insulation need not be non-combustible but they are to be kept to a minimum and their exposed surfaces are to have low-flame spread characteristics. In spaces where penetration of oil products is possible, the surfaces of the insulation are to be impervious to oil or oil vapours.

   (9) The framing, including grounds and the joint pieces of bulkheads, linings, ceilings and draught stops are to be of non-combustible material.

   (10) All exposed surfaces in corridors and stairway enclosures and surfaces in concealed or inaccessible spaces in accommodation and service spaces and control stations are to have low flame-spread characteristics. Exposed surfaces of ceilings in accommodation and service spaces and control stations are to have low-flame-spread characteristics.

   (11) Bulkheads, linings and ceilings may have combustible veneers provided that the thickness of such veneers are not to exceed 2 mm within any space other than corridors, stairway enclosures and control stations where the thickness is not to exceed 1.5 mm. Combustible materials used on these surfaces are to have a calorific value not exceeding 45 MJ/m² of the area for the thickness used.

   (12) Primary deck coverings, if applied within accommodation and service spaces and control stations, are to be of approved material by the Society or organizations deemed appropriate by the Society, which will not readily ignite, this being determined in accordance with the Fire Test Procedures Code.

   (13) Paints, varnishes and other finishes used on exposed interior surfaces are not to be capable of producing excessive quantities of smoke and toxic products; this being approved by the Society or organizations deemed
appropriate by the Society in accordance with the Fire Test Procedures Code.

(14) The portions of the exterior boundaries of superstructures and deckhouses enclosing accommodation spaces, service spaces and control stations, including any overhanging decks which support accommodation spaces, that face cargo areas, including 3m of side boundaries, are to be protected against heat by Class A-60 insulation. In cases where the relevant deckhouses, etc. are facing production areas, exterior boundaries of those portions facing production areas, including 3m of side boundaries, are to be protected against heat by Class H-60 insulation. In cases where there is a minimum of 30 separation from cargo areas and the production areas, however, Class A-0 insulation or Class A insulation deemed appropriate by the Society may be applied.

8 Ventilation provided with units except those provided in hazardous area are to be in accordance with following (1) to (10).

(1) The ventilation of the accommodation spaces and control stations are to be arranged in such a way as to prevent the ingress of flammable, toxic or noxious gasses, or smoke from the surrounding area.

(2) Ventilation ducts are to be of non-combustible material. Short ducts, however, not generally exceeding 2m in length and with a cross-sectional area not exceeding 0.02m² need not be non-combustible, subject to the following conditions:
   (a) These ducts are to be of a material which, in the opinion of the Society, has a low fire risk;
   (b) They may only be used at the end of the ventilation devices; and
   (c) They are not to be situated less than 600mm, measured along the duct, from where it penetrates any “A” or “B” Class division including continuous “B” Class division.

(3) Where a thin plated duct with a free cross-sectional area equal to, or less than, 0.02m² passes through “A” class bulkhead or decks, the opening is to be lined with a steel sheet sleeve having a thickness of at least 3mm and a length of at least 200mm, divided preferably into 100mm on each side of the bulkhead or, in the case of the deck, wholly laid on the lower side of the deck pierced. Where ventilation ducts with a cross-sectional area exceeding 0.02m² pass through class “A” bulkheads or decks, the opening is to be lined with a steel sheet sleeve unless the ducts passing through the bulkheads or decks are of steel in the vicinity of penetrations through the deck or bulkhead. The ducts and sleeves at such places are to comply with the followings.
   (a) The ducts or sleeves are to have a thickness of at least 3mm and a length of at least 900mm. When passing through bulkheads, this length is to be divided preferably into 450mm on each side of the bulkhead. These ducts, or sleeves lining such ducts, are to be provided with fire insulation. The insulation is to have at least the same fire integrity as the bulkhead or deck through which the duct passes. Equivalent penetration protection may be provided to the satisfaction of the Society.
   (b) Ducts with a cross-sectional area exceeding 0.075m², except those serving hazardous areas, are to be fitted with fire dampers in addition to meeting the requirement of (a). The fire damper is to operate automatically but is also to be capable of being closed manually from both sides of the bulkhead or deck. The damper is to be provided with an indicator which shows whether the damper is open or closed. Fire dampers are not required, however, where ducts pass through spaces surrounded by “A” Class divisions, without serving these spaces, provided those ducts have the same fire integrity as the divisions which they pierce. The Society may, given special considerations, permit operation from one side of a division only.

(4) In general, ventilation systems for machinery spaces of category A, galleys and hazardous areas are to be separated from each other and from the ventilation systems serving other spaces. Ducts serving hazardous areas are not to pass through accommodation spaces, service spaces, or control spaces. Ducts provided for ventilation of machinery spaces of category A and galleys are not to pass through accommodation and service spaces or control stations, except in cases where any of the following requirements of (a) or (b) are complied with:
   (a) The ducts are constructed of steel having a thickness of at least 3mm for ducts of 300mm in width or less and at least 5mm for ducts of 760mm in width and over. In case of ducts the width or diameter of which is between 300mm and 760mm, the thickness are to be obtained by interpolation;
   (b) The ducts are suitably supported and stiffened;
   (c) The ducts are to be fitted with automatic fire dampers close to the boundaries penetrated; and
   (d) The ducts are to be insulated to “A-60” standard from the machinery or galleys to a point at least 5m beyond each fire damper.
(b) i) The ducts are constructed of steel in accordance with the preceding (4)(a)i) and ii);
ii) The ducts are to be insulated to “A-60” standard throughout the accommodation spaces, service spaces or control stations.

(5) Ducts provided for ventilation of accommodation and service spaces or control stations are not to pass through machinery spaces of category A, galleys or hazardous areas, except for the following requirements (a) or (b) may be complied with:

(a) i) The ducts where they pass through a machinery space of category A or galley are constructed of steel in accordance with the requirement in preceding (4)(a)i) and ii);
ii) Automatic fire dampers are fitted close to the boundaries penetrated; and
iii) The integrity of the machinery space or galley boundaries is maintained at the penetrations.

(b) i) The ducts where they pass through a machinery space of category A or a galley are constructed of steel in accordance with the preceding requirements (4)(a)i) and ii);
ii) The ducts are insulated to “A-60” standard within the machinery space or galley.

(6) Ventilation ducts with a cross-sectional area exceeding 0.02 m$^2$ passing through “B” Class bulkheads are to be lined with steel sleeves of 900 mm in length divided preferably into 450 mm on each side of the bulkhead unless the duct is of steel for this length.

(7) Where they pass through accommodation spaces or spaces containing combustible materials, the exhaust ducts from galley ranges are to be of equivalent fire integrity to “A” class divisions.

(8) Each galley exhaust duct is to be fitted with the following (a) to (d):

(a) a grease trap readily removable for cleaning
(b) both of the dampers specified in the following i) and ii)
   i) a fire damper located in the galley end of the duct which is automatically and remotely operated
   ii) a remotely operated fire damper located in the exhaust end of the duct
(c) arrangements, operable from within the galley, for shutting off the exhaust fans
(d) fixed means for extinguishing a fire within the duct

(9) The main inlets and outlets of all ventilation systems are to be capable of being closed from outside the spaces being ventilated.

(10) Power ventilation of accommodation spaces, service spaces, control stations, machinery spaces and hazardous areas are to be capable of being stopped from an easily accessible position outside the space being served. The means provided for stopping the power ventilation serving machinery spaces or hazardous areas are to be entirely separate from the means provided for stopping ventilation of other spaces.

9 The construction of the helidecks is to be of steel or other equivalent materials. If the helideck forms the deckhead of a deckhouse or superstructure, it is to be insulated to “A-60” class standard. For use of aluminium or other low melting point metal construction that is not made equivalent to steel, the following requirements are to be satisfied:

1) if the helideck is cantilevered over the side of the unit, after each fire on the unit or on the helideck, the helideck is to undergo a structural analysis to determine its suitability for further use; and

2) if the helideck is located above the unit’s deckhouse or similar structure, the following conditions are to be satisfied:
   a) the deckhouse top and bulkheads under the helideck are to have no openings;
   b) windows under the helideck are to be provided with steel shutters; and
   c) after each fire on the helideck or supporting structure, the helideck is to undergo a structural analysis to determine its suitability for further use.
<table>
<thead>
<tr>
<th>Spaces</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
<th>(9)**</th>
<th>(10)</th>
<th>(11)</th>
<th>(12)</th>
<th>(13)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control stations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corridors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accommodation spaces</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stairways</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service spaces with low risk of fire</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machinery spaces of Category A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other machinery spaces</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cargo areas</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production areas **</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hazardous areas</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service spaces with high risk of fire</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spaces on open decks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sanitary spaces</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes)

The superscripts to the notation for fire integrity and asterisks in Table 6.1 are as specified below:

a: For clarification of application, refer to 9.2.3-1 and 9.2.3-6, Part R of the Rules for the Survey and Construction of Steel Ships.

b: In cases where the adjacent spaces are of the same category, a bulkhead of the rating given in the table is required only in cases where the adjacent spaces are for a different purpose. For example, in the case of Category (11), a galley next to a galley does not require a bulkhead, but a galley next to a paint room requires an “A-0” class bulkhead.

c: Bulkheads separating wheelhouses, chart rooms and radio rooms from each other may be of “B-0” class.

*: In cases where an asterisk appears in the table, the division is required to be of steel or other equivalent material, but is not required to be of “A-0” class.

**: In cases where a double asterisk appears in the table, the required “H” Class may be modified in cases where deemed appropriate by the Society.
The superscripts to the notation for fire integrity and asterisks in Table 6.2 are as specified below:

b and d: As specified in the Notes to Table 6.1, “bulkhead” is to be read as “deck”.

e: As for the machinery spaces of Category (7), in cases where the Society deems there is little risk of fire, insulation need not be fitted.

* and **: As specified in the Notes to Table 6.1.

### 6.4 Fire Extinction

#### 6.4.1 Fire Pumps and Water Supply

1. At least two independently driven power pumps are to be provided, each arranged to draw directly from the sea and discharge into a fixed fire main. However, in units with high suction lifts, booster pumps and storage tanks may be installed.

2. At least one of the pumps required in -1 is to be dedicated from fire-fighting duties and be available for such duties at all times.

3. The arrangements of the pumps, sea suction and sources of power are to be such as to ensure that a fire in any one space would not put both the pumps required in -1 out of action.

4. The capacity of the pumps required in -1 is to be appropriate to the fire-fighting services supplied from the main. Where more pumps than required are installed, their capacity is to be to the satisfaction of the Society.

5. Each pump is to be capable of delivering at least one jet simultaneously from each of any two fire hydrants, hoses and 19mm nozzles while maintaining a minimum pressure of 0.35MPa at any hydrant. In addition, where a foam system is provided for protection of the helicopter deck, the water consumption used for foam system is to be added to the pump capacity and the pumps are to be capable of maintaining a pressure of 0.7MPa at the foam installation. If the water consumption for any other fire protection or fire-fighting purpose are to exceed the rate of the helicopter deck foam installation, this consumption is to be the determining factor in calculating the required capacity of the fire pump.

6. Where either of the pumps required in -1 is located in a space not normally manned and is relatively far removed...
from working areas, suitable provision is to be made for remote start-up of that pump and remote operation of associated suction and discharge valves.

7 Except as provided in -2, sanitary, ballast, bilge or general service pumps may be accepted as fire pumps, provided that they are not normally used for pumping oil.

8 Every centrifugal pump which is connected to the fire main is to be fitted with a non-return valve.

9 Relief valves are to be provided in conjunction with all pumps connected to the fire main if the pumps are capable of developing a pressure exceeding the design pressure of the fire main, hydrants and hoses. Such valves are to be so placed and adjusted as to prevent excessive pressure in the fire main system.

10 At least two water supply sources (sea chests, valves, strainers and pipes) are to be provided and so arranged that one supply source failure will not put all supply sources out of action.

6.4.2 Fire Main, Hydrants and Hoses

1 The diameter of the fire main and water service pipes are to sufficient for the effective distribution of the maximum required discharge from the required fire pumps operating simultaneously.

2 With the required fire pumps operating simultaneously, the pressure maintained in the fire mains is to be adequate for the safe and efficient operation of all equipment supplied therefrom.

3 The fire main is, where practicable, to be routed clear of hazardous areas and be arranged in such a manner as to make maximum use of any thermal shielding or physical protection afforded by the structure of the unit.

4 The fire main is to be provided with isolating valves located so as to permit optimum utilization in the event of physical damage to any part of the main.

5 The fire main is not to have connections other than those necessary for fire-fighting purposes.

6 All practical precautions consistent with having water readily available are to be taken to protect the fire main against freezing.

7 Materials readily rendered ineffective by heat are not to be used for fire mains and hydrants unless adequately protected. The pipes and hydrants are to be so placed that the fire hoses may be easily coupled to them.

8 A cock or valve is to be fitted to serve each fire hose so that any fire hose may be removed while the fire pumps are operating.

9 The number and position of the hydrants are to be such that at least two jets of water, not emanating from the same hydrant, one of which is to be from a single length of fire hose, may reach any part of the unit normally accessible to those on board while the unit is operating. A hose is to be provided for every hydrant.

10 Fire hoses are to be of material approved by the Society and be sufficient in length to project a jet of water to any of the spaces in which they may be required to be used. Their maximum length is to be to the satisfaction of the Society. Every fire hose is to be provided with a dual purpose nozzle and the necessary couplings. Fire hoses, together with any necessary fittings and tools, are to be kept ready for use in conspicuous positions near the water service hydrants or connections.

11 Fire hoses are to have a length of at least 10m, but not more than:
   (1) 15m in machinery spaces;
   (2) 20m in other spaces and open decks; and
   (3) 25m for open decks with a maximum breadth in excess of 30m.

6.4.3 Nozzles

Nozzles are to comply with the following requirements:

(1) Standard nozzle sizes are to be 12mm, 16mm and 19mm or as near thereto as possible. Larger diameter nozzles may be permitted at the discretion of the Society.

(2) For accommodation and service spaces, a nozzle size greater than 12mm need not be used.

(3) For machinery spaces and exterior locations, the nozzle size is to be such as to obtain the maximum discharge possible from two jets at the pressure specified in 6.4.1-5 from the smallest pump, provided that a nozzle size greater than 19mm need not be used.

6.4.4 Fire-extinguishing Arrangements in Production Areas

1 Fixed water protection systems are to be installed to cover the following areas and equipment:

   (1) Mooring turret areas, except in cases where such areas do not contain production systems (e.g. swivel and hydraulic piping systems, etc.)
(2) Production system and associated pressurized piping areas
(3) Utility systems containing flammable gas or liquids in significant volumes or under pressure

2 The quantity of water supplied to areas requiring protection is to be sufficient to provide exposure protection to equipment within that area. A minimum water application rate of 10 l/min per square meter of the area is to be available for this purpose.

The horizontal extent of areas requiring protection may be limited by adjacent vertical A class divisions and/or the near the edges of units.

3 Exposed pipes, pressure vessels and tanks containing inflammable gas or liquids in the areas and systems specified in -1 above are to be protected by fixed water protection systems with a minimum 10 l/min per square meter of exposed surfaces.

4 Fixed water protection systems may consist of automatic deluge/sprinkler systems or water monitors or a combination of both. Water monitors are only considered suitable for protection of equipment in open areas.

The layout is to ensure that all protected surfaces are wetted in all weather conditions.

5 In areas where liquid pool fires can be predicted, manual or fixed facilities are to be provided for the application of suitable type foams. Foam systems are to have the capacity to apply foam over protected areas for not less than 15 minutes.

6 At least two independent pipes from fire main system to each area are to be provided.

7 Fixed fire fighting systems, including deluge valves and fire water distribution pipes, are normally to be designed so that fire water protection is available within 30 seconds of demand.

8 Deluge valves are to be located to provide safe access from emergency control stations and are to be located outside the fire zones they protect.

9 Deluge valve systems are to be activated by signals from the fire and gas detection systems and are to have local energy sources for valve actuators. Overall control systems are to be designed to minimize the possibility of unintended valve opening if associated utilities are damaged, while a high degree of availability is maintained.

10 In addition to -1 to -9, fire-extinguishing arrangements in production areas are to be in accordance with the standards deemed appropriate by the Society such as NFPA 59A “Standard for the production, storage, and handling of liquefied natural gas (LNG)”.

6.4.5 Fire Extinguishing Systems in Accommodation, Service and Working Spaces

1 Portable fire extinguishers

(1) The accommodation spaces, service spaces, control stations and machinery spaces of category A are to be provided with approved portable fire extinguishers accepted by the Society in accordance with Table 6.3.

(2) In addition to the preceding (1), fire extinguishers are to be provided with in accordance with Table 6.4. However, other fire extinguishers, differing from those in accordance with Table 6.4 may be required by the Society taking into account the levels of the fire hazards.
Table 6.3  Minimum Numbers and Distribution of Portable Fire Extinguishers in the Various Types of Spaces Onboard Ships

<table>
<thead>
<tr>
<th>Type of space(1)</th>
<th>Minimum number of extinguishers</th>
<th>Class(es) of extinguisher(s)(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accommodation spaces</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public spaces(3)</td>
<td>1 per 250m² of deck area or fraction thereof</td>
<td>A</td>
</tr>
<tr>
<td>Corridors</td>
<td>Travel distance to extinguishers should not exceed 25m within each deck</td>
<td>A</td>
</tr>
<tr>
<td>Stairway</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Lavatories, cabins, offices, pantries, containing no cooking appliances</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Hospital</td>
<td>1</td>
<td>A</td>
</tr>
<tr>
<td>Service spaces</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laundry drying rooms, pantries containing cooking appliances</td>
<td>1(4)</td>
<td>A or B</td>
</tr>
<tr>
<td>Lockers and store rooms (having a deck area of 4 m² or more), baggage rooms and workshops(3) (not part of machinery spaces, galleys)</td>
<td>1(4)</td>
<td>B</td>
</tr>
<tr>
<td>Galleys</td>
<td>1 class B and 1 Additional class F or K for galleys with deep fat fryers</td>
<td>B, F or K</td>
</tr>
<tr>
<td>Lockers and store rooms(deck area is less than 4m²)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Other spaces in which flammable liquids are stowed</td>
<td>In accordance with 10.6.2, Part R</td>
<td></td>
</tr>
<tr>
<td>Control stations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control stations (other than wheelhouse)</td>
<td>1(5)</td>
<td>A or C</td>
</tr>
<tr>
<td>Wheelhouse</td>
<td>2, if the wheelhouse is less than 50m² only 1 extinguisher is required</td>
<td>A or C</td>
</tr>
<tr>
<td>machinery space of category A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central control station for propulsion machinery</td>
<td>1, and 1 additional extinguisher suitable for electrical fires when main switchboards are arranged in central control station</td>
<td>A and/or C</td>
</tr>
<tr>
<td>Vicinity of the main switchboards</td>
<td>2</td>
<td>C</td>
</tr>
<tr>
<td>Workshops(3)</td>
<td>1</td>
<td>A or B</td>
</tr>
<tr>
<td>Enclosed space with oil-fired inert gas generators, incinerators and waste disposal units</td>
<td>2</td>
<td>B</td>
</tr>
<tr>
<td>Separately enclosed room with fuel oil purifiers</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Periodically unattended Machinery spaces of category A</td>
<td>1 at each entrance(4)</td>
<td>B</td>
</tr>
</tbody>
</table>
Notes:

(1) Unless otherwise specified, one of portable fire extinguishers required is to be located at or near entrance and exits in the space. If a space is locked when unmanned, portable fire extinguishers required for that space may be kept inside or outside the space.

(2) The types of portable fire extinguishers are classified below. However, with respect to the application of the requirements specified in 24.1.2, Part R such classifications need not apply to extinguishers which have been deemed appropriate for use at certain locations in accordance with standards approved by the relevant Administration or organizations deemed appropriate by the Society.

(3) It is recommended that the portable fire extinguishers except (1) above in public spaces and workshop be located at or near the main entrances and exits.

(4) A portable fire extinguisher required for that small space placed outside or near the entrance to that space may also be considered as part of the requirement for the space in which it is located.

(5) If the wheelhouse is adjacent with the chartroom and has a door giving direct access to chartroom, no additional fire extinguisher is required in the chart room.

<table>
<thead>
<tr>
<th>Fire Classifications</th>
<th>International Organization for Standardization (ISO standard 3941)</th>
<th>National Fire Protection Association (NFPA 10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class A: Fire involving solid materials, usually of an organic nature, in which combustion normally takes places with the formation of glowing embers.</td>
<td>Class A: Fire involving solid materials, usually of an organic nature, in which combustion normally takes places with the formation of glowing embers.</td>
<td>Class A: Fires in ordinary combustible materials such as wood, cloth, paper, rubber and many plastics.</td>
</tr>
<tr>
<td>Class B: Fires involving liquids or liquefiable solids</td>
<td>Class B: Fires involving liquids or liquefiable solids.</td>
<td>Class B: Fires involving liquids or liquefiable solids.</td>
</tr>
<tr>
<td>Class C: Fires involving gases.</td>
<td>Class C: Fires involving gases.</td>
<td>Class C: Fires involving gases.</td>
</tr>
<tr>
<td>Class D: Fires involving materials.</td>
<td>Class D: Fires involving materials.</td>
<td>Class D: Fires involving combustible metals such as magnesium, titanium, zirconium, sodium, lithium and potassium.</td>
</tr>
</tbody>
</table>
Table 6.4 An Example of the Number and Distribution as Well as Classes of Additional Portable Extinguishers

<table>
<thead>
<tr>
<th>Type of Space</th>
<th>Minimum number of extinguishers&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Class(es) of extinguisher(s)&lt;sup&gt;c&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space containing the controls for the main source of electrical power</td>
<td>1; and 1 additional extinguisher suitable for electrical fires when main switchboards are arranged in the space</td>
<td>A and/or C</td>
</tr>
<tr>
<td>Cranes:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>With electric motors/hydraulics</td>
<td>not required</td>
<td>-</td>
</tr>
<tr>
<td>Cranes:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>With internal combustion engine</td>
<td>2 (1 in cab and 1 at exterior of engine compartment)</td>
<td>B</td>
</tr>
<tr>
<td>Drill floor</td>
<td>2 (1 at each exit)</td>
<td>C</td>
</tr>
<tr>
<td>Helidecks</td>
<td>In accordance with 6.4.10</td>
<td>B</td>
</tr>
<tr>
<td>Machinery spaces of category A</td>
<td>In accordance with 6.4.8</td>
<td>B</td>
</tr>
<tr>
<td>Machinery spaces of category A which are periodically unattended</td>
<td>At each entrance in accordance with 6.4.8&lt;sup&gt;b&lt;/sup&gt;</td>
<td>B</td>
</tr>
<tr>
<td>Main switchboards</td>
<td>2 in the vicinity</td>
<td>C</td>
</tr>
<tr>
<td>Mud pits, Mud processing areas</td>
<td>1 for each enclosed space (Travel distance to an extinguisher not to exceed 10 m for open space)</td>
<td>B</td>
</tr>
</tbody>
</table>

Notes:

- Minimum sizes are to be in accordance with 24.2.1, Part R of the Rules for the Survey and Construction of Steel Ships.
- A portable extinguisher provided for that space may be located outside near the entrance to that space.
- The Classes are the same as in Table 6.3.

6.4.6 International Shore Connection

1 Ship-type, barge-type and column-stabilized units are to be provided with the at least one international shore connection complying with Chapter 22, Part R of the Rules for the Survey and Construction of Steel Ships.
2 Facilities are to be available enabling such a connection to be used on either side of the unit.

6.4.7 Fire-fighters’ Outfits

1 At least two fire-fighters’ outfits complying with 23.2.1, Part R of the Rules for the Survey and Construction of Steel Ships are to be provided, each with portable instruments for measuring oxygen and flammable vapour concentrations acceptable to the Society.
2 Two spare charges are to be provided for each required breathing apparatus. However, for units that are equipped with suitably located means for fully recharging the air cylinders free from contamination, only one spare charge for each required apparatus may be acceptable. The apparatus for recharging air cylinders are to comply with the following requirements (1) to (6).

(1) The apparatus for recharging air cylinders are to be one of the following (a) or (b):
   - (a) an apparatus having its power supplied from the emergency supply or being independently diesel-powered.
   - (b) other apparatus being so constructed or equipped that the air cylinders may be used immediately after recharging.

(2) The apparatus is to be suitably located in a sheltered space above main deck level on the unit.
(3) Intakes for air compressors are to be drawn from a source of clean air.
(4) The air is to be filtered after compression to eliminate compressor oil contamination.
(5) The recharging capacity is to meet the requirements of SOLAS regulation II-2/10.10.2.6.
(6) The equipment and its installation are to be to the satisfaction of the Society.
3 The fire-fighters’ outfits are to be kept ready for use in an easily accessible location that is permanently and clearly marked. They are to be stored in two or more widely separated locations.
6.4.8 Fire Extinguishing Systems in Machinery Spaces and in Spaces containing Fired Processes

1 In spaces where main or auxiliary oil-fired boilers and other fired processes of equivalent thermal rating are situated, or in spaces containing oil fuel units or settling tanks, the unit is to be provided with the following:

(1) One of the following fixed fire extinguishing systems complying with 10.4, Part R of the Rules for the Survey and Construction of Steel Ships:
   (a) a fixed pressure water-spraying system complying with Chapter 27, Part R of the Rules for the Survey and Construction of Steel Ships;
   (b) a fixed gas fire-extinguishing system complying with Chapter 25, Part R of the Rules for the Survey and Construction of Steel Ships;
   (c) a fixed high-expansion foam installation complying with Chapter 26, Part R of the Rules for the Survey and Construction of Steel Ships.

Where the machinery space and spaces containing fired processes are not entirely separate, or if fuel oil can drain from the latter spaces into the machinery space, the combined machinery space and fired process space are to be considered as one compartment.

(2) At least two approved portable foam extinguishers or equivalent in each space containing a fired process and each space in which a part of the oil fuel installation is situated. In addition, at least one extinguisher of the same description with a capacity of 9 litres for each burner, provided that the total capacity of the additional extinguisher or extinguishers need not exceed 45 litres for any one space.

(3) A receptacle containing sand, sawdust impregnated with soda, or other approved dry material in such quantity as may be required by the Society. Alternatively, an approved portable extinguisher may be substituted.

The following arrangements are to be provided in the spaces containing internal combustion machinery used either for main propulsion or for other purposes when such machinery has a total power output of not less than 750 kW.

(1) One of the fixed arrangements required in 6.4.8(1):

(2) One approved foam-type extinguisher of not less than 45 litres capacity or equivalent in every engine space and one approved portable foam extinguisher for each 750 kW of engine power output or part thereof. The total number of portable extinguishers so supplied is to be not less than two and need not exceed six.

3 Fire extinguishing arrangements provided in spaces not fitted with fixed fire-extinguishing installations are to be to the satisfaction of the Society.

4 Where a fire hazard exists in any machinery space for which no specific requirements for fire-extinguishing appliances are prescribed in 6.4.8 to 6.4.9, there are to be provided in, or adjacent to, that space a number of approved portable fire extinguishers of other means of fire extinction to the satisfaction of the Society.

6.4.9 Fire-extinguishing Arrangements in Engine and Boiler Rooms in cases where Boilers, Turbines and Diesel Engines are fuelled by gas

Fixed fire-extinguishing systems having sufficient capacity to fill machinery spaces and the ducts and hoods in the spaces specified in 7.2 and 7.3 and capable of operating independently of systems for machinery spaces are to be fitted in engine and boiler rooms in cases where boilers and turbines are fuelled by gas. Such systems are to be installed in such a way that it is possible for approved fire-extinguishing mediums to be directed on to boiler fronts and on to spill trays. The emission of extinguishing mediums is automatically to stop duct and hood exhaust fans.

6.4.10 Fire Extinguishing Systems, Drainage Systems, etc. of Helicopter Facilities

1 This paragraph provides additional measures in order to address the fire safety objectives for units fitted with facilities for helicopters and meets the following functional requirements:

(1) helideck structure is to be adequate to protect the unit from the fire hazards associated with helicopter operations;
(2) fire-fighting appliances are to be provided to adequately protect the unit from the fire hazards associated with helicopter operations;
(3) refuelling facilities and operations are to provide the necessary measures to protect the unit from the fire hazards associated with helicopter operations; and
(4) helicopter facility operation manuals and training are to be provided.

2 In close proximity to the helideck, the following fire-fighting appliances are to be provided and stored near the means of access to that helideck:
(1) primary extinguishers:
   at least two dry powder extinguishers having a total capacity of not less than 45 kg but not less than 9 kg each;

(2) back-up extinguishers:
   carbon dioxide extinguishers of a total capacity of not less than 18 kg or equivalent, one of these extinguishers being so equipped as to enable it to reach the engine area of any helicopter using the deck. The back-up extinguishers are to be located so that they would not be vulnerable to the same damage as the primary extinguishers;

(3) a suitable foam application system consisting of monitors or foam-making branch pipes capable of delivering foam to all parts of the helideck in all weather conditions in which the helideck is intended to be available for helicopter operations. The capacity and other specifications of the foam production system are to comply with the following (a) to (c):
   (a) a minimum application rate of $6/l/m^2$ (4.1$l/min·m^2$ for Aqueous Film Forming Foam or Film-Forming Fluoroprotein Foam) within a circle having a diameter equal to $D_{hc}$;
   (b) a minimum of 5 minutes discharge capability is to be provided; and
   (c) foam delivery at the minimum application specified in the preceding (a) is to start within 30 sec of system activation;

(4) the principal agent is to be suitable for use with salt water and a type deemed as appropriate by the Society;

(5) at least two nozzles of an approved dual-purpose type (jet/spray) and hoses sufficient in length to reach any part of the helideck;

(6) in addition to the fire-fighter’s outfits required in 6.4.7, at least two fire-fighter’s outfits; and

(7) At least the following equipment is to be stored in a manner that provides for immediate use and protection from the elements:
   (a) adjustable wrench;
   (b) blanket, fire-resistant;
   (c) cutters, bolt, 600 mm;
   (d) hook, grab or salving;
   (e) hacksaw, heavy duty complete with six spare blades;
   (f) ladder;
   (g) lift line 5 mm diameter and 30 m in length;
   (h) pliers, side-cutting;
   (i) set of assorted screwdrivers;
   (j) harness knife complete with sheath; and
   (k) crowbar.

3 Drainage facilities in way of helidecks are to be constructed of steel or other arrangements providing equivalent fire safety, are to lead directly overboard independent of any other system, and are to be designed so that drainage does not fall onto any part of the unit.

4 Where the unit has helicopter refuelling, the following requirements are to be complied with:
   (1) a designated area is to be provided for the storage of fuel tanks which is:
      (a) as remote as is practicable from accommodation spaces, escape routes and embarkation stations; and
      (b) isolated from areas containing a source of vapour ignition;
   (2) the fuel storage area is to be provided with arrangements whereby fuel spillage may be collected and drained to a safe location;
   (3) tanks and associated equipment are to be protected against physical damage and from a fire in an adjacent space or area;
   (4) where portable fuel storage tanks are used, special attention is to be given to:
      (a) design of the tank for its intended purpose;
      (b) mounting and securing arrangements;
      (c) electric bonding; and
      (d) inspection procedures;
   (5) storage tank fuel pumps are to be provided with means which permit shutdown from a safe remote location in the event of a fire. Where a gravity-fuelling system is installed, equivalent closing arrangements are to be provided to isolate the fuel source;
(6) the fuel pumping units are to be connected to one tank at a time. The piping between the tank and the pumping unit is to be of steel or equivalent material, as short as possible, and protected against damage;
(7) electrical fuel pumping units and associated control equipment are to be of a type suitable for the location and potential hazards;
(8) fuel pumping units are to incorporate a device which will prevent over-pressurization of the delivery or filling hose;
(9) equipment used in refuelling operations is to be electrically bonded; and
(10) “NO SMOKING” signs are to be displayed at appropriate locations.

6.5 Environmental Controls

The environmental controls of Gas Floating Offshore Facility are to be in accordance with the requirements in Chapter 9, Part N of the Rules for the Survey and Construction of Steel Ships.

6.6 Means of Escape

6.6.1 Means of Escape

1 Within the accommodation spaces, service spaces and control stations, the means of escape specified in the following (1) to (4) are to be provided:

(1) In every general area which is likely to be regularly manned or in which personnel are accommodated, at least two separate escape routes are to be provided, situated as far apart as practicable, to allow ready means of escape to the open decks and embarkation stations. Where, however, deemed appropriate by the Society in consideration of the nature, location of spaces and the number of persons who might normally be accommodated or employed there, one of these means of escape may be dispensed with.

(2) Stairways are normally to be used for means of vertical escape. Where, however, the installation of a stairway is shown to be impracticable, a vertical ladder may be used for one of the means of escape.

(3) Every escape route is to be readily accessible and unobstructed. All exit doors along the route are to be readily operable. Dead-end corridors exceeding 7 m in length are not to be provided.

(4) The means of escape in accommodation areas, including stairways and exits, are to comply with the following requirements (a) to (d):

   (a) In addition to the emergency lighting, the means of escape are to be marked in the following locations i) and ii) by lighting or photoluminescent strip indicators complying with Chapter 31, Part R of the Rules for the Survey and Construction of Steel Ships:

      i) places not more than 300 mm above the deck at all points of the escape route, including angles and intersections; and

      ii) escape route signs and fire equipment location markings.

   (b) The marking specified in the preceding (a) is to enable personnel to identify the routes of escape and readily identify the escape exits.

   (c) Electric illumination is to be supplied by the emergency source of power.

   (d) The failure of any single light or cut in a lighting strip indicators is not to result in the marking being ineffective.

2 Two means of escape are to be provided from every machinery space of category A by either one of the following (1) or (2). Ladders are to be of steel or other equivalent material.

   (1) two sets of ladders, as widely separated as possible, leading to doors in the upper part of the machinery space of category A, similarly separated and from which access is provided to the open deck. One of these ladders is to comply with the following requirements:

      a) The ladder is to be located within a protected enclosure that satisfies Tables 6.1 and 6.2, category (4), from the lower part of the space it serves to a safe position outside the space. Self-closing fire doors of the same fire integrity standards are to be fitted in the enclosure; and

      b) The ladder is to be fixed in such a way that heat is not transferred into the fire shelter through non-insulated fixing points. The enclosure is to have minimum internal dimensions of at least 800 mm x 800 mm, and is to have emergency lighting provisions.
(2) the means of escape specified in the following (a) and (b);
   (a) one ladder leading to a door in the upper part of the machinery space of category A from which accesses to the open deck; and
   (b) a steel door capable of being operated from each side, in the lower part of the machinery space of category A, in a position well separated from the ladder. The steel door is to be provided with access to a safe escape route from the lower part of the machinery space of category A to the open deck.

3 From machinery spaces other than those of category A, escape routes are to be provided to the satisfaction of the Society, having regard to the nature and location of the space and whether persons are normally employed in that space.

4 Lifts are not to be considered as forming one of the required means of escape.

5 Consideration is to be given to the siting of superstructures and deckhouses such that in the event of fire at the drill floor at least one escape route to the embarkation position and survival craft is protected against radiation effects of that fire as far as practicable.

6 Stairways and corridors used as a means of escape are to meet the requirements of Chapter 33, Part R of the Rules for the Survey and Construction of Steel Ships.

7 For emergency escape breathing devices (hereinafter, referred to as “EEBDs”), the following requirements are to be complied with:
   (1) EEBDs are to comply with the requirements of Chapter 23, Part R of the Rules for the Survey and Construction of Steel Ships. Spare EEBDs are to be kept on board;
   (2) In machinery spaces of category A containing internal combustion machinery used for main propulsion, EEBDs are to be positioned as specified in the following (a) to (d):
      (a) one EEBD in the engine control room, if located within the machinery space;
      (b) one EEBD in workshop areas. If there is, however, a direct access to an escape way from the workshop, an EEBD is not required; and
      (c) one EEBD on each deck or platform level near the escape ladder constituting the second means of escape from the machinery space (the other means being an enclosed escape trunk or watertight door at the lower level of the space).
      (d) Alternatively, a different number or location than as specified in (a) to (c) may be required by the Society taking into consideration the layout and dimensions or the normal manning of the space.
   (3) For machinery spaces of category A other than those containing internal combustion machinery used for main propulsion, one EEBD is, as a minimum, to be provided on each deck or platform level near the escape ladder constituting the second means of escape from the space (the other means being an enclosed escape trunk or watertight door at the lower level of the space).
   (4) For other machinery spaces, the number and location of EEBDs are to be to the satisfaction of the Society.

8 A helideck is to be provided with both a main and an emergency means of escape and access for fire fighting and rescue personnel. These are to be located as far apart from each other as is practicable and preferably on opposite sides of the helideck.
Chapter 7   MACHINERY INSTALLATIONS

7.1   General

7.1.1   Application
1   With respect to prime movers, power transmission systems, shafting systems, propellers, boilers, etc.,
iccinerators, pressure vessels, auxiliaries, piping systems and their control systems (hereinafter referred to as
“machinery installations” in these Guidelines) of Gas Floating Offshore Facilities, the requirements given in this
Chapter are to be applied.
2   Positioning systems are to comply with the requirements given in this Chapter in addition to the requirements
given in Chapter 4. In cases where applying the requirements given in this Chapter, the components of positioning
systems are to be regarded as auxiliary machinery for maneuvering and safety.
3   Production systems are to comply with the requirements given in this Chapter in addition to the requirements
given in Chapter 9. In cases where applying the requirements given in this Chapter, the components, except
auxiliary machinery and pumps, etc. for handling cargo, in such systems are to be regarded as auxiliary machinery for
specific use.
4   Auxiliary machinery and pumps, etc. handling cargo are to comply with the requirements given in Annex 1
“Guidance For Equipment And Fittings Of Ships Carrying Liquefied Gases In Bulk”, Part N of the Guidance
for the Survey and Construction of Steel Ships in addition to the requirements given in this Chapter and to be
regarded as auxiliary machinery for cargo handling.
5   Process pressure vessels and liquid, vapour, and pressure piping systems are to comply with the requirements
given in Chapter 5, Part N of the Rules for the Survey and Construction of Steel Ships.
6   Mechanical ventilation in the cargo area is to comply with the requirements given in Chapter 12, Part N of the
Rules for the Survey and Construction of Steel Ships.
7   The drawings and data of package installations (e.g. turbines, compressors and pumps, etc.) to be submitted
are generally as follows:
   (1) Package installation particulars and details
   (2) General piping diagrams and instrumentation piping diagrams
   (3) Control and monitoring systems/Instrumentation lists
   (4) Information lists on in-system installations
   (5) Support structures
   (6) Test procedures
   (7) Any other drawings and data deemed appropriate by the Society.

7.1.2   General
1   With respect to machinery installations other than those used solely for the specific operation which is the
purpose of the Gas Floating Offshore Facility (the processing of natural gases, etc. extracted from seabeds.), relevant
requirements given in Part D of the Rules for the Survey and Construction of Steel Ships listed in the following
(1) to (40) as well as the requirements given in this Chapter are to be applied. (The term “cargo oil” is to be construed
as “cargo”, “carry” and “transport” are to be construed as “process/store”, “ship” and “ship carrying liquefied gases
in bulk” are to be construed as “Gas Floating Offshore Facility”.)
   (1) 1.1.2, Part D of the Rules for the Survey and Construction of Steel Ships General - General - Equivalency
   (2) 1.1.3, Part D of the Rules for the Survey and Construction of Steel Ships General - General - Machinery
       Installations with Novel Design Features
   (3) 1.1.4, Part of the Rules for the Survey and Construction of Steel Ships General - General - Modification of
       Requirements
   (4) 1.1.6, Part D of the Rules for the Survey and Construction of Steel Ships General - General - Terminology
   (5) 1.2, Part D of the Rules for the Survey and Construction of Steel Ships General - Materials
   (6) 1.3.4, Part D of the Rules for the Survey and Construction of Steel Ships General - General Requirements
Guidelines for Floating Offshore Facilities for LNG/LPG Production, Storage, Offloading and Regasification

for Machinery Installations - Fire protections

(7) 1.3.5, Part D of the Rules for the Survey and Construction of Steel Ships General - General Requirements for Machinery Installations - Ventilating Systems for Machinery Spaces

(8) 1.3.6, Part D of the Rules for the Survey and Construction of Steel Ships General - General Requirements for Machinery Installations - Protection against Noise

(9) Chapter 2, Part D of the Rules for the Survey and Construction of Steel Ships Diesel Engines

(10) Chapter 3, Part D of the Rules for the Survey and Construction of Steel Ships Steam Turbines

(11) Chapter 4, Part D of the Rules for the Survey and Construction of Steel Ships Gas Turbines

(12) Chapter 5, Part D of the Rules for the Survey and Construction of Steel Ships Power Transmission Systems

(13) Chapter 6, Part D of the Rules for the Survey and Construction of Steel Ships Shaftings

(14) Chapter 8, Part D of the Rules for the Survey and Construction of Steel Ships Torsional Vibration of Shaftings

(15) Chapter 9, Part D of the Rules for the Survey and Construction of Steel Ships Boilers, etc. and Incinerators

(16) Chapter 10, Part D of the Rules for the Survey and Construction of Steel Ships Pressure Vessels

(17) Chapter 11, Part D of the Rules for the Survey and Construction of Steel Ships Welding for Machinery Installations

(18) Chapter 12, Part D of the Rules for the Survey and Construction of Steel Ships Pipes, Valves, Pipe Fittings and Auxiliaries

(19) 13.1, Part D of the Rules for the Survey and Construction of Steel Ships Piping Systems - General

(20) 13.2, Part D of the Rules for the Survey and Construction of Steel Ships Piping Systems - Piping

(21) 13.3, Part D of the Rules for the Survey and Construction of Steel Ships Piping Systems - Sea Suction Valves and Overboard Discharge Valves

(22) 13.4, Part D of the Rules for the Survey and Construction of Steel Ships Piping Systems - Scuppers and Sanitary Discharges, etc.

(23) 13.6, Part D of the Rules for the Survey and Construction of Steel Ships Piping Systems - Air Pipes

(24) 13.7, Part D of the Rules for the Survey and Construction of Steel Ships Piping Systems - Overflow Pipes

(25) 13.8, Part D of the Rules for the Survey and Construction of Steel Ships Piping Systems - Sounding Pipes

(26) 13.9.1, Part D of the Rules for the Survey and Construction of Steel Ships Piping Systems - Fuel Oil Systems - General


(28) 13.9.4, Part D of the Rules for the Survey and Construction of Steel Ships Piping Systems - Fuel Oil Systems - Drip Trays and Drainage System

(29) 13.9.5, Part D of the Rules for the Survey and Construction of Steel Ships Piping Systems - Fuel Oil Systems - Fuel Oil Heaters

(30) 13.10.1, Part D of the Rules for the Survey and Construction of Steel Ships Piping Systems - Lubricating Oil Systems and Hydraulic Oil Systems - General

(31) 13.11, Part D of the Rules for the Survey and Construction of Steel Ships Piping Systems - Thermal Oil Systems

(32) 13.13, Part D of the Rules for the Survey and Construction of Steel Ships Piping Systems - Pneumatic Piping System

(33) 13.14, Part D of the Rules for the Survey and Construction of Steel Ships Piping Systems - Steam Piping Systems and Condensate Systems

(34) 13.15.3, Part D of the Rules for the Survey and Construction of Steel Ships Piping Systems - Feed Water Systems for Boilers - Distilling Plant

(35) 13.15.4, Part D of the Rules for the Survey and Construction of Steel Ships Piping Systems - Feed Water Systems for Boilers - Pipes passing through Tanks

(36) 13.16, Part D of the Rules for the Survey and Construction of Steel Ships Piping Systems - Exhaust Gas Piping Arrangement

(37) 13.17, Part D of the Rules for the Survey and Construction of Steel Ships Piping Systems - Tests

(38) Chapter 17, Part D of the Rules for the Survey and Construction of Steel Ships Refrigerating Machinery and Controlled Atmosphere Systems
Guidelines for Floating Offshore Facilities for LNG/LPG Production, Storage, Offloading and Regasification

(39) Chapter 18, Part D of the Rules for the Survey and Construction of Steel Ships Automatic and Remote Control

(40) Chapter 21, Part D of the Rules for the Survey and Construction of Steel Ships Spare Parts, Tools and Instruments

2 With respect to machinery installations used solely for a specific operation which is the purpose of the Gas Floating Offshore Facility (the processing of natural gases, etc. extracted from seabeds.), relevant requirements given in Part D of the Rules for the Survey and Construction of Steel Ships listed in the following (1) to (25) as well as the requirements given in 7.1.3 and 7.1.4 are to be applied. (The term “cargo oil” is to be construed as “cargo”, “carry” and “transport” are to be construed as “process/store”, “ship” and “ship carrying liquefied gases in bulk” are to be construed as “Gas Floating Offshore Facility”.)

(1) 1.1.2, Part D of the Rules for the Survey and Construction of Steel Ships General - General - Equivalency
(2) 1.1.3, Part D of the Rules for the Survey and Construction of Steel Ships General - General - Machinery Installations with Novel Design Features
(3) 1.1.4, Part D of the Rules for the Survey and Construction of Steel Ships General - General - Modification of Requirements
(4) 1.1.6, Part D of the Rules for the Survey and Construction of Steel Ships General - General - Terminology
(5) 1.2, Part D of the Rules for the Survey and Construction of Steel Ships General - Materials
(6) 1.3.4, Part D of the Rules for the Survey and Construction of Steel Ships General - General Requirements for Machinery Installations - Fire Protections
(7) 1.3.5, Part D of the Rules for the Survey and Construction of Steel Ships General - General Requirements for Machinery Installations - Ventilating Systems for Machinery Spaces
(8) 1.3.6, Part D of the Rules for the Survey and Construction of Steel Ships General - General Requirements for Machinery Installations - Protection against Noise
(9) 2.2.2-4, Part D of the Rules for the Survey and Construction of Steel Ships Diesel Engines - Materials, Construction and Strength - Construction, Installation and General
(10) 2.2.2-5, Part D of the Rules for the Survey and Construction of Steel Ships Diesel Engines - Materials, Construction and Strength - Construction, Installation and General
(11) 2.2.2-6, Part D of the Rules for the Survey and Construction of Steel Ships Diesel Engines - Materials, Construction and Strength - Construction, Installation and General
(12) 2.4, Part D of the Rules for the Survey and Construction of Steel Ships Diesel Engines - Safety Devices
(13) 2.5.4, Part D of the Rules for the Survey and Construction of Steel Ships Diesel Engines - Associated Installations - Fuel Oil Arrangements
(14) 3.3, Part D of the Rules for the Survey and Construction of Steel Ships Steam Turbines - Safety Devices
(15) 4.3, Part D of the Rules for the Survey and Construction of Steel Ships Gas Turbines - Safety Devices
(16) 5.2.5, Part D of the Rules for the Survey and Construction of Steel Ships Power Transmission Systems - Materials and Construction - Lubricating Oil Arrangements
(17) Chapter 9, Part D of the Rules for the Survey and Construction of Steel Ships Boilers, etc. and Incinerators
(18) Chapter 10, Part D of the Rules for the Survey and Construction of Steel Ships Pressure Vessels
(19) Chapter 11, Part D of the Rules for the Survey and Construction of Steel Ships Welding for Machinery Installations
(20) 13.9.1, Part D of the Rules for the Survey and Construction of Steel Ships Piping Systems - Fuel Oil Systems - General
(22) 13.9.4, Part D of the Rules for the Survey and Construction of Steel Ships Piping Systems - Fuel Oil Systems - Drip Trays and Drainage System
(23) 13.9.5, Part D of the Rules for the Survey and Construction of Steel Ships Piping Systems - Fuel Oil Systems - Fuel Oil Heaters
(24) 13.10.1, Part D of the Rules for the Survey and Construction of Steel Ships Piping Systems - Lubricating Oil Systems and Hydraulic Oil Systems - General
(25) 13.11, Part D of the Rules for the Survey and Construction of Steel Ships Piping Systems - Thermal Oil
With respect to machinery installations used for positioning systems, relevant requirements given in Part D of the Rules for the Survey and Construction of Steel Ships listed in the following (1) to (6) as well as the requirements given in -1 above are to be applied. (The term “cargo oil” is to be construed as “cargo”, “carry” and “transport” are to be construed as “process/store”, “ship” and “ship carrying liquefied gases in bulk” are to be construed as “Gas Floating Offshore Facility”.)

1.3.8, Part D of the Rules for the Survey and Construction of Steel Ships
General - General Requirements for Machinery Installations - Engineers’ Alarm

13.9, Part D of the Rules for the Survey and Construction of Steel Ships
Piping Systems - Fuel Oil Systems (except 13.9.1, 13.9.2, 13.9.4 and 13.9.5)

13.10, Part D of the Rules for the Survey and Construction of Steel Ships
Piping Systems - Lubricating Oil Systems and Hydraulic Oil Systems (except 13.10.1)

13.12, Part D of the Rules for the Survey and Construction of Steel Ships
Piping Systems - Cooling Systems

Chapter 15, Part D of the Rules for the Survey and Construction of Steel Ships
Steering Gears

Chapter 16, Part D of the Rules for the Survey and Construction of Steel Ships
Windlasses and Mooring Winches

Tests

1 Before being installed on board, equipment and components constituting machinery installations are to be tested at plants provided with installations and equipment necessary for such tests (hereinafter referred to as “manufacturers, etc.” in these Guidelines) in accordance with relevant requirements given in Part D of the Rules for the Survey and Construction of Steel Ships.

2 Notwithstanding the requirements given in -1 above, in the case of machinery installations, other than boilers and pressure vessels belonging to Group I or II and piping systems which contain flammable or toxic liquids, used solely for a specific operation which is the purpose of the Gas Floating Offshore Facility, tests deemed appropriate by the Society may be performed instead.

3 Notwithstanding the requirements given in -1 and -2 above, in the case of equipment manufactured by mass-production systems deemed appropriate by the Society, test procedures suited to specific production methods may be accepted upon manufacturer request.

4 Machinery installations used for systems or equipment essential for the safety of Gas Floating Offshore Facilities are to be subjected to onboard testing in accordance with 11.2.9 after being installed.

5 The Society may require tests other than those specified in 7.1.3 in cases where deemed necessary.

General Requirements for Machinery Installations

1 Machinery installations are to be of a design and construction adequate for the service for which they are intended and are to be installed and protected so as to reduce to a minimum any danger to persons on board with due regard being paid to moving parts, hot surfaces and other hazards. Designs is to have regard to the purpose for which the equipment is intended, the working conditions to which it will be subjected and the environmental conditions on board.

The temperature of piping systems and machinery which may be exposed to gas and cargo is not to exceed 200°C.

2 The prime movers for generators and auxiliary machinery as well as the prime movers for such machinery fitted onto Gas Floating Offshore Facilities are to be designed to operate under the static conditions of an inclination up to 15 degrees at either way, and, simultaneously, a trim up to 5 degrees at the bow or stern. The Society may permit deviation from the angles given above after taking into consideration the type and size of the Gas Floating Offshore Facility.

3 The prime movers for emergency generators are to be designed to function at full rated power in cases where inclined up to the maximum angle of heel in the intact and damaged conditions as determined in accordance with Chapter 3. Under no circumstances does equipment need to be designed to operate in cases where inclined at angles more than 22.5 degrees either way and, simultaneously, a trim of 10 degrees at the bow or stern.

4 In cases where the valves of piping systems are arranged for remote control and are power operated, secondary means of operating such valves which may be manual control or other form of control are to be provided.

5 Means are to be provided to ensure that machinery installations can be brought into operation from a dead
condition without external aids.

6  Machinery installations are to be designed to operate smoothly under the temperature conditions given in Table 7.1.

7  With respect to the machinery installations of Gas Floating Offshore Facilities which work or navigate in icy sea areas, special consideration is to be paid to ice strengthening and low temperatures.

8  Provisions are to be made in the designs, construction and installation of machinery installations to facilitate cleaning, inspection, maintenance and operation.

9  In cases where fuel oils with flash points (to be determined by the closed cup method) of less than 60°C are used, the flashpoints of such fuel oils are to be clearly indicated on drawings submitted for Society approval.

7.1.5  Piping Systems containing flammable or toxic liquids or gases

1  Service and utility systems connected to systems containing flammable or toxic liquids or gases are normally not to be combined with similar systems located in non-hazardous areas or connected to non-hazardous systems.

2  Any connection between hazardous and non-hazardous systems is to be designed to eliminate or control the risk of any ingress of hazardous material from one system to the other due to incorrect operation or leaks taking into account the following items (1) to (3):

   (1) Identify possible failure modes and define a realistic range of leak sizes

   (2) Evaluate possible consequences of cross contamination

   (3) Reliability, maintainability and testability of protection systems (e.g. liquid seals, non-return valves, detectors and actuated valves, etc.)

<table>
<thead>
<tr>
<th>Table 7.1 Temperature</th>
<th>Installed location</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In enclosed spaces</td>
<td>0 ~ 45°C</td>
</tr>
<tr>
<td></td>
<td>In spaces subject to temperatures exceeding 45°C, and below 0°C</td>
<td>According to specific local conditions</td>
</tr>
<tr>
<td>Air</td>
<td>On open decks</td>
<td>-25 ~ 45°C</td>
</tr>
<tr>
<td>Seawater</td>
<td></td>
<td>32°C</td>
</tr>
</tbody>
</table>

Note) *1 : Other temperatures deemed appropriate by the Society may be accepted.

7.1.6  Sea Suction Valves and Overboard Discharge Valves

In cases where the spaces of the Gas Floating Offshore Facilities containing valves operable from accessible positions outside such spaces are normally unattended and are not provided with high bilge water level alarms, each seawater inlet and discharge in spaces below assigned load lines or designed maximum load lines are to be provided with such valves operable from accessible positions outside such spaces. In cases where remote operation is provided by power actuated valves for seawater inlets and discharges for operation of the machinery for generators, a power supply failure of the control system is not to result in the “closing” of “open” valves or the “opening” of “closed” valves.

7.1.7  Sea Chests

Hinged gratings are to be installed on all sea chests and constructed so as to facilitate opening and closing by divers.

7.1.8  Bilge Piping

1  Efficient bilge pumping systems are to be provided, capable of pumping from and draining any watertight compartment other than spaces specifically designed for holding liquids and for which other efficient means of pumping are provided, under all practical conditions. Means are to be provided to detect the presence of any water in such compartments which are adjacent to the sea or adjacent to tanks containing liquids and in void compartments through which pipes conveying liquids pass. If the Society is satisfied that the safety of a Gas Floating Offshore Facility is not impaired, bilge pumping arrangements and means to detect the presence of water may be dispensed with in particular compartments.

2  Suitable measures are to be taken with respect to bilge pumping systems to prevent the possibility of seawater flowing back into watertight compartments or the possibility of bilge inadvertently flowing from one space to another. To achieve these requirements, all bilge distribution boxes and manually operated valves in connection with the bilge pumping systems are to be in positions which are accessible under ordinary circumstances. All valves in bilge
distribution boxes are to be non-return types. In cases where such valves are located in normally unattended spaces below assigned load lines or designed maximum load lines, high bilge water level alarms are to be provided for such spaces or such valves are to be operable from outside such spaces.

3 Means to indicate whether valves are open or closed are to be provided at each location from which valves can be controlled. Indicators are to rely on the movement of valve spindles.

4 Hazardous and non-hazardous areas are to be provided with separate bilge suction arrangements.

5 At least two independent self-priming type power bilge pumps or equivalent thereto are to be provided and are to be connected respectively to main bilge suction pipes. Ballast pumps, sanitary pumps, general service pumps, etc. driven by independent power may be accepted as independent power bilge pumps provided that they are connected properly to main bilge lines.

6 The internal sectional areas of main bilge suction pipes are not to be less than the combined internal sectional areas of the two largest branch bilge suction pipes.

7 Branch bilge suction pipes from each compartment are to be of the internal diameter obtained from the following formula or the internal diameter of standard pipes nearest to the calculated diameter. In cases where the internal diameter of such standard pipes is short of the calculated value by 5mm or more, standard pipes of one grade higher diameter are to be used.

\[ d' = 2.15 \sqrt{A} + 25 \text{ (mm)} \text{ minimum } 50\text{mm} \]

\[ d' : \text{Internal diameter (mm) of branch bilge suction pipes} \]

\[ A : \text{Wetted surface area (m}^2\text{) of the compartment, excluding stiffening members in cases where the compartment is half filled with water} \]

8 The capacity of each bilge pump is to be capable of discharging bilge of not less than that obtained from the following formula through the main bilge lines specified in -6.

\[ Q = 5.66d^2 \times 10^{-3} \]

\[ Q : \text{Required quantity (m}^3/\text{hour)} \]

\[ d : \text{Internal diameter (mm) of the main bilge line specified in -6} \]

9 Bilge pipes passing through deep tanks are to be led through oiltight or watertight pipe tunnels or, alternatively, are to be of a sufficient thicknesses which complies with the requirements given in Table D12.6(1) to Table D12.6(2), Part D of the Rules for the Survey and Construction of Steel Ships and all joints are to be welded.

10 Bilge pipes passing through double bottom tanks are to be led through oiltight or watertight pipe tunnels or, alternatively, are to be of a sufficient thicknesses which complies with the requirements given in Table D12.6(1) to Table D12.6(2), Part D of the Rules for the Survey and Construction of Steel Ships.

11 Bilge pipes passing through double bottoms, side tanks, bilge hopper tanks or void spaces, in cases where there is a possibility of damage of these pipes due to collisions, etc., are to be provided with non-return valves near the bilge suctions or stop valves capable of being closed from readily accessible positions.

12 Chain locker bilge may be drained by eductors, hand pumps or portable means. Means are to be provided for the removal of mud and debris from bilge systems.

7.1.9 Drainage Systems

1 Efficient drainage systems are to be provided for all enclosed spaces on decks and watertight compartments. The capacity of such drainage systems is to be based on fire extinction systems that use water.

2 The drainage systems of hazardous areas are to be kept separated from the drainage systems of non-hazardous areas.

3 Equipment which handles cargo, etc. is to be equipped with metallic drip trays of sufficient capacity and height for collecting any accidental oil leakage. In cases where it is not practicable to provide metallic drip trays, coamings are to be provided to hold oil spillage. Drip trays or coamings are to be drained through water traps to closed waste oil tanks.

Drainage directly to slop tanks may be accepted provided that low level alarms are fitted on water traps, and that such water traps have static pressures that are higher than inert gas pressure.

7.1.10 Ballast Piping

1 Efficient ballast piping systems are to be provided that are capable of pumping ballast water into and from any tanks holding ballast water under all practical conditions.
2 Ballast piping systems are to be provided with suitable provisions such as non-return valves or stop valves which can be kept closed any time excluding times of ballasting and deballasting, and which are provided with indicators to show whether they are open or closed, in order to prevent the possibility of seawater inadvertently flowing back into ballast tanks or of ballast passing from one ballast tank to another.

3 Ballast pipes passing through deep tanks other than ballast tanks are to be led through oiltight or watertight pipe tunnels or, alternatively, are to be of a sufficient thickness which complies with the requirements given in Table D12.6(1) to Table D12.6(2), Part D of the Rules for the Survey and Construction of Steel Ships.

7.1.11 Air Pipes and Overflow Pipes
1 Air pipe openings and the discharge openings of overflow pipes are to be located above the final calculated immersion lines in the assumed damage conditions specified in Chapter 3 and are to be positioned outside the extent of damage as defined in Chapter 3.
2 Vent heads with suitable flame arresters are to be fitted to the vent pipes of helicopter fuel oil tanks.

7.1.12 Sounding Pipes
1 The internal diameter of sounding pipes of 20m or more in length is not to be less than 50mm.
2 In cases where remote level indicators are used for tanks which are not always accessible, additional sounding systems are to be provided.

7.1.13 Burning Systems for Boilers
In cases where the removal of residual fuel oil in burners is conducted by means of steam or air, means are to be taken to prevent the mixing of oil into steam or air.

7.1.14 Feed Water Systems for Boilers
1 Boilers which could be rendered dangerous by the failure of their feed water supplies are to be provided with two separate feed water systems including feed pumps so that such systems are capable of supplying feed water to boilers with any one system being out of use. However, single penetrations of steam drums are acceptable.
2 In the case of boilers intended to supply steam for systems or equipment other than those related to Gas Floating Offshore Facility safety, only one feed water system may be acceptable notwithstanding the requirement given in above.

7.2 Cargo Pressure/Temperature Control
Cargo Pressure/Temperature Control is to comply with the requirements given in Chapter 7, Part N of the Rules for the Survey and Construction of Steel Ships.

7.3 Dual Fuel Diesel Engines, Boilers and Gas Turbines

7.3.1 General
1 The construction and installation of dual fuel diesel engines are to comply with relevant requirements given in this Chapter as well as the requirements given in Chapter 16, Part N of the Rules for the Survey and Construction of Steel Ships, Annex 3 “Guidance For High Pressure Dual Fuel Diesel Engines”, Part N of the Guidance and Annex 4 “Guidance For Low Pressure Dual Fuel Diesel Engines”, Part N of the Guidance for the Survey and Construction of Steel Ships.
2 The construction and installation of gas turbines and dual fuel boilers are to comply with relevant requirements given in this chapter as well as the requirements given in Chapter 16, Part N of the Rules for the Survey and Construction of Steel Ships and Annex 2 “Guidance For Dual Fuel Boilers”, Part N of the Guidance for the Survey and Construction of Steel Ships. The gas turbines are to comply with relevant requirements given in the following (1) to (3):

(1) API Standard 616, 1968: “Combustion Gas Turbine for General Refinery Services
(2) ISO 2314, 1973: Gas Turbine Acceptance Tests
(3) National Fire Protection Agency (NFPA) No.37, 1975: Stationary Combustion Engines and Gas Turbines

7.3.2 Drawings and Data to be Submitted
The drawings and data to be submitted are generally as follows:
(1) General arrangements
(2) Engine room equipment construction and arrangements
(3) Gas and fuel oil piping arrangements
(4) Gas-tight boiler casing (including funnels) arrangements
(5) Piping diagrams showing fuel supply arrangements
(6) Ventilation arrangements
(7) Drawings and data related to automatic controls and remote controls

7.3.3 Ventilation Systems
1. The ventilation of engine and boiler rooms is to be carried out at pressures which exceed atmospheric pressure. Main ventilation systems are to be independent of all other ventilation systems. If boilers and gas turbines are installed in confined parts of engine and boiler rooms, this requirement only applies to those parts of such rooms. The number of pressure fans for engine or boiler rooms is to be such that capacity is not reduced by more than 50%, if one fan is out of operation.
2. Ventilation systems are to ensure good air circulation in all spaces, and in particular, ensure that there is no possibility of the formation of gas pockets in any space.

7.3.4 Gas Detectors
Gas detectors are to be fitted in spaces where gas fuel is used, particularly in zones where air circulation is reduced. Gas detection systems are to comply with the requirements given in Chapter 13, Part N of the Rules for the Survey and Construction of Steel Ships.

7.3.5 Gas Fuel Supply Systems
1. Gas fuel piping is not to pass through accommodation spaces, service spaces or control stations. Gas fuel piping may pass through or extend into other spaces provided they fulfill one of the following conditions:
   (1) Gas fuel piping is to be a double wall piping system with the gas fuel contained in the inner pipe. The space between the concentric pipes is to be pressurized with inert gas at a pressure greater than the gas fuel pressure. Suitable alarms are to be provided to indicate a loss of inert gas pressure between the pipes; or
   (2) Gas fuel piping is to be installed within ventilated pipes or ducts. The air space between the gas fuel piping and inner wall of such pipes or ducts are to be equipped with mechanical exhaust ventilation having a capacity of at least 30 air changes per hour. Ventilation systems are to be arranged to maintain pressures less than the atmospheric pressure. Fan motors are to be placed outside ventilated pipes or ducts. Ventilation outlets are to be placed in positions where no flammable gas-air mixture may be ignited. Ventilation is to always be in operation in cases where there is gas fuel in the piping. Continuous gas detection is to be provided to indicate leaks and to shut down gas fuel supplies to machinery spaces in accordance with 16.3.10, Part N of the Rules for the Survey and Construction of Steel Ships. Master gas fuel valves required by 16.3.7, Part N of the Rules for the Survey and Construction of Steel Ships are to automatically close if required air flows are not established and maintained by exhaust ventilation systems.
2. If a gas leak occurs, the gas fuel supply is not to be restored until the leak has been found and repaired. Instructions to this effect are to be placed in prominent positions in machinery spaces.
3. The double wall piping systems or the ventilated pipes or ducts provided for gas fuel piping are to terminate at the ventilation hood or casing required by 16.3.4, Part N of the Rules for the Survey and Construction of Steel Ships.
4. Ventilation hoods or casings are to be provided for areas where flanges, valves, etc. are installed, and for gas fuel piping of gas fuel utilization units such as boilers or gas turbines. If such ventilation hoods or casings are not served by the exhaust ventilation fans serving the ventilated pipes or ducts as specified in 16.3.1(2), Part N of the Rules, then they are to be equipped with exhaust ventilation systems and continuous gas detection is to be provided to indicate leaks and to shut down gas fuel supplies to machinery spaces in accordance with 16.3.10, Part N of the Rules for the Survey and Construction of Steel Ships. Master gas fuel valves required by 16.3.7, Part N of the Rules for the Survey and Construction of Steel Ships are to automatically close if required air flows are not established and maintained by exhaust ventilation systems. Ventilation hoods or casings are to be installed or mounted to permit ventilating air to sweep across gas utilization units and be exhausted at the top of such ventilation hoods or casings.
5 Ventilation inlets and discharges for required ventilation systems are to be installed in safe locations.

6 Gas detection systems provided in accordance with the requirements given in -1 and -4 above are to comply with 13.6.2 and 13.6.4 through 13.6.8, Part N of the Rules for the Survey and Construction of Steel Ships as applicable. They are to activate alarms at 30% of lower flammable limits and shut down the master gas fuel valves referred to in -10 above before gas concentrations reach 60% of lower flammable limits.

7 Gas fuel supply arrangements are to comply with the requirements given in -1 to -6 above. In such cases, complete systems for gas processing, i.e. storage vessels, compressors, separators, filters, pressure control valves, etc., are to be located in hazardous areas and separated from engine and boiler rooms by gas-tight bulkheads.

8 Each gas utilization unit is to be provided with a set of three automatic valves. Two of these valves are to be fitted in a series onto gas fuel pipes leading to consuming equipment. A pipe that vents to a safe open air location is to be installed between this series of two valves, and the third valves is to fitted onto that vent pipe. These valves are to be arranged so that failure of necessary forced draught, loss of flame on boiler burners, abnormal pressure in gas fuel supply lines, or failure of valve control systems will cause the two gas fuel valves which are in a series to automatically close and the vent valve to automatically open. Alternatively, the function of one of the valves in the series and the vent valve can be incorporated into one valve body arranged so that, in cases where one of the above conditions occur, the flow to gas utilization units will be blocked and the vent opened. The three shutoff valves are to be arranged for manual reset.

9 Gas fuel piping in machinery spaces is to comply with 5.2 to 5.5, Part N of the Rules for the Survey and Construction of Steel Ships as needed. Such piping is to, as far as practicable, have welded joints. Those parts of gas fuel piping, which are not enclosed in ventilated pipes or ducts according to 16.3.1, Part N of the Rules for the Survey and Construction of Steel Ships and are on open decks outside cargo areas are to have full penetration butt welded joints and are to be fully radiographed.

10 Master gas fuel valves that can be closed from within machinery spaces are to be provided within cargo areas. Such valves are to be arranged to automatically close in cases where gas leakage is detected, duct or casing ventilation loss or double wall gas fuel piping pressurization loss occurs.

11 Provisions are to be made for inerting and gas-freeing the portion of gas fuel piping systems located in machinery spaces.

7.4 Monitoring and Remote Control Systems

7.4.1 General

1 Common control stations located in non-hazardous areas are to be provided for the centralized monitoring and control of the systems specified in (1) to (8) below. Remote operation of production systems and ballast systems may be required in cases where such systems are not accessible at all times.

(1) Fire detection systems
(2) Gas detection systems
(3) Emergency shutdown systems (ESD)
(4) Process shutdown systems (PSD)
(5) General alarm systems
(6) Fire extinction systems for cargo areas and production areas
(7) Monitoring systems for production systems
(8) Dynamic positioning systems

2 Monitored uninterruptable power supplies (UPS) are to be provided for all safety systems (e.g. fire and gas detection systems, emergency shutdown systems, process shutdown systems, communication and general alarm systems).

3 Instrumentation (gauging, gas detection) of cargo are to comply with the requirements given in Chapter 13, Part N of the Rules for the Survey and Construction of Steel Ships.

7.5 Emergency Shutdown (ESD) Systems

7.5.1 General

1 In view of the special conditions where the risk of explosions may accidentally extend outside hazardous areas,
ESDs are to be provided to facilitate the selective manual disconnection or shutdown of the facilities listed in the following (1) to (4):

1. Ventilation systems
2. Production systems
3. All non-essential electrical equipment in non-hazardous areas
4. All essential electrical equipment including battery supplied equipment and generator prime movers except explosion-proof equipment such as emergency lights, general alarms, etc. which have to operate during special conditions.

ESDs are to be based on normally open circuits, except for the shutdown of production activity and the entrance to production systems which are to be based on normally closed circuits or the fail safe principle.

Electrical shutdown systems provided in order to comply with the requirements specified in (1) and (3) above are to be designed so that any risk of unintentional shutdown caused by system malfunction or inadvertent operation is minimized.

Audible and visual alarms which indicate ESD initiation are to be installed at control stations. Alarms displaying the locations and the sources of ESD initiation or equipment effecting ESDs are to be readily identified at the control station.

ESD systems including sensors, actuators and their associated connections and circuits are normally to be arranged to operate independently of other monitoring, control and alarm systems. ESD systems are to be arranged with sufficient segregation so that a failure in a particular part of the system would not render other parts of the system inoperative.

Manually operated ESD systems are, as far as possible, to be arranged independent of the automatic operated ESD systems.

ESD systems are to be designed such that they can be tested in cases where installations are in operation.

7.6 Machinery Installations in Hazardous areas

7.6.1 General

1. Combustion equipment and combustion engines are normally not to be located in hazardous areas. In cases where it is necessary to house combustion engines in hazardous areas, pressurization of such areas will be accepted to make it non-hazardous provided such pressurized locations comply with the following minimum criteria:

   (1) Pressurization air is taken from non-hazardous areas
   (2) Alarm systems are fitted to indicate loss of air pressure
   (3) Air-lock systems with self-closing doors are fitted
   (4) Exhaust outlets are located in non-hazardous areas and arranged according to (2)
   (5) Combustion air inlets are located in non-hazardous areas
   (6) Automatic shutdowns are arranged to prevent over-speed in cases where flammable gas has been detected

2. Machinery installations in the areas specified in (1) above are to be constructed and installed so as to reduce the risk of ignition from sparking due to the formation of static electricity or friction between moving parts and from the high temperatures of exposed parts due to exhausts or other emissions.
Chapter 8   ELECTRICAL INSTALLATIONS

8.1   General

8.1.1   Application

With respect to the electrical equipment, wiring and their control systems (hereinafter referred to as “electrical installations” in these Guidelines) of Gas Floating Offshore Facilities, the requirements given in this Chapter and Chapter 10, Part N of the Rules for the Survey and Construction of Steel Ships are to be applied.

8.1.2   General

1   In the case of electrical installations other than those used for solely for the specific operation which is the purpose of Gas Floating Offshore Facility (the processing of natural gases, etc. extracted from seabeds.), relevant requirements given in Part H of the Rules for the Survey and Construction of Steel Ships listed in the following (1) to (8) as well as the requirements given in this Chapter are to be applied. (The term “cargo oil” is to be construed as “cargo”, “carry” and “transport” are to be construed as “process/store”, “ship” and “ship carrying liquefied gases in bulk” are to be construed as “Gas Floating Offshore Facilities”.)

(1) 1.1.2, Part H of the Rules for the Survey and Construction of Steel Ships General - General - Equivalency
(2) 1.1.3, Part H of the Rules for the Survey and Construction of Steel Ships General - General - Electrical
(3) 1.1.5, Part H of the Rules for the Survey and Construction of Steel Ships General - General - Definitions
(4) Chapter 2, Part H of the Rules for the Survey and Construction of Steel Ships Electrical Installations and System Design
(5) 3.4, Part H of the Rules for the Survey and Construction of Steel Ships Design of Installations - Starting Arrangement for Emergency Generating Sets
(6) 3.7, Part H of the Rules for the Survey and Construction of Steel Ships Design of Installations - Lightning Conductors
(7) 3.8, Part H of the Rules for the Survey and Construction of Steel Ships Design of Installations - Spare Parts, Tools and Instruments
(8) Chapter 6, Part H of the Rules for the Survey and Construction of Steel Ships Special Requirements for Ships with Restricted Service, Small Ships and Fishing Vessels

2   With respect to electrical installations used solely for the operation (the processing of natural gases, etc. extracted from seabeds.) which is the purpose of the Gas Floating Offshore Facility, relevant requirements given in Part H of the Rules for the Survey and Construction of Steel Ships listed in the following (1) to (5) as well as the requirements given in 8.1.4-1 are to be applied. (The term “cargo oil” is to be construed as “cargo”, “carry” and “transport” are to be construed as “process/store”, “ship” and “ship carrying liquefied gases in bulk” are to be construed as “Gas Floating Offshore Facility”.) However, electrical installations which do not comply with the requirements given in Part H of the Rules for the Survey and Construction of Steel Ships may be in accordance with standards deemed appropriate by the Society.

(1) 1.1.2, Part H of the Rules for the Survey and Construction of Steel Ships General - General - Equivalency
(2) 1.1.3, Part H of the Rules for the Survey and Construction of Steel Ships General - General - Electrical
(3) 1.1.5, Part H of the Rules for the Survey and Construction of Steel Ships General - General - Definitions
(4) Chapter 2, Part H of the Rules for the Survey and Construction of Steel Ships Electrical Installations and System Design
(5) Chapter 6, Part H of the Rules for the Survey and Construction of Steel Ships Special Requirements for Ships with Restricted Service, Small Ships and Fishing Vessels

8.1.3   Tests

1   The electrical installations used for systems or equipment essential for the safety of Gas Floating Offshore
Facilities or for the positioning of Gas Floating Offshore Facilities (only applicable to electrical positioning systems) and listed in the following (1) to (5) are to be tested in accordance with the relevant requirements given in Part H of the Rules for the Survey and Construction of Steel Ships at manufacturers or at other works which are adequately equipped for such testing and inspections.

1. Generators and motors
2. Control gears for motors
3. Main and emergency switchboards
4. Transformers for power and lighting of single phase 1 kVA or more and three phase 5 kVA or more
5. Power semiconductor rectifiers not less than 5 kW and their accessories used for supplying power to electrical equipment

In the case of electrical installations manufactured by mass-production systems, test procedures suited to their production methods, notwithstanding the requirements given in -1 above, may be applied subject to Society approval in accordance with Part 5, of the Guidance for the Approval and Type Approval of Materials and Equipment for Marine use.

Electrical installations used for systems or equipment essential for the safety of Gas Floating Offshore Facilities or for the positioning of Gas Floating Offshore Facilities (only applicable to electrical positioning systems) and listed in the following (1) to (5) are to be subjected to type tests for each of product in accordance with Part 8, of the Guidance for the Approval and Type Approval of Materials and Equipment for Marine use. In cases where it is inadequate to deal with them under type approval requirements (e.g. those used only for specific units or purposes with little possibility of continued use, or items for which the acquisition of individual test/inspection certificates is desired), tests and inspections on individual product items may be accepted by application in place of type approval tests.

1. Fuses
2. Circuit breakers
3. Electromagnetic contactors
4. Explosion-protected electrical equipment
5. Power, lighting and internal communication cables

Electrical equipment and cables having certificates considered acceptable to the Society may be exempted partially or wholly from tests and inspections.

Among the electrical equipment used solely for the specific operation which is the purpose of the Gas Floating Offshore Facility, fuses, circuit breakers, explosion-protected electrical equipment and cables are to be in accordance with the requirements given in -3 above. However, electrical installations which do not comply with these requirements may be accepted provided that documents such as specifications, sectional assembly drawings, test reports, certificates issued by public bodies are submitted to the Society for examination.

Electrical equipment used solely for the specific operation which is the purpose of the Gas Floating Offshore Facility and not listed in -5 above may be in accordance with standards deemed appropriate by the Society.

In the case of electrical installations used for systems or equipment essential for the safety of Gas Floating Offshore Facilities or for the positioning of Gas Floating Offshore Facilities (only applicable to electrical positioning systems), the performance tests specified in 2.18, Part H of the Rules for the Survey and Construction of Steel Ships are to be carried out after installation on board.

In the case of electrical installations used solely for the specific operation which is the purpose of the Gas Floating Offshore Facility, the insulation resistance tests specified in 2.18.1, Part H of the Rules for the Survey and Construction of Steel Ships and the performance tests of safety devices for generators and transformers are to be carried out after installation on board.

The Society may require tests other than those specified in 9.1.3 in cases where deemed necessary.

8.1.4  General Requirements for Electrical Installations

1. Electrical installations are to be designed to operate under the static conditions specified in 7.1.4-2. The Society may permit deviation from the angles given in 7.1.4-2 taking into consideration the type and size of the Gas Floating Offshore Facility.

2. Emergency electrical installations are to be designed to operate at full rated power under the static conditions specified in 7.1.4-3.
Electrical installations are to be designed to operate smoothly under the temperature conditions given in Table 7.1.

8.2 Main Source of Electrical Power and Lighting Systems

8.2.1 Main Source of Electrical Power

1 Gas Floating Offshore Facilities are to be provided with main sources of electrical power that are of sufficient capacity. Such main sources of electrical power are to consist of at least two generating sets.

2 The capacity of the generating sets required by 1 above is to be such that in the event of any one generating set being stopped it will still be possible to supply the electrical installations listed in the following (1) and (2) with power:

   (1) Electrical installations necessary for maintaining the safety of Gas Floating Offshore Facilities and the positioning of Gas Floating Offshore Facilities (only applicable the electrical positioning systems) under normal operational conditions. At the very least, the electrical installations listed in the following (a) to (e) are to be included.
      (a) Navigation lights, other lights and sound signals required by national regulations or international regulations
      (b) Radio installations
      (c) Fire detecting and extinguishing systems
      (d) Ventilation systems of hazardous areas and those areas maintained at an overpressure to exclude the ingress of dangerous gases
      (e) Bilge pumps

   (2) Electrical installations necessary to ensure minimum comfortable conditions of habitability which at least include adequate services for cooking, heating, domestic refrigeration, mechanical ventilation, sanitary and fresh water.

3 In 1 above, the electrical installations listed in the following (1) to (3) may be excluded from those electrical installations which are to be power supplied in the event of any one generating set being stopped.

   (1) Thrusters not forming part of the main propulsion machinery or positioning systems specified in Chapter 4
   (2) Refrigerating compressors for air conditioning installations
   (3) Others as deemed acceptable by the Society

4 In cases where transformers or converters constitute an essential part of the electrical supply systems required by 8.2.1, such systems are to be arranged to ensure the same continuity of supply as is stated in 1 and 2 above.

5 In cases where transformers are to supply power for the electrical auxiliary services necessary for maintaining Gas Floating Offshore Facilities under normal operational and habitable conditions, at least two sets transformers are to be provided. Note, however, that in the case of transformers used exclusively for specific loads, one set of transformers may be accepted in cases where such is deemed acceptable by the Society.

6 The capacities of the transformers specified in 4 above are to be such that the power feeding necessary for services to provide normal operational conditions of propulsion and safety, even in the event of the failure of one set of transformers, is available. Furthermore, at least, minimum habitable conditions are to be secured by such equipment including items for cooking, heating, provision refrigeration, mechanical ventilation, sanitary and fresh water services.

7 Notwithstanding the requirements given in 4 above, one set of transformers is acceptable if the respective primary and secondary sides of three single phase transformers are formed by delta connections, and if necessary power can be supplied as transformers of V connections in cases where either one of the transformers fails.

8 The arrangements of transformers are to be as follows: (See Fig. 8.2.1-1)

   (1) Each transformer is to be located as a separate unit with a separate enclosure or equivalent thereto.
   (2) Each transformer is to be served by separate circuits on the primary and secondary sides.
   (3) Each primary circuit is to be provided with a protection device and a multipole isolating switch.
   (4) Each secondary circuit is to be provided with a multipole isolating switch.

9 The main switchboard and one main generating station are to be located in the same space. However, main switchboards may be separated from generators by environmental enclosures, such as may be provided by machinery control rooms situated within the main boundaries of such spaces.
8.2.2 Lighting systems

1 Main lighting systems supplied from the main sources of electrical power are to be provided in spaces or compartments that crew and personnel normally use and work in while on duty.

2 Main lighting systems are to be arranged so as not to be impaired in the event of a fire or other accidents in spaces containing emergency sources of electrical power, associated transforming equipment (including converters, hereinafter the same), emergency switchboards and emergency lighting switchboards.

3 Emergency lighting systems providing sufficient illumination necessary for safety are to be provided:

   (1) At every muster and embarkation station, and over side;
   (2) In all service and accommodation alleyways, stairways and exits (include those leading to muster stations and launching stations required to be illuminated by the lighting specified in (1) above), personnel lift cars, and personnel lift trunks;
   (3) In machinery spaces and main generating stations including their control positions;
   (4) In all control stations, machinery control rooms, and at each main and emergency switchboard;
   (5) At the all storage locations of fireman outfits;
   (6) At fire pumps, at sprinkler pumps and at emergency bilge pumps, and at the starting positions of their motors;
   (7) In all spaces from which the control of production processes is performed and where the controls of machinery
essential for the performance of such processes, or devices for emergency switching-off of power plants are
located; and
(8) On helicopter landing decks
4  The emergency lighting systems required by -2 above and the navigation lights, signaling devices, etc. required
by 8.3.2-1(2) and (3) are to be arranged so as not to be impaired in the event of fire or other accidents in spaces
containing main sources of electrical power, associated transforming equipment, main switchboards and main
lighting switchboards.

8.3  Emergency Source of Electrical Power

8.3.1  General
1  Gas Floating Offshore Facilities are to be provided with self-contained emergency sources of electrical power.
2  Emergency sources of electrical power, associated transforming equipment, transitional sources of emergency
electrical power, emergency switchboards and emergency lighting switchboards are to be located above the worst
damage waterline and in spaces not within the assumed extent of damage referred to in Chapter 3, and are to be
readily accessible from open decks. They are not to be located forward of collision bulkheads, if any.
3  The locations of emergency sources of electrical power, associated transforming equipment, transitional sources
of emergency electrical power, emergency switchboards and emergency lighting switchboards are to be such as to
ensure to the satisfaction of the Society that a fire or other accident in spaces containing main sources of electrical
power, associated transforming equipment and main switchboards, or in any machinery space of Category A will not
interfere with the supply, control and distribution of emergency electrical power. As far as practicable, spaces
containing emergency sources of electrical power, associated transforming equipment, transitional sources of
emergency electrical power and emergency switchboards are not to be contiguous to the boundaries of machinery
spaces of Category A or to those spaces containing main sources of electrical power, associated transforming
equipment and main switchboards, or to hazardous areas. In cases where such spaces can not avoid being contiguous
to such boundaries, all contiguous boundaries are to comply with the requirements given in Chapter 6.
4  In the case of Gas Floating Offshore Facilities where the main sources of electrical power are located in two or
more spaces which have their own systems, including power distribution and control systems, completely
independent of the systems in other spaces and such that a fire or other accident in any one of the spaces will not
affect the power distribution from the others, or the emergency services required by 8.3.2, the requirements given in
-1 to -3 may be considered satisfied without additional emergency sources of electrical power, provided that the
Society is satisfied with the following (1) to (3):
(1) At least two generating sets meeting the requirements given in 7.1.4-3 and each of sufficient capacity to meet the
requirements given in 8.3.2, in each of at least two spaces are provided.
(2) The arrangements required by (1) above in each such space are equivalent to those required by 8.3.3(1), 8.3.4 to
8.3.5 and 3.4, Part H of the Rules for the Survey and Construction of Steel Ships so that sources of electrical
power are available at all times for the services required by 8.3.2.
(3) The location of each of the spaces referred to in (1) above is in compliance with -2 above and the boundaries
meet the requirements of -3 above except that contiguous boundaries are to consist of steel bulkheads insulated
to class “A-60” on both sides.
5  Provided that suitable means are taken for safeguarding independent emergency operations under all
circumstances, and in the case of temporary conditions (e.g. a blackouts, dead ship, periodic testing, maintenance and
examinations, brief parallel running between main generators and emergency generators, etc.), emergency generators
may be used in special cases for short periods to supply non-emergency circuits.
6  With respect to the application of -5 above in cases where emergency generators are used to supply ship mains,
such emergency generators and their associated equipment are to comply with the following requirements:
(1) In order to prevent generators or their prime movers from becoming overloaded, arrangements are to be
provided to shed sufficient non-emergency loads to ensure continuous safe operation.
(2) Diesel Prime movers are to be equipped with the devices for the alarms and automatic trips specified in 18.5.2,
Part D of the Rules for the Survey and Construction of Steel Ships (excluding (2) and (5) where local
control stations are not unattended).
(3) The fuel oil supply tanks of prime movers are to be provided with low level alarms, arranged at levels ensuring
Guidelines for Floating Offshore Facilities for LNG/LPG Production, Storage, Offloading and Regasification

sufficient fuel oil capacity for emergency services for the period of time required by 8.3.2. In addition, such alarms are to be activated in the spaces specified in (2) above.

(4) Fire detectors complying with Chapter 20, Part R of the Rules for the Survey and Construction of Steel Ships are to be installed in spaces where emergency generator sets and emergency switchboards are installed.

(5) Means are to be provided to readily change over into emergency operations.

(6) Control, monitoring and supply circuits for the purpose of using emergency generators are to be arranged and protected so that any electrical fault will not influence the operation of main and emergency services. In cases where necessary for safe operation, emergency switchboards are to be fitted with switches to isolate circuits.

(7) Instructions are to be provided on board to ensure that all control devices, e.g., valves, switches, etc. are in their correct positions.

7 The emergency electrical power available is to be sufficient to supply all those services that are essential for safety in an emergency, due regard being paid to such services that may have to be simultaneously operated. Emergency sources of electrical power are to be capable, with consideration given to starting currents and the transitory nature of certain loads, of at least simultaneously supplying the services required by 8.3.2 and 8.5.1-4 for the periods specified hereinafter, if they depend upon electrical power sources for their operation.

8.3.2 Capacity of Emergency Sources of Electrical Power

1 Emergency sources of electrical power are to be capable of simultaneously supplying the services listed in the following (1) to (7) for the period specified hereinafter if they depend upon electrical power sources for operation.

(1) For a period of 24 hours, the emergency lighting specified in 8.2.2-3.

(2) For a period of 24 hours, navigation lights, other lights and sound signals required by national regulations or international regulations.

(3) For a period of 4 days, any signaling lights or sound signals which may be required for the marking of Gas Floating Offshore Facilities.

(4) For a period of 24 hours, the following services unless such services have independent power supplies for a period of 24 hours from accumulator batteries suitably located for use in an emergency.

(a) All internal communication equipment required in an emergency.

(b) VHF radio installations, MF radio installations, INMARSAT ship earth stations and MF/HF radio installations as required by international conventions and the national regulations of coastal states and installed in Gas Floating Offshore Facilities. However, in cases where those radio installations are installed in duplicate, it is not necessary to consider whether duplicated installations can be simultaneously operated in determining the capacity of an emergency source of electrical power.

(c) Fire and gas detection systems and their alarm systems.

(d) Manual fire alarms and all internal signals which are required in an emergency.

(5) For a period of 30 minutes, the emergency shutdown systems required by 7.5.

(6) For a period of 24 hours, one of the fire pumps if dependent upon emergency generators for its source of power except in the case of pumps driven by prime movers.

(7) For a period of 30 minutes, the services listed in the following (a) and (b): 

(a) Devices to operate the watertight doors required by Chapter 3, but not necessarily all of them simultaneously, unless an independent temporary source of stored energy is provided.

(b) The control devices and indicators required by Chapter 3.

8.3.3 Kind and Performance of Emergency Sources of Electrical Power

Emergency sources of electrical power are to be either generators or accumulator batteries which comply with the following:

(1) In cases where emergency sources of electrical power are generators, they are to comply with the following (a) to (c):

(a) Emergency generators are to be driven by suitable prime movers with independent supplies of fuel having flashpoints of not less than 43 °C.

(b) Emergency generators are to be automatically started upon the failure of main sources of electrical power unless transitional sources of emergency electrical power in accordance with (c) are provided. In cases where emergency generators are automatically started, they are to be automatically connected to emergency switchboards and those services referred to in the requirements given in 8.3.4 are then to be automatically
connected to emergency generators.

(c) The transitional sources of emergency electrical power specified in 8.3.4 are to be provided unless emergency generators are provided which are capable both of supplying the services mentioned in 8.3.4 and of being automatically started and supplying required loads as quickly as is safe and practicable within a maximum period of 45 seconds. Automatic starting systems are to comply with the following requirements given in i) to iii):

i) Sources of stored energy are to have capacities which are capable of starting prime movers at least six times.

ii) In cases where automatic starting systems are consecutive start types, the number of starts is to be three or less.

iii) In the case of automatic starting systems, means are to be provided to hold such an allowance of sources of energy capable of starting the prime movers three more times after making the initial consecutive starts.

(2) In cases where emergency sources of electrical power are accumulator batteries, they are to be capable of:

(a) Carrying emergency electrical loads without recharging while maintaining battery voltage throughout the discharge period within 12% above or below nominal voltage. However, in cases where inverters or converters are connected to the output circuits of batteries (consumer side), maximum permitted voltage fluctuations may be taken as those specified in Table H2.1(a) or H2.1(b), 3.2.1.2-3, Part H of the Rules for the Survey and Construction of Steel Ships respectively, notwithstanding any battery voltage drops;

(b) Automatically connecting to emergency switchboards in the event of the failure of main sources of electrical power;

(c) Immediately supplying at least those services specified in 8.3.4.

8.3.4 Transitional Sources of Emergency Electrical Power

Transitional sources of emergency electrical power are, in cases where required by 8.3.3(1)(c), to consist of accumulator batteries suitably located for use in an emergency which are to:

(1) Operate without recharging while maintaining battery voltage throughout the discharge period within 12% above or below nominal voltage. However, in cases where inverters or converters are connected to the output circuits of batteries (consumer side), the requirements specified in 8.3.3-2(a) may be applied; and

(2) Be of sufficient capacity and be arranged to automatically supply power to at least the following services if they depend upon electrical power sources for operation for 30 minutes in the event of failure or either the main or the emergency source of electrical power.

(a) The emergency lighting systems required by 8.3.2-1(1) and 8.5.1-4(1). During transitional phases, required emergency lighting systems, in respect to machine spaces, accommodation spaces and service spaces may be provided by permanently fixed, individual, automatically charged, relay operated accumulator lamps.

(b) The navigation lights and signaling devices required by 8.3.2-1(2).

(c) All services required by 8.3.2-1(4)(a), (c), (d) and 8.5.1-4(2) unless such services have independent power supplies for the period specified from accumulator batteries suitably located for use in an emergency.

8.3.5 Location, etc. of Emergency Sources of Electrical Power

1 Emergency switchboards are to be installed as near as is practicable to emergency sources of electrical power. In cases where emergency sources of electrical power are generators, emergency switchboards are to be located in the same space unless emergency switchboard operation would thereby be impaired.

2 No accumulator batteries fitted in accordance with 8.3 are to be installed in the same space as emergency switchboards, unless appropriate measures to the satisfaction of the Society are taken to extract any gases discharged from the said batteries. Indicators are to be mounted in suitable places on main switchboards or in machinery control rooms to indicate when batteries constituting either the emergency source of electrical power specified 8.3.3(2) or the transitional source of electrical power specified in 8.3.4 are being discharged.

3 Emergency switchboards are to be supplied power from main switchboards. Interconnect or feeders connecting emergency switchboards and main switchboards are to be:

(1) Adequately protected at main switchboards against overloads and short circuits;

(2) Automatically disconnected at emergency switchboards upon the failure of main sources of electrical power; and
(3) Protected at emergency switchboards against at least short circuits in cases where systems are arranged for feedback operations.

4 Arrangements are to be made in cases where necessary to automatically disconnect non-emergency circuits from emergency switchboards to ensure that electrical power is to be automatically available to emergency circuits.

8.3.6 Testing Provisions

Emergency electrical system is to be provided with measures for periodic testing. The periodic testing is to include the testing of automatic starting arrangements.

8.4 Emergency Alarm Systems and Internal Means of Communication

8.4.1 Emergency Alarm Systems

1 The following emergency alarm systems that issue easily distinguishable alarms are to be provided:
(1) General emergency alarms
(2) Fire alarms
(3) Gas detection alarms
(4) Toxic gas alarms
(5) Fire extinguishing medium release alarms
(6) Power-operated sliding watertight door closing alarms

The above emergency alarm systems are to comply with the statutory requirements of National Authorities having jurisdiction in the waters where Gas Floating Offshore Facilities are located during operation in addition to the requirements given in the Code on Alarms and Indicators (IMO Res. A.830(19))

2 Emergency alarm systems are to be installed to be clearly perceptible in all parts of Gas Floating Offshore Facilities.

3 Emergency alarm systems are to be connected to uninterruptable power supplies (UPS) with the capacity to supply power for 18 hours or to main and emergency sources of power with automatic change overs.

4 Manual call points complying with the requirements given in Chapter 29 to Chapter 35, Part R of the Rules for the Survey and Construction of Steel Ships are to be located in accommodation spaces, service spaces and control stations, and one call point is to be arranged at every exit. Fire and gas alarms are, in general, to be manually activated from the control stations. Call points are to be located at readily accessible locations which are within 20m from any location in corridors on each deck, and their height is to be not less than 1.2m or more than 1.5m above the floor. Call points are to be marked in red.

5 Emergency alarm systems installed in spaces in cases where audible alarms are not effective because of noise, etc. are to be capable of providing audible and visual alarms.

8.4.2 Internal Means of Communication

1 Internal means of communication available for the transfer of information between all spaces where action may be necessary in case of an emergency are to be provided.

2 Such means are to be capable of giving instructions over public address systems in cases where general emergency alarm systems are activated.
Chapter 9 PRODUCTION SYSTEMS

9.1 General

9.1.1 Application

1. The requirements given in this Chapter apply to the following production systems which may be installed on Gas Floating Offshore Facilities which comply with the requirements given in Chapters 1 to 8.

(1) Gas processing facilities
(2) Liquefaction facilities
(3) Regasification facilities
(4) Riser compensating and tensioning systems
(5) Flare systems
(6) Safety systems
(7) Control systems
(8) Production support systems
(9) Water injection systems (only for production systems)
(10) Gas injection systems (only for production systems)
(11) Inlet manifolds and manifolds

2. The following are considered as main boundaries between production systems and other onboard systems:

(1) Lower riser connections to sub-sea systems
(2) Control system connections to sub-sea systems
(3) Connection flanges to production systems (in cases where production systems are provided outside Gas Floating Offshore Facilities)
(4) Shutdown valves at outlets from production systems to cargo tanks or storage units, etc. provided outside Gas Floating Offshore Facilities
(5) Injection systems (only for outlet flanges of piping connections to sub-sea systems)

3. Attention is to be given to any statutory requirements of the National Authority having jurisdiction in the waters where Gas Floating Offshore Facilities are located during operation.

4. Flow-line systems are to comply with the following requirements given in (1) to (4):

(1) The design pressures of flow-line systems from pipeline end manifolds (PLEM) to first connecting points on Gas Floating Offshore Facilities (or periphery facilities for positioning) are defined as the larger of the following:
   (a) The shut-off heads at the manifolds of Gas Floating Offshore Facilities or periphery facilities for positioning at zero flow, plus the gravity head of the fluid contents in pipes or hoses.
   (b) The head calculated due to surge pressure, resulting from design valve closing time.

(2) PLEMs are to be firmly connected to seabeds in consideration of environmental loads, like current forces, etc. as well as the floating structures of periphery facilities for positioning.

(3) Effective means are to be provided to isolate Gas Floating Offshore Facilities or periphery facilities for positioning from underwater pipelines.

(4) Shut-off valves are to be provided on periphery facilities for positioning enabling the manual shut off of flow-line systems from above the water surface.

5. In cases where flexible risers are used for flow-line systems, the length, buoyancy, arrangement of supports, etc. of flexible risers are to be designed with consideration given to at least the following aspects:
(1) The maximum excursion of Gas Floating Offshore Facilities or periphery facilities for positioning both under the operating conditions of moored Gas Floating Offshore Facilities and the design conditions of unmoored Gas Floating Offshore Facilities.

(2) The motion of riser system components

(3) The external forces on risers (current forces, tension from Gas Floating Offshore Facilities or periphery facilities for positioning, etc.)

(4) The range of the specific gravity of the anticipated contents passing through riser systems including sea water.

(5) Chafing or wear of underwater risers due to contact with Gas Floating Offshore Facilities, periphery facilities for positioning or other seabed facilities.

(6) Adequate reinforcement against flexible riser maximum flexing areas

(7) The construction of connections between flexible risers and Gas Floating Offshore Facilities or periphery facilities for positioning.

7 The pipes or hoses used for flexible risers are to comply with standards deemed appropriate by the Society (OCIMF, API, etc.). Hoses are to have certificates for necessary tests and inspections including pressure/vacuum tests.

8 In cases where floating hoses are used for flow-line systems, such floating hoses are to comply with the following requirements given in (1) to (4):

(1) In cases where floating hoses are used to transfer the gas from periphery facilities for positioning to Gas Floating Offshore Facilities, special hoses are to be provided at the moored Gas Floating Offshore Facility end to accommodate the properties of low temperature products and the bending of hoses over handrails, etc. In addition, swivels are to be provided at the connecting ends of floating hoses to periphery facilities for positioning and are to accommodate the properties of low temperature products and the bending of hoses.

(2) Breakaway couplings are to be provided with shut off valves in each floating hose string in order to protect from surges and axial overloads.

(3) Floating hoses are to comply with standards deemed appropriate by the Society (OCIMF, API, etc.), and to hold appropriate certificates for necessary tests and inspections including pressure/vacuum tests.

(4) The construction of connections between hoses and Gas Floating Offshore Facilities or periphery facilities for positioning. (bolting, gaskets, etc. and their designs) are to be suitable for their intended services.

9 The components of PLEMs, Sub-sea Systems, etc. are to comply with the following requirements given in (1) to (4):

(1) Pipes, valves, flanges, fittings, etc. used for PLEMs are to comply with applicable recognized standards, and are subject to hydrostatic tests with test pressures of 1.5 times design pressure.

(2) Swivels and other components of the sub-sea systems are to be suitable for their intended services and are to comply with applicable recognized standards/codes.

(3) Swivel bearings are to have sufficient performance and durability suitable for their intended services, and to comply with applicable recognized standards/codes (such as Anti-Friction Bearing Manufacturers (AFBM) code).

(4) On each sub-sea system component, attention is to be paid to corrosive environmental conditions such as seawater, H2S, etc.

9.2 Recognized Codes and Standards

9.2.1 General

1 Production systems are to be in accordance with the following recognized codes, standards or the equivalent approved by the Society from a safety point of view.

(a) API RP 14C

Recommended Practice for the analysis, design, installation and testing of basic surface safety systems on offshore production platforms

(b) API RP 520

Recommended Practice for the design and installation of pressure-relieving systems in refineries

(c) API RP 521

Recommended Practice for pressure relieving and depressurizing systems
2 The mixing of codes or standards for production systems or the components of production system is to be avoided. In cases where codes or standards cannot to be used in their entirely, selection from two or more codes or standards may be made, but only after proper consideration is given to any possible contradictions.

3 In cases where production system components are designed/constructed in accordance with codes or standards deemed appropriate by the Society and are provided with certificates issued by bodies deemed appropriate by the Society, Surveyors may modify test items, test ranges, etc.

9.3 Drawings and Data

9.3.1 General
Drawings and data about design and fabrication are to be in accordance with this Chapter and applied recognized codes and standards.

9.3.2 Drawing and Data of Production Systems
Drawings and data to be submitted are generally as follows:
(1) Drawings and data for approval
(a) Piping diagrams
(b) Flare/gas release area arrangements
(c) Riser compensating and tensioning systems
(d) Electrical equipment and cable installation arrangement plans
(e) Wiring system diagrams including normal working currents, rated currents, prospective short-circuit currents in the circuits, line drops of voltages, type of cables, cable sizes, ratings and settings of circuit breakers, ratings of fuses and switches, and breaking capacities of circuit breakers and fuses
(f) Summary of gas processing facilities
(g) Summary of liquefaction facilities
(h) Summary of regasification facilities
(i) Summary of safety systems
(j) Test procedures (However, in cases where test procedures conform to codes or standards deemed appropriate by the Society or in cases where provided with certificates deemed appropriate by the Society, Surveyors may modify test items, extents, etc.)

(2) Reference drawings and data
(a) Process description and operating philosophy
(b) Process flow diagrams including heat and mass balance
(c) Heat radiation and dispersion calculations
(d) Operational philosophy of gas processing facilities
(e) Operational philosophy of liquefaction facilities
(f) Operational philosophy of regasification facilities
(g) Activation logic of pressure relief systems
(h) Process shutdown system philosophy
(i) Injection shutdown system philosophy
(j) Corrosion/erosion monitoring and maintenance systems
(k) Summary data for control systems and emergency shutdown systems
(l) Risk assessment data, if performed

9.4 General Requirements for the Design of Production System Components

9.4.1 Application
Production system components are to be designed by sufficiently taking into account the following requirements:

9.4.2 Design Criteria
1 The design limits for production system components are to be decided by sufficiently taking into account the effects of operational conditions such as starts, changeovers, stops, hydrate formation, water hammers and slug in
addition to the requirements given in the survey specified in Chapter 11.
2 The effects of operational conditions such as atmospheric temperatures, seawater temperatures, snow and ice are to be sufficiently taken into account with respect to design criteria in cases where relevant according to respective service environment, in addition to the requirements specified in -1 above.
3 Production system components are to be adequately matched with regard to their functions, capacities, strengths and interface compatibility.

9.4.3 Design Pressure and Design Temperature
1 Design pressures for production systems are to be decided by sufficiently taking into account the dynamic closing pressures occurring when the emergency shut-off valves fitted with such components are actuated.
2 Production system components are to be designed to operate smoothly under the temperature conditions given in 7.1.4-6.
3 Production system components are to be located to ensure safe operation and, if located in hazardous areas, are to be suitably protected. Components in hazardous areas are to be protected so that surface temperatures do not exceed 160°C.

9.5 General Requirements for the Design of Production Systems

9.5.1 General
1 Production systems are to be arranged so that one single maloperation or malfunction will not lead to critical situations for personnel or the Gas Floating Offshore Facility. Protective devices are to provide two independent levels of protection to prevent or minimize the effects of a single malfunction or fault in processing systems and production support systems including their controls. It is desirable that the two levels of protection are provided by functionally different types of protective devices to reduce the probability for common cause failures.
2 Applicable equipments are to be equipped with indicating instruments considered necessary for safe operation.
3 All components and parts to be operated or subject to inspection and maintenance are to be installed and arranged for easy access.
4 All components are to be of designs and constructions adequate for the service for which they are intended and are to be installed and protected to reduce to a minimum any danger to personnel, due regard being paid to moving parts, hot surfaces and other hazards. Designs are to take into account the purposes for which such equipment are intended, the working conditions to which they will be subjected to and surrounding environmental conditions.
5 Suitable measures are to be taken to prevent the freezing of bilge pipes, air pipes, sounding pipes, drain pipes, etc., in cases where the inner surfaces of such pipers are at risk of freezing.

9.5.2 Emergency Stopping Devices
1 It is to be possible to either manually or automatically stop production systems in an emergency as necessary, if an accident occurs. Systems designed to be automatically stopped in an emergency are also to be designed to be manually stop in an emergency.
2 Emergency stopping devices are to function independently and be able to operate after the loss of main power.
3 In cases where emergency stopping devices are put into action and the operation of production system components are stopped, such components are not to automatically restart before manual reset is made.
4 In the case of automatic emergency stopping systems, the condition of system activation, the stopping sequence and dynamic effect including response time for action are to be precisely considered so that the activation of such systems do not lead to critical situations of production systems.
5 In the case of emergency stopping devices in which automatic emergency stop are put into action upon the detection of abnormal conditions, alarm systems for providing pre-alarm warnings or signals indicating the locations of any emergency stops are to be provided. Control stations are to receive such pre-alarm warnings or signals.

9.5.3 Safety Systems
1 Unattended systems are to be provided with the safety systems specified in the following -2 to -4 if the failure of such systems can endanger safety.
2 Safety system construction
   Safety systems are to be, as far as practicable, provided independently of control systems and alarm systems.
3 Safety system functions
   Safety system functions are to comply with the following requirements:
   (1) The functions specified in 9.5.2
   (2) Alarm systems which have the functions specified in the following (a) to (e) are to operate in cases where safety systems are put into action.
      (a) In cases where abnormal conditions are detected, devices for issuing visual and audible alarms are to operate.
      (b) In cases where arrangements are made to shut off audible alarms, such arrangements are not to shut off visual alarms.
      (c) Two or more faults are to be indicated at the same time.
      (d) Audible alarms for production systems are to be clearly distinguishable from other audible alarms such as general alarms, fire alarms, CO₂ flooding alarms, etc.
      (e) Visual alarms are to be arranged so that each abnormal condition of production systems is readily distinguishable and that acknowledgement is clearly noticeable.
   (3) In cases where safety systems are put into action and production system operations are stopped, production systems are not to automatically restart before manual reset is made.
4 Override arrangements
   In cases where arrangements are provided for overriding safety systems, the following requirements (1) and (2) are to be complied with:
   (1) Visual indications are to be given at relevant control stations of production systems in cases where an override is operated.
   (2) Override arrangements are to be such that inadvertent operation is prevented.

9.6 Emergency Shutdown Systems and Process Shutdown Systems of Production Systems

9.6.1 Application
   This Section gives the requirements for the following:
   (1) Emergency shutdown systems and process shutdown systems
   (2) Relief, depressurizing and disposal systems

9.6.2 Interconnections with Emergency Shutdown (ESD) Systems
   Process shutdown (PSD) systems are to receive input from emergency shutdown (ESD) systems so that if an emergency shutdown (ESD) system is put into action, the following occur:
   (1) Entrances to production systems are to close
   (2) All production activity is to shut down
   (3) All injection activity is to shut down

9.6.3 Process Shutdown (PSD) Systems
   1 In cases where automatic process shutdown systems are provided, such systems are to allow for manual operation. Systems are to be designed to provide operators with alarms and status overviews for safe operation.
   2 Automatic process shutdown systems are to be put into action upon the detection of abnormal conditions by sensors in the system.
   3 Process shutdown valves are to be able to segregate production systems taking into consideration the layout and operation of such systems.
   4 Emergency shutdown valves and process shutdown valves are to be provided with indicators showing whether the valves are open or closed. In the event such valves are closed, alarms are to be issued at relevant control stations.

9.6.4 Design of Pressure Relief, Depressurizing and Disposal Systems
   1 Production systems are to be provided with pressure relief, depressurizing and disposal systems complying with the following requirements:
      (1) Protection against excessive pressure
      (2) Minimization of cargo leakages in the case of rupture
      (3) Ensure the safe collection and discharge of released cargo
2 Such systems are to be designed to handle the maximum release rates expected due to any single production system component failure.
3 Power driven depressurizing systems are to be provided with sources of power to open by uninterruptable power supplies. Such systems are to be arranged to be manually remote operated from adequately protected areas such as control stations.

9.6.5 Cold Vents
1 Suitable measures are to be taken to prevent freezing in cases where there is a risk of freezing.
2 Cold vent piping is to be provided with drain systems or liquid collection systems to prevent liquid accumulation in cold vent lines.
3 Fire extinguishing and cooling systems are to be provided in order to avoid continuous burning in the case of accidental ignitions near cold vent piping.

9.6.6 Drain Systems
1 Drain systems to collect and discharge drains to a location where drainage can be safely handled and stored are to be provided.
2 Production systems are to be equipped with one open system for hazardous areas and one open system for non-hazardous areas, and such systems are to be completely separate.
3 All drains systems are to be led to exclusive facilities for cleaning.

9.7 Production System Components

9.7.1 General
1 Production system components are to comply with the requirements given in this Section as well as the requirements given in 7.1.2-2.
2 The following (1) to (5) production system components may be in accordance with recognized codes, standards or the equivalent approved by the Society notwithstanding the requirements specified in -1 above.
(1) Unfired pressure vessels
   (a) American Society of Mechanical Engineers (ASME) section VIII Div.1 and 2 Pressure Vessels
   (b) British Standard (BS) 5500 Unfired Fusion Welded Pressure Vessels
   (c) Norwegian Pressure Vessel Committee (TBK) 1-2 General Rules for Pressure Vessels
(2) Heat exchangers
   (a) Tabular Exchanger Manufacturers Association (TEMA) Class R Heat Exchanger Tubing
   (b) API 661 Air Cooled Heat Exchanger for General Refinery Services
(3) Thermal fluid heaters
(4) Pressure containing components which can be regarded as pressure vessels
(5) Atmospheric vessels

9.8 Gas Processing Facilities

9.8.1 General
1 Gas processing facilities are, in general, all facilities for the processing of raw gas such as acid gas removal, dehydration and mercury removal.
2 An appropriate method for gas processing process is to be selected according to various conditions such as the properties of the raw gas and product specifications.
3 A summary and operational philosophy of the gas processing facilities are to be submitted to the Society in order to evaluate the safety of the entire system according to the adopted gas processing process.

9.9 Liquefaction Facilities

9.9.1 General
1 Liquefaction facilities are, in general, all facilities for liquefaction such as pre-cooling, fractionation, main cryogenic refrigeration and storage of refined gas by gas processing facility.
An appropriate method for liquefaction process is to be selected according to various conditions such as the properties of the raw gas and product specifications.

A summary and operational philosophy of the liquefaction facilities are to be submitted to the Society in order to evaluate the safety of the entire system according to the adopted liquefaction process.

9.10 Regasification Facilities

9.10.1 General

Regasification facilities are, in general, all facilities for removing liquefied gas from cargo containment systems, pressurizing, heating and vaporizing such gas with water, air or steam, etc. and discharging ashore the vaporized gas through an off-loading system.

An appropriate method for regasification process is to be selected according to various conditions such as the properties of the raw gas and product specifications.

A summary and operational philosophy of the regasification facilities are to be submitted to the Society in order to evaluate the safety of the entire system according to the adopted regasification process.
Chapter 10 SPECIAL REQUIREMENTS

10.1 General

10.1.1 Application

Cargoes which are processed, stored and offloaded by Gas Floating Offshore Facilities subject to the application of these Guidelines are to be in accordance with the requirements in Chapter 17 and 19, Part N of the Rules for the Survey and Construction of Steel Ships in addition to the requirements in these Guidelines.
Chapter 11  SURVEYS

11.1  General

11.1.1  Application
1  The surveys of Gas Floating Offshore Facilities specified in these Guidelines are to be in accordance with the requirements given in this Chapter.
2  In the case of items not specified in this Chapter, the requirements specified in Chapter 12 and 13, Part B of the Rules for the Survey and Construction of Steel Ships are to be applied.
3  For general requirements regarding classification surveys, class maintenance surveys and other surveys, Chapter 1, Part B of the Rules for the Survey and Construction of Steel Ships is to be applied as appropriate.

11.2  Classification Surveys

11.2.1  General
   At Classification Surveys during construction, the hull, equipment, fire protection and detection means, means of escape, fire extinction means, machinery, electrical installations, etc. are to be examined in detail in order to ascertain that they meet the relevant requirements given in these Guidelines.

11.2.2  Submission of Plans and Documents for Approval
1  At the Classification Surveys during construction of Gas Floating Offshore Facilities, the following plans and documents are to be submitted to the Society for approval before the work is commenced.
   (1)  Hull
      (a) General arrangement
      (b) Cross section
      (c) Longitudinal section
      (d) Details of inspection facilities
      (e) Details of welding procedures
      (f) Information regarding corrosion control procedures adopted for each part of the Floating Offshore Facility
      (g) Arrangement and construction of positioning system (including related equipment, such as windlasses, etc.)
      (h) Summary of the distributions of fixed and variable weights
      (i) Plan indicating the design loads for all decks
      (j) Stability information booklet (including information for towing)
      (k) Loading manual
      (l) Details of maintenance and inspection procedures and docking plans and in-water inspection procedures
      (m) Pumping arrangements (indicating the capacity of each water or cargo tank)
      (n) Construction for fire protection (indicating the details of fire protection)
      (o) Plans showing the means of escape (escape routes including their details, such as the widths of passages, etc.)
      (p) Plans showing fire extinction arrangements (arrangement, type, capacity, etc., of fire extinguishers and fire detectors, etc.)
      (q) Plans and documents specified in 2.1.1-1 (3), Part B of the Rules for the Survey and Construction of Steel Ships
      (r) Other plans and/or documents deemed necessary by the Society
   (2)  Machinery
      (a) Machinery arrangement in machinery spaces, diagrams for internal communication systems
      (b) Piping diagram (both for machinery spaces and the entire Gas Floating Offshore Facility, including protection against any spraying of fuel/lubrication oil, etc.)
      (c) Prime movers including attached auxiliaries (plans and data specified in 2.1.2, 3.1.2 and 4.1.2, Part D of
the Rules for the Survey and Construction of Steel Ships corresponding to the kind of prime mover)
(d) Power transmission gears, shaftings and propellers (plans and data specified in 5.1.2, 6.1.2, 7.1.2 and 8.1.2, Part D of the Rules for the Survey and Construction of Steel Ships)
(e) Boilers, etc., incinerators and pressure vessels (plans and data specified in 9.1.3, 9.1.3-2 and 10.1.4, Part D of the Rules for the Survey and Construction of Steel Ships)
(f) Storage and off loading systems (their arrangement and plans/data specified in 14.1.2, and 14.5.2, Part D of the Rules for the Survey and Construction of Steel Ships)
(g) General arrangement and diagram of production systems (plans and data specified in 9.3.2)
(h) Automatic and remote controls (plans and data specified in 18.1.3, Part D of the Rules for the Survey and Construction of Steel Ships)
(i) Electrical installations (plans and data specified in 1.1.6, Part H of the Rules for the Survey and Construction of Steel Ships)
(j) Other plans and/or documents deemed necessary by the Society

2 In the Classification Surveys during construction of Gas Floating Offshore Facilities, the following plans and documents are to be submitted for reference in addition to those specified in -1 above.

(1) Methods and calculation sheets of structural analysis for relevant loading condition
(2) Data or documents on environmental conditions used for the determination of design loads, which indicate in detail the past measurement data of the service area such as wind, waves, current, etc., and the calculation method of the total external force and moment due to winds, waves, currents and tidal currents, reaction of positioning systems and other loads
(3) Documents on the effects of loading, stability and the projected area due to icing or snowing, if any
(4) Calculation sheets for intact and damage stability at all conditions
(5) Relating to above (2) to (4), documents concerning model tests or computing methods in cases where loads and stability are determined using appropriate model tests or computing methods
(6) Lines of hulls
(7) Cross curves of stability
(8) Curves of righting moments and wind heeling moments
(9) Capacity plans and sounding tables of tanks
(10) Method and location of the non-destructive inspections and procedures of thickness measurements
(11) Plans indicating the arrangement of watertight compartments, openings, their closing appliances, etc. necessary for stability calculations
(12) In the case of machinery installations used for the safety of Gas Floating Offshore Facilities or for positioning systems, plans and documents required in the relevant Chapters given in Part D of the Rules for the Survey and Construction of Steel Ships
(13) In the case of machinery installations used solely for the specific purpose of Gas Floating Offshore Facilities (including production systems, etc.), plans and documents indicating the safety devices of machinery installations and those specified in Chapter 9 and Chapter 10, Part D of the Rules for the Survey and Construction of Steel Ships
(14) Operating booklets and emergency operation manuals which are defined in 1.2.10 and 1.2.11
(15) Plans and documents indicating an outline of the construction work schedule (including the work to be completed, or equipment to be installed onboard Gas Floating Offshore Facilities at the building shipyard or engineering companies where the midway stage of construction work is made prior to the installation of Floating Offshore Facilities at their site of operation)
(16) Towing methods and strength calculation sheets during towing
(17) Procedures for onboard testing (including testing in cases where equipment is installed on Floating Offshore Facilities and any testing before and during the installation of Floating Offshore Facilities at their site of operation, etc.) and stability experiments
(18) Calculation sheets on positioning systems
(19) Installation procedures of positioning systems and production systems, etc., and the installation work procedures of Floating Offshore Facilities at their site of operation
(20) Plans and documents specified in 2.1.3-1 (7), Part B of the Rules for the Survey and Construction of Steel Ships
(21) Plans and documents specified in each chapter of these Guidelines
(22) Other plans and/or documents deemed necessary by the Society
3 The installation work procedures specified in (21) above are to include the following as applicable. The work process of each item is to include a method of confirming the adequacy of completed work as well as relevant judgment criteria.

1. A general outline of all of the systems of a Gas Floating Offshore Facility and its periphery facilities, including such items as positioning systems, risers, sub-sea pipelines, pipeline end manifolds (PLEM), etc.

2. Documents indicating the condition of the seabed at the site of operation where a Gas Floating Offshore Facility is installed

3. The installation procedures of seabed mooring points including things such as sinkers and piles and the procedures of connecting mooring lines to seabed mooring points including at least the following:
   a. Necessary preparations and processes for the installation of the Gas Floating Offshore Facility (including information about the rigging arrangements for piles, chaser piles and driving hammers as well as information about the work barges used, etc.)
   b. Procedures for positioning and orientation of seabed mooring points (including the criteria for allowable deviations in positioning and orientation)
   c. Item list to be confirmed before the completion of work and their criteria for acceptance (driven depth of the piles, sank depth of the sinker, etc.) corresponding to the type of seabed mooring points (sinkers, piles, etc.) used
   d. Procedures for connecting mooring lines to seabed mooring points including precautions to prevent the twisting of moorings

4. Procedures for the tensioning tests of mooring lines
   a. Rigging arrangements for the tensioning tests of mooring lines and seabed mooring points
   b. Work-ship (barge) set up to carry out such tests
   c. Detailed tensioning procedures
   d. Mooring line retrieval and abandoning procedures

5. Procedures for hooking up mooring lines to Gas Floating Offshore Facilities
   a. Rigging and towing procedures of Gas Floating Offshore Facilities for hooking them up to mooring lines
   b. Preferred ballast condition of Gas Floating Offshore Facilities prior to the hook up
   c. Procedures for the sequential hook up of mooring lines, the repositioning of Gas Floating Offshore Facilities and the tensioning of the lines
   d. Method of determining the correct tension of chains and acceptable design tolerances
   e. In the case of Gas Floating Offshore Facilities that employ single point mooring systems, procedures for determining the positioning of the Gas Floating Offshore Facility relative to PLEM or wellhead and the acceptable design tolerances for such position
   f. In the case of turret mooring, the method of securing turrets against movement and the overall safety precautions for the entire hook-up installation
   g. Procedures for tensioning by the ballasting of Gas Floating Offshore Facilities (if applicable in the case of tension mooring systems, etc.)

6. Procedures for hooking up flow line systems to the receiving sides of Gas Floating Offshore Facilities (import systems), and flow line systems to the offloading side of Gas Floating Offshore Facilities (export systems)
   a. Procedures for the hook up of import systems
      i) Handling and rigging of flexible risers during installation,
      ii) Positioning of work vessels for various purposes during installation,
      iii) Procedures for the installation of buoyancy tanks, supports, clump weights, if applicable, etc. (including precautions against damage); and,
      iv) Tie-in rigging methods for the hook up of both ends of risers.
   b. Procedures for the installation of export systems
      i) Rigging, handling, make-up of export systems and precautions against damage during installation
      ii) Fitting of all the necessary accessories and navigation aids
      iii) Procedures for paying out the hose string into the sea
      iv) Procedures for the pressure tests of hoses (including testing pressure and duration)
11.2.3 Presence of Surveyors

1 At Classification Surveys during construction, the presence of a surveyor is required at all stages of the work on hull construction, equipment, machinery and electrical installations in cases where the tests, examinations or inspections specified in 2.1, Part B of the Rules for the Survey and Construction of Steel Ships and 11.2.4 to 11.2.8 are carried out and in cases where the submitted plans and documents regarding tests, examinations or inspections specified in 11.2.2 are verified by the Society.

11.2.4 Hydrostatic and Watertight Tests

1 Hydrostatic and watertight tests conducted during Classification Surveys during construction are to be in accordance with Part B, 2.1.5 of the Rules for the Survey and Construction of Steel Ships.

2 In the case of machinery and electrical installations related to production systems and the pipes and hoses installed on Gas Floating Offshore Facilities during off loading, hydrostatic, leakage or airtight tests are to be carried out as specified in each Chapter of Part D of the Rules for the Survey and Construction of Steel Ships and these Guidelines corresponding to the kind of machinery.

11.2.5 Survey during Construction for the Hulls of Gas Floating Offshore Facilities

1 Surveys at shipbuilding yards, etc. where the hulls of Gas Floating Offshore Facilities are constructed, are to be carried out in accordance with Part B, Chapter 2 of the Rules for the Survey and Construction of Steel Ships for those survey items that are considered to be in common with those of ordinary ships.

2 In cases where production systems are installed on board Gas Floating Offshore Facilities at works different from the shipbuilding yards where hull structures are constructed (including the sea areas of the site of operation), surveys necessary in order to tow the hull structures of Gas Floating Offshore Facilities to their site of operation are to be carried out.

3 For those cases specified in 2 above, the tests, examinations or inspections for the support structures of installations are to be carried out at suitable places/occasions before the final inspection at the site of operation.

11.2.6 Survey for Storage Facilities

In the case of the equipment found in storage facilities (process pressure vessels, liquid, vapour, and pressure piping system, venting systems, inert gas systems, etc.), tests and surveys are to be carried out in accordance with relevant requirements specified in Part D and Part N of the Rules for the Survey and Construction of Steel Ships as applicable.

11.2.7 Surveys for Production and Off Loading Systems

1 The following surveys are to be carried out during the fitting out of production and off loading systems:

   (1) It is to be verified that all piping is adequately and firmly fixed. Piping which is used for flammable liquids is to be subjected to leakage tests at test pressures of 1.25 times design working pressure after fitting work has been completed.

   (2) It is to be verified that all electrical installations are adequately and firmly fixed. Insulation resistance tests are to be carried out after fitting work has been completed.

   (3) It is to be verified that all machinery is adequately and firmly fixed. Performance tests are to be carried out after fitting work has been completed.

   (4) Production systems are to be examined and verified that they do not endanger the Gas Floating Offshore Facility or its crew under operating conditions.

2 It is to be verified that the offloading systems for Gas Floating Offshore Facilities (export systems) which are permanently and exclusively equipped for such Gas Floating Offshore Facilities are fitted out as designed. In such cases, the hose string bend radii, hose flange gaskets, the positioning of navigation aids, the correct locations of break-away couplings, the tightening of the flange bolts are also verified for compliance with the procedures.

11.2.8 Surveys during the Installation of Gas Floating Offshore Facilities at their Site of Operation

1 During the installation of positioning systems, the following items are to be verified and surveyed by the attending surveyor:

   (1) The components of positioning systems are to be examined for abnormalities before installation.

   (2) Certificates are to be confirmed for those components which are required to be tested at manufacturer facilities.

   (3) The area around the seabed mooring points is to be examined and reported on by divers or remotely operated
vehicles (ROVs) before installation to ensure that there is no obstruction.

(4) During the installation of Gas Floating Offshore Facilities to their seabed mooring points, the following is to be verified:
   (a) Proper locking of all connecting shackles from mooring lines to seabed mooring points, and from mooring lines to mooring lines.
   (b) Sealing of all kenter shackle locking pins
   (c) Correct size and length of all the components of mooring lines
   (d) Whether seabed mooring points are installed in their designed positions and are orientated within allowable design tolerance

(5) Mooring lines are to be confirmed to be paid out as designed and in accordance with predetermined procedures.

(6) After mooring systems are deployed at their site of operation, the following tensioning tests are required for each mooring line:
   (a) During tests, each mooring line is to be pulled to its maximum design load determined by dynamic analysis for the intact design condition and held at that load for 30 minutes. The integrity of the entire mooring line from the seabed mooring point to the connecting end at the hull structure of the Gas Floating Offshore Facility as well as movement of the seabed mooring point is to be verified.
   (b) Notwithstanding (a) above, the test load for soft clay may be modified as deemed appropriate by the Society. Even in such cases, however, test loads cannot be reduced less than 80% of the maximum intact design loads.
   (c) Notwithstanding (a) and (b) above, the tensioning tests of mooring lines may be waived in cases where detailed investigation reports are submitted to the Society and deemed appropriate. In such cases, however, preloading each seabed mooring point is required. The load of this preloading is not to be less than the mean intact design tension, and such that the integrity and proper alignment of mooring lines can be verified.

(7) Mooring lines are to be verified for firm and adequate connections to chain stoppers.

(8) It is to be verified that the relative position of the single point mooring centre of single point mooring systems to PLEMs is in compliance with design specifications and tolerances.

(9) Catenary angles of mooring lines are to be measured and verified for compliance with design specifications and tolerances.

(10) During installation, it is to be verified that the risers and other supporting facilities of Gas Floating Offshore Facilities are not deformed or damaged, buoyancy tanks, etc. are in their correct position, and flow lines are firmly and adequately connected.

(11) Upon completion of installation, the connection of Gas Floating Offshore Facilities to their periphery facilities is to be verified for compliance with design specifications. Divers or ROVs are to be arranged as necessary for the survey of any underwater parts deemed necessary by Surveyors.

11.2.9 Onboard Testing and Stability Experiments

1 During the onboard testing of Gas Floating Offshore Facilities, the following items are to be verified and surveyed by the attending surveyor.
   (1) Performance tests of positioning systems (performance tests of windlasses, etc.)
   (2) Performance tests of such systems that are necessary for adjusting the draught, inclination, etc. of Gas Floating Offshore Facilities, like ballasting systems
   (3) Running tests of machinery and electrical installations, etc. (during their operation, no abnormalities in the condition of Gas Floating Offshore Facilities are found)
   (4) The accumulation tests of boilers
   (5) Confirmation of safety systems (fire/gas detection systems, fire fighting systems, Emergency Shutdown Systems)
   (6) Function tests of communication systems
   (7) Emergency procedures against fires, etc.
   (8) Confirmation of fire fighting systems
      (a) Fire pumps
      (b) Fixed fire-extinguishing systems
(c) Portable fire extinguishers

(9) Function tests of detection and alarm systems
   (a) Fire detection systems
   (b) Gas detection systems
   (c) Control panels of fire/gas detection systems
   (d) ESD systems

(10) Confirmation that all systems of Gas Floating Offshore Facility systems are functioning normally

(11) Confirmation of production systems (controlling system, emergency shutdown, etc.)

(12) Confirmation of purging capability.

(13) Confirmation of flare systems

However, if the items specified above are verified by simulating installed conditions at shipbuilding yards, such tests may be dispensed with after installation.

2 The results of onboard tests are to be submitted to the Society as Onboard Testing Records.

3 Equipment which cannot be verified due to special reasons that are related to such equipment only being capable of functioning after start-up and commissioning is to be identified for verification at the next annual survey.

4 Stability experiments are to be carried out at suitable occasions after the completion of the main structures of Gas Floating Offshore Facilities and before proceeding to the site of operation. A stability information booklet prepared on the basis of the stability particulars determined by the results of stability experiments is to be approved by the Society and provided on board.

11.2.10 Classification Surveys of Gas Floating Offshore Facilities not Built under Survey

1 During the Classification Surveys of Gas Floating Offshore Facilities not built under Society surveys, the actual scantlings of the main parts of Gas Floating Offshore Facilities are to be measured in addition to the examination of the main structures, equipment, machinery, fire protection, means of escape, fire extinguishing arrangements, electric installations, stability, etc. in order to ascertain that they meet the relevant requirements given in these Guidelines as required for the Special Survey corresponding to the age, kind and purpose of the Gas Floating Offshore Facilities.

2 In the case of those Gas Floating Offshore Facilities intended to be surveyed in accordance with -1 above, the plans and documents as required by the requirements given in 11.2.2 are to be submitted for Society approval.

3 Hydrostatic and watertight tests are to be carried out in accordance with the requirements given in 11.2.4.

4 Onboard testing and stability experiments are to be carried out in accordance with the requirements given in 11.2.8. However, onboard testing and stability experiments may be dispensed with provided that sufficient information based on previous tests is available and neither alteration nor repair affecting onboard testing has been made after such previous tests.

11.3 Class Maintenance Surveys

11.3.1 Application

1 Periodical surveys for the hull structures of Gas Floating Offshore Facilities (the hull parts of Special Surveys, Intermediate Surveys, and Annual Surveys as well as the survey items for Docking Surveys) are to be in accordance with those specified in Chapter 12 and 13, Part B of the Rules for the Survey and Construction of Steel Ships.

2 Periodical Surveys for equipment, machinery, fire extinguishing systems, etc. are to be carried out in accordance with relevant provisions given in Chapter 3 to Chapter 12, Part B of the Rules for the Survey and Construction of Steel Ships, at such times as specified in 1.1.3, Part B of the Rules for the Survey and Construction of Steel Ships. In the case of the piping systems for cargo loading/off-loading, ventilation systems for storage tanks, inert gas systems, etc., the relevant requirements for ships carrying liquefied gases in bulk are to be applied.

3 In addition to -1 and -2 above, necessary items (positioning systems, production systems, etc.) unique to Gas Floating Offshore Facilities are to comply with the requirements specified in this Chapter.

11.3.2 Annual Surveys and Intermediate Surveys for Gas Floating Offshore Facilities

1 Annual Surveys and Intermediate Surveys for Gas Floating Offshore Facilities are to be carried out according to 11.3.2 as well as according to 11.3.1-1 and -2 for hulls, equipment, machinery, etc.

2 During the Annual Surveys and Intermediate Surveys for positioning systems, the following are to be carried out:
(1) General examinations of structures of mooring line stoppers (including their foundations)

(2) General examinations of mooring line tensioning equipment

(3) Measurements of the catenary angles of mooring lines in order to confirm that tensions remain within their designed permissible limit. In cases where mooring wires are used, wire tensions are to be confirmed to be within designed permissible limits by using methods appropriate for such wires.

(4) Visual inspections of mooring lines above the water to confirm no wear/tear.

(5) General examinations of turret mooring system bearings (including confirmation of the effectiveness of lubricating systems)

(6) General examinations of all of the parts of structures, equipment, etc. above water and so far as can be seen/accessible to confirm no harmful corrosion, wear, damage, etc.

(7) Confirmation of no abnormalities in the working condition of mooring system equipment (winches, windlasses, etc.).

The piping for importing and transferring natural gas from seabeds are to be surveyed as follows during Annual Surveys and Intermediate Surveys and are to be confirmed to be in good order:

(1) General examinations of the swivels, flexible risers, floating hoses, etc. associated with the import piping, expansion joints, seals, etc. which transfer natural gas from seabeds, and are attached to Gas Floating Offshore Facilities.

(2) Confirmation of that swivels are without leaks

(3) Visual examinations and demonstrations of the functions of navigation aids for floating hoses

(4) Confirmation that riser tensioning arrangements are in proper functioning order

(5) General examinations of electrical equipment installed in hazardous areas

During Annual Surveys and Intermediate Surveys for production systems, the following are to be carried out:

(1) Review of maintenance records (test items required at Annual/Special surveys, those results, alterations, if any, etc. are to be recorded.)

(2) Visual examinations and performance tests of the following systems:
   (a) Remote shutdown systems of fuel oil systems and ventilation systems
   (b) Emergency shutdown systems
   (c) Emergency control stations
   (d) Safety valves/relief valves
   (e) General condition of piping, equipment, etc.
   (f) Alarm systems, escape arrangements (including the general conditions of escape routes, lighting arrangements, etc.)
   (g) General examinations of structures, piping, etc. which are at risk of damage (flare towers, etc.)
   (h) General examinations of explosion proof equipment
   (i) Others deemed necessary by Surveyors

11.3.3 Special Surveys for Gas Floating Offshore Facilities

1. Special Surveys for Gas Floating Offshore Facilities are to be carried out according to 11.3.3 as well as according to 11.3.1-1 and -2 for hulls, equipment, machinery, etc.

2. During the Special Surveys for positioning systems, the following general examinations and performance tests are to be carried out in addition to 11.3.2. Divers, video cameras, etc. are to be arranged as necessary in order to carry out examinations of underwater parts:

   (1) Measurements of tension acting on the mooring lines
   (2) General examinations of mooring lines (entire length including end attachments for connections)
   (3) Close examinations and measurements of dimension reductions for the mooring lines in way of areas which are potential hazards for excessive corrosion and wear (areas subject to abrasion, i.e. seabed connecting parts, wind-and-water areas near the water line, etc.)
   (4) General examinations and non-destructive tests of mooring lines and stoppers on board Gas Floating Offshore Facilities (to be cleaned up before surveys)
   (5) General examinations of turrets and their related equipment. Reductions of thickness due to corrosion are to be measured for structure members with heavy corrosion, and for Gas Floating Offshore Facilities in which 15 or more years have passed since being commissioned
Guidelines for Floating Offshore Facilities for LNG/LPG Production, Storage, Offloading and Regasification

(6) General examinations of intermediate buoyancy tanks
(7) General examinations and nondestructive tests for high stress level areas, or relatively short fatigue life areas (to be cleaned up before surveys)
(8) General examinations of the parts connecting mooring lines to seabeds (to be cleaned up before surveys)
(9) Measurements of cathodic potential readings at representative underwater locations of positioning systems to confirm the effectiveness of cathodic protection systems within a designed acceptable range

3 In cases where it is not reasonable or practicable to be in accordance with -2 above due to mooring system type, etc., operators or designers may submit alternative survey procedures based on their experiences or the recommended practice of the manufacturers of such Floating Offshore Facilities, etc. In cases where such procedures are deemed acceptable by the Society, surveys may be carried out in accordance with such procedures.

4 In addition to 11.3.2, the piping for importing and transferring natural gas from seabeds are to be surveyed as follows during Special Surveys and are to be confirmed to be in good order:

1. Swivels are to be disassembled and examined for wear, leaks, etc. Upon completion of reconditioning, fluid swivels are to be hydrostatically tested, and electrical swivels are to be insulation tested. Disassembly, however, may be waived if deemed acceptable by the Society providing that no abnormalities are found by general examination.

2. Close examinations of the piping for receiving natural gas fitted on board Gas Floating Offshore Facilities are to be carried out. In cases where deemed necessary by surveyors, open-up inspections and non-destructive tests may be required. In such cases, hydrostatic tests are to be carried out after reassembly.

3. The piping for exporting natural gas from Gas Floating Offshore Facilities is to be generally examined. Hydrostatic tests for floating export hoses are to be carried out. Hydrostatic tests, however, may be waived if deemed acceptable by the Society providing that no abnormalities are found by general examination.

4. Close examination of riser suspension and tensioning arrangements fitted on board Gas Floating Offshore Facilities are to be carried out to confirm no harmful abnormalities (corrosion, wear, etc.).

5 During the Special Surveys for production systems, the following visual inspections and performance tests are to be carried out in addition to 11.3.2:

1. Open-up inspections of pressure vessels and safety valves
2. Close examinations of production system piping to confirm no abnormalities (corrosion, wear, damages, leaks, etc.). In cases where any abnormalities are found, thickness measurements, hydrostatic tests, etc. are to be carried out as required.

3. Measurements of the insulation resistance of generators and motors
4. Examinations of electrical equipment and circuits for possible damage
5. General examinations of rotating machinery under running condition (confirmation of no abnormal vibrations)
6. Confirmation of the functions of the controlling systems for production systems
Guidelines for Floating Offshore Facilities for
LNG/LPG Production, Storage, Offloading and Regasification
(Third Edition)

ClassNK
Development Operations Headquarters
Hull Rules Development Department
3-3 Kioi-cho, Chiyoda-ku, Tokyo 102-0094, JAPAN
Tel: 03-5226-2181
E-mail: dhd@classnk.or.jp

www.classnk.com

December 2015