
RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

Part PS **Floating Offshore Facilities for Crude Oil/
Petroleum Gas Production, Storage and
Offloading**

RULES

Rule No.45 30th October 2009
Resolved by Technical Committee on 24th June 2009
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AMENDMENT TO THE RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

“Rules for the survey and construction of steel ships” has been partly amended as follows:

Part PS has been added as follows.

Part PS FLOATING OFFSHORE FACILITIES FOR CRUDE OIL/PETROLEUM GAS PRODUCTION, STORAGE AND OFFLOADING

Chapter 1 GENERAL

1.1 General

1.1.1 Application

1 The requirements given in this Part PS apply to the materials, welding, stability, hull construction, equipment, positioning systems, machinery installations, electrical installations, fire protection and detection system, fire extinguishing systems, means of escape and load lines of the floating offshore facilities (hereinafter referred to as “Floating Offshore Facility” defined in **1.2.1**), not primarily intended for the transport of cargo, which are positioned at a specific oil producing sea areas permanently or for long periods of time, and also fitted with systems for the production, storage and offloading of crude oil/petroleum gases, notwithstanding the provisions specified in other Parts,

2 Attention is to be paid to complying with the National Regulations of the coastal state in which the facility is located and of the flag state.

1.1.2 Equivalency

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

1.1.3 Floating Offshore Facilities with Novel Design Features

With respect to Floating Offshore Facilities of different types or with different systems from those specified in this Part, the required hull construction, equipment, and installation are to be specified respectively based upon the fundamental concepts found in the requirements given in this Part.

1.1.4 Class Notations

1 For Floating Offshore Facilities approved by the Society in accordance with the provisions given in this Part, appropriate notation is affixed to the Classification Characters in accordance with the following provisions:

- (1) For Floating Offshore Facility defined in **1.2.1-1**:
Floating Offshore Facility for Hydro-carbon Production, Storage and Offloading
- (2) For Floating Offshore Facility defined in **1.2.1-2**:

Floating Offshore Facility for Hydro-carbon Production and Offloading

(3) For Floating Offshore Facility defined in **1.2.1-3**:

Floating Offshore Facility for Hydro-carbon Storage and Off-loading

2 In addition to **-1** above, additional notation corresponding to the type of Floating Offshore Facility defined in **1.2.2** and additional notation corresponding to the type of positioning system defined in **1.2.4** are affixed to the Classification Characters. (e.g. for Floating Offshore Facility defined in **1.2.1-1** and positioned by Catenary Anchor Leg Mooring: *Floating Offshore Facility for Hydro-carbon Production, Ship Type, Storage and Offloading, Catenary Anchor Leg Mooring*)

3 For Floating Offshore Facilities approved by the Society in accordance with the provisions given in this Part, the notation of "Designated Service Area" is affixed to the Classification Characters to provide information about the designated service area.

1.1.5 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 Floating Offshore Facilities are to be recorded in the Classification Register.

1.1.6 Operating Booklets

An appropriate operating booklet corresponding to the particular use of the 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, 1.2, Part P** and **Chapter 3, Part R**, the definitions of the terms given in this Part are as specified below:

1.2.1 Purpose of Floating Offshore Facilities

1 FPSO

FPSO is the Floating Offshore Facility which is positioned at a specific oil producing sea areas of oil field permanently or for long periods of time, and also fitted with systems for the production, storage and offloading of crude oil, etc. drawn up from the seabed

2 FPO

FPO is the Floating Offshore Facility which is positioned at a specific oil producing sea areas permanently or for long periods of time, and also fitted with systems for the production and offloading of crude oil, etc. drawn up from the seabed

3 FSO

FSO is the Floating Offshore Facility which is positioned at a specific oil producing sea areas permanently or for long period of times, and also fitted with systems for the storage and offloading of crude oil, etc. drawn up from the seabed

1.2.2 Type of Floating Offshore Facilities

1 Ship type

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

2 Column-stabilized type

Column-stabilized type is the Floating Offshore Facility consisting of decks with top-side installations, surface piercing columns, submerged lower hulls (footings), bracings, etc., which are semi-submerged to a predetermined draught (including such units as those supported by the seabed in shallow water) during operation.

3 Other type

Other type is the Floating Offshore Facility not specified in -1 and -2 above such as the Cylindrical Facilities.

1.2.3 Production Systems

1 Production systems

Production systems are the systems for processing (separation of contaminants such as water, sand, etc., and degassing) crude oils, etc. drawn up from the seabed, which generally consists of processing systems, safety/control systems and production support systems.

2 Processing systems

Processing systems are systems for the separation of contaminants such as water, sand, etc., the separation of salt content, sulphur compounds, etc. of the crude oils, etc. drawn up from the seabed, and the removal of water from separated gases, which generally consist of crude oil processing systems, water processing systems and gas processing systems.

3 Production support systems

Production support systems are systems to support the drawing up and processing of crude oils, etc., 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.

4 Hazardous areas

Hazardous areas are areas in which flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures.

1.2.4 Positioning Systems

1 Positioning systems are such systems to keep Floating Offshore Facility at a specific position of designated service area permanently or for long periods of time, which are specified in -2 through -4.

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 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, connecting means such as shackles, or intermediate buoys or intermediate sinkers, except periphery facilities for positioning such as piles, sinkers, etc. which are laid onto the seabeds.

(1) Catenary Mooring, CM

CM 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, TM

TM 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 (SPM)

SPM is a system that allows Floating Offshore Facilities to weathervane so that the Floating Offshore Facility changes its heading corresponding to wind and wave directions. Typical SPM 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 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 Floating Offshore Facility is moored to the buoy by mooring lines or a rigid yoke structure.

(3) Turret mooring

The 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 Floating Offshore Facility, or externally at the stern/bow of the Floating Offshore Facility. The turret is generally connected to the seabed using a spread mooring system.

4 Other Type of Positioning System

Positioning Systems other than those specified in -1 and -2 above.

1.2.5 Periphery Facility for Positioning

Periphery facilities for positioning are independent separate floating structures connected to the mooring installations of 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 Crude Oil Spaces

Crude oil space means spaces used for the storage of crude oil (including crude oil tanks), and the trunks leading to such spaces.

1.2.7 Crude Oil Areas

Crude oil area means crude oil tanks, slop tanks, crude oil pump rooms, and adjacent pump rooms, cofferdams, ballast space or void spaces to crude oil tanks as well as the deck areas above these spaces covering all of the length and breadth of the Floating Offshore Facility.

1.2.8 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 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.

1.2.9 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 Floating Offshore Facility:

- (1) General description of the 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 oil and ballast.
- (21) Other instructions deemed necessary by the Society

1.2.10 Emergency Operation Manuals

Emergency operation manual means such that includes all of the elements of the ordinary systems and emergency systems of the 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 Floating Offshore Facility and the design loads acting on the 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 of a 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 of the Floating Offshore Facility but not less than 100 *years*. In the case of design environmental conditions which are expected to be unable to be evaluated by the return period, i.e. tsunami, etc. the maximum tsunami that occurred in the past at the specified operation site is to be taken account.

2 The design environmental condition of a 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 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 Floating Offshore Facility is to be as deemed appropriate 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 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 submerged hulls, 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 a 100-year return period.

2 Current force $F_{current}$ 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 $F_{current}$ is adopted, it is to comply with provisions specified otherwise.

$$F_{current} = 1/2 \rho_{water} C_D A_{current} u_c |u_c| F$$

ρ_{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.

$A_{current}$: 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.

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

$$P_{wind} = 0.611C_s C_h V_{wind}^2$$

C_s , C_h : Shape coefficient and Height coefficient given in **Table PS2.1**, **Table PS2.2**.

Table PS2.1 Shape Coefficient C_s

Structural members	C_s
Spherical structures	0.40
Cylindrical structures	0.50
Main Hulls	1.00
Deckhouses	1.00
Independent structural members (cranes, shapes, beams, etc.)	1.50
Under-deck parts (smooth surface)	1.00
Under-deck parts (exposed beams, girders, etc.)	1.30
Working towers (each surface)	1.25

Table PS2.2 Height Coefficient C_h

Height (m)		C_h
Not less than	Less than	
	15.3	1.00
15.3	30.5	1.10
30.5	46.0	1.20
46.0	61.0	1.30
61.0	76.0	1.37
76.0	91.5	1.43
91.5	106.5	1.48
106.5	122.0	1.52
122.0	137.0	1.56
137.0	152.5	1.60
152.5	167.5	1.63
167.5	183.0	1.67
183.0	198.0	1.70
198.0	213.5	1.72
213.5	228.5	1.75
228.5	244.0	1.77
244.0	259.0	1.79
259.0		1.80

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.

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 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.

7 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 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 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 are to be taken into account as the maximum tsunami that has occurred in the past for the specified operation site. However, in cases where water depth is deep enough, the effect 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

Consideration is to be given to accidental damage (e.g. collision, dropped objects, fire and explosions, etc.) 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 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 Floating Offshore Facilities as deemed appropriate by the Society or in positions easily distinguishable by the person in charge of liquid transfer operations.

2 The designation of load lines is to comply with the requirements given in the “**International Convention on Load Lines, 1996 and Protocol of 1988 relating to the International Convention on Load Lines, 1966**”, **Part V** and **Chapter 8, Part P**, unless specified otherwise by the relevant flag states or coastal states.

3.1.3 Loading Manual, Stability information and Instruction for Operation

1 In order to avoid the occurrence of unacceptable stress in Floating Offshore Facility structures corresponding to all oil 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, 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**.

- (1) The loading conditions on which the design of a 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 Floating Offshore Facilities corresponding to all oil 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**. 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 oil 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**. 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, Part K**.

2 The welding work of important structural members is to be in accordance with the requirements specified in **Part M**.

3 Mooring system chains, chain parts, wire ropes, fiber ropes, and anchors as well as the windows provided for accommodation spaces are to be in accordance with the requirements specified in **Part L**, or standards deemed appropriate by the Society.

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** under the environmental conditions specified in **Chapter 2**. When calculating wind overturning moments, in cases where 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, Chapter 4, Chapter 13** and **Chapter 29, Part C** and **Part CSR-T**.

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**.

2 The designs of welded joints are to be in accordance with the requirements specified in **1.2, Part C**. 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 Floating Offshore Facilities which operate in icy sea areas are to comply with the requirements given in **Chapter 5, Part I**.

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

5 The strength of 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

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**, 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**.

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 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 Floating Offshore Facility and buoyancy.

(2) Combined loading

Combined loading is a condition in which a 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 Floating Offshore Facility due to the above loads and heeling.

3.5 Structural Strength for Ship-Type Floating Offshore Facility

3.5.1 Overall Strength

1 In the case of ship-type Floating Offshore Facilities, longitudinal strength is to comply with the requirements given in **Chapter 15, Part C**.

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** relating to allowable stress are satisfied.

4 The structural strength of cargo holds is to be evaluated based on the corrosion margins specified in **3.8** and the allowable stresses specified in **Part CSR-T** or **Table P7.1, Part P**.

5 With respect to those areas designed by the Society in the neighborhood of openings such as moonpools, etc. and those areas at which detailed strength evaluations are required in accordance with **Part CSR-T**, fine mesh structural strength analysis 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**.

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**. 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 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**.

3.5.3 Structural Redundancy

1 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 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 Column-Stabilized and Other Type Floating Offshore Facilities

3.6.1 General

1 Overall Strength is to be in accordance with the requirements specified in **Part P**.

2 Local Strength is to be in accordance with relevant requirements specified in **Part P, Part C, or Part CSR-T**. In such cases, applied corrosion margins are to be in accordance with **3.8.3**.

3.7 Fatigue Strength

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 Floating Offshore Facility.

3 Design fatigue life of a structure is equal to the design service life of the 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 spaces providing oil storage tanks, areas subject to reaction forces from mooring systems and the connections of plates to plates.

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.

3.7.3 Criteria for Fatigue Strength Evaluation

1 The cumulative fatigue damage ratio (D) divided by Usage Factor (η) taking into account the criticality of structural members and the accessibility to structural members is not to exceed 1.0. The Usage Factor (η) is to be as given in **Table PS3.1**.

$$\frac{D}{\eta} \leq 1.0$$

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.

Table PS3.1 Usage Factor, η

Criticality of the structural members	Accessibility	Usage Factor η
Normal	High	1.0
Normal	Low	0.5
High	High	0.33
High	Low	0.1 ^{*1}

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.

3.8 Corrosion Control Means and Corrosion Margins

3.8.1 General

Corrosion control means for Floating Offshore Facilities are to be provided in accordance with the relevant provisions specified in **Part C** and taking design service life, maintenance, corrosive environment, etc. into account.

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 PS3.2**

Table PS3.2 Standard Corrosion Control Means

Structural members to be provided with corrosion control means		Means of corrosion control
Above the light draught	External shell structural members	Upper deck, side-shell plating of hull
Below the light draught		Side-shell plating and bottom shell plating of hull
In ballast tank		Primary members such as bulkheads, floors, girders Stiffeners such as longitudinals
In oil tank		Surface of tank bottom
Primary structural members other than those shown above		Coating with rust-resistant paint.

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 PS3.3**. In cases where a corrosive environment is clearly severer than assumed, values that are bigger than the values given in **Table PS3.3** 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**, 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 PS3.3**.
- (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 PS3.3** 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**, they are to follow **(1)** or **(2)** below:

- (1) In cases where the scantling is determined by plate thickness
The values given in **Table PS3.3** 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 PS3.3** 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**.

Table PS3.3 One Side Corrosion Margin for Structural Members

Corrosive environment		One Side Corrosion Margin (mm)		
		Period intended to operate: 20 years	Period intended to operate: 30 years	
In oil tank	Under tank top surface		1.5	1.8
	Upper bottom plating surface		2.0	2.3
	Other than those shown above	Face of girder	1.0	1.3
		Other than shown in above	0.8	1.0
In ballast tank	Face of girder		1.0	1.3
	Other than those shown above		0.8	1.0
Exposed to air		1.0	1.1	
Exposed to sea water		0.5	0.6	
Other than those shown above		0.5	0.6	

Note)

In cases where the period intended to operate assumes an intermediate value of **Table PS3.3**, 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** need not be fitted. In cases where the Society deems such necessary in consideration of the form of Floating Offshore Facility operations, the mooring systems for temporary mooring specified in **9.2, Part P** are required.

2 In the case of single-point mooring systems to moor shuttle tankers, 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**, 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** 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**.

4 Ladders, steps, etc. are to be provided inside compartments for safety examinations as deemed appropriate by the Society.

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**.

Chapter 4 POSITIONING SYSTEMS

4.1 General

4.1.1 General

1 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 Floating Offshore Facilities at a specific position by connecting mooring systems installed on the 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 as deemed appropriate by the Society.

4.1.2 Mooring Systems

1 Mooring systems are to be sufficiently capable of positioning 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 crude oil from such Floating Offshore Facilities.

2 In the case of mooring systems of 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

1 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 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 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 Floating Offshore Facility exhibits transient motion (overshooting) until it has settled at a new equilibrium position.

(4) Damaged condition of Floating Offshore Facilities proper

A condition with the Floating Offshore Facility proper damaged to the extent assumed as specified in **Chapter 4, Part P**, where, however, all the mooring system components remain intact.

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 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 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 Floating Offshore Facility are to be taken into consideration. In the case of Floating Offshore Facilities mooring to individual periphery facilities, such as CALM, separate from the 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 Floating Offshore Facilities.

4 The mooring systems of Floating Offshore Facilities and the seabed mooring points (anchors, sinkers, piles, etc.) of any periphery facilities for positioning are not to be slid, 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 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 The maximum offset of a 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 may be used for calculations.

7 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 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.

$$S_{max} = S_{mean} + S_{lf(max)} + S_{wf(sig)}$$

OR

$$S_{max} = S_{mean} + S_{lf(sig)} + S_{wf(max)}$$

whichever is greater.

where

- S_{mean} : Mean offset of the Floating Offshore Facility due to wind, current and mean drift
- $S_{lf(sig)}$: Significant single amplitude low frequency motion
- $S_{wf(sig)}$: Significant single amplitude wave frequency motion

The maximum values of low frequency motion $S_{lf(max)}$ and wave frequency motion $S_{wf(max)}$ may be calculated by multiplying their corresponding significant single amplitude values by the factor C, which is to be calculated as follows:

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

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

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_a : Average response zero up-crossing period (*seconds*)

In the case of low frequency components, T_a may be taken as the natural period T_n of a Floating Offshore Facility with a mooring system. T_n can be calculated as follows using the mass of the 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 Floating Offshore Facility's mean position and equilibrium heading as follows:

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

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 In order to assess the motion of 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 Floating Offshore Facility motion and the tension acting on mooring lines is to be considered.

4 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 PS4.1** 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 Floating Offshore Facilities induced by wind, waves and current
- (3) Quasi-static varying tension of mooring lines due to 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 PS4.1 Safety Factors for Mooring Lines

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

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

$$T_{max} = T_{mean} + T_{lf(max)} + T_{wf(sig)}$$

OR

$$T_{max} = T_{mean} + T_{lf(sig)} + T_{wf(max)}$$

whichever is greater

where

T_{mean} : Mean mooring line tension due to wind, current and mean steady drift

$T_{lf(sig)}$: Significant single amplitude low frequency tension

$T_{wf(sig)}$: Significant single amplitude wave frequency tension

The maximum values of low frequency tension $T_{lf(max)}$ and wave frequency tension $T_{wf(max)}$ 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 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 PS4.1** 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.

5 In the analysis of the one broken mooring line condition given in **-4** above, in the case of a 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 PS4.1**.

6 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 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 Floating Offshore Facility in a horizontal plane is sufficiently longer than the period of ordinary waves)

7 In the case of Taut Mooring systems, the following are to be complied with in addition to **-1** to **-5** 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.

8 In the case of single-point mooring systems, the requirements specified in **10.5.2, Part P** are to be complied with in addition to **-1** to **-5** above.

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 within the tension range interval, 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 (η) 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 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 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 PS4.2**.

Table PS4.2 Safety Factors

Safety factor	
Intact condition (unmoored Floating Offshore Facility in storm conditions)	2.50
Intact condition (moored Floating Offshore Facility under operating conditions)	3.00* ¹

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 PS4.3** 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 PS4.4**. 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.

Table PS4.3 Coefficient of Friction f

	Starting (f_{st})	Sliding (f_{sl})
Chain	1.00	0.70
Wire rope	0.60	0.25

Table PS4.4 Safety Factor for the Horizontal Holding Capacity of the Seabed Mooring Points of Catenary Mooring Systems and Taut Mooring Systems

Safety factor	
Intact	1.50
One broken mooring line extreme	1.00

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 PS4.5**.

Table PS4.5 Safety Factor for the Vertical Holding Capacity of the Seabed Mooring Points of Taut Mooring Systems

Safety factor	
Intact	1.20
One broken mooring line extreme	1.00

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 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 Floating Offshore Facility in cases where deemed appropriate by the Society.

- (1) In the case of ship-type and barge-type Floating Offshore Facilities:
Rolling up to *22.5 degrees* and simultaneously pitching up to *7.5 degrees*
- (2) In the case of column-stabilized 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** and **Chapter 4, Part L** or any standards deemed appropriate by the Society. In cases where the Grade R4 chains specified in **3.2, Part L** 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 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 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 PS4.1** upto 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 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 -2 above, bearings which do not carry loads may be designed in accordance with standards/codes deemed appropriate by the Society.

Chapter 5 HAZARDOUS AREAS

5.1 General

5.1.1 Application

1 The requirements given in this Chapter apply to the categorization of hazardous areas, corresponding ventilation systems and so on.

2 Notwithstanding the requirements of **-1** above, Floating Offshore Facility hazardous areas that exclusively handle substances having flashpoints exceeding 60°C are to be deemed appropriate by the Society.

5.2 Hazardous Areas

5.2.1 General

1 Hazardous areas are subdivided into Zones 0, 1 and 2, and the definitions of each category are as follows:

(1) Zone 0

Areas such as those specified in **(a)** where explosive gas-air mixtures are continuously present or present for long periods.

(a) The internal spaces of closed tanks and pipes for crude oil and gas products, or spaces in which oil/gas/air mixtures are continuously present or present for long periods.

(2) Zone 1

Areas such as those specified in **(a)** to **(d)** where explosive gas-air mixtures are likely to occur under normal operating conditions.

(a) Adequately ventilated enclosed or semi-enclosed spaces containing primary grades of release. (See **Fig. PS5.1**)

(b) Tanks and cofferdams adjacent to crude oil tanks. (See **Fig. PS5.5**)

(c) In outdoor locations, the area within 1.5m from the boundaries of the primary grades of release and crude oil tank decks. (See **Fig. PS5.3** and **Fig. PS5.5**)

(d) Inadequately ventilated areas in Zone 2 which are arranged so that gas dispersion may not occur. (See **Fig. PS5.3** and **Fig. PS5.4**)

(3) Zone 2

Areas such as those specified in **(a)** to **(d)** where explosive gas-air mixtures are not likely to occur, and if such mixtures do occur, they will only exist for a short time.

(a) Adequately ventilated enclosed or semi-enclosed spaces containing secondary grades of release. (See **Fig. PS5.2**)

(b) In outdoor locations, the area with 1.5m beyond the Zone 1 areas specified in **-1(2)(c)**. (See **Fig. PS5.3**)

(c) The areas 3.5m beyond the Zone 1 areas specified for ventilation outlets of crude oil tanks. (See **Fig. PS5.5**)

(d) Outdoor locations within 3m from the boundaries of ventilation outlets and secondary grades of release. (See **Fig. PS5.2** and **Fig. PS5.4**)

2 The grading of some sources of release in different zones is as follows:

(1) Continuous grade of release (Zone 0)

(a) Crude oil tanks.

(b) Free vents and other openings which release gas or vapor into atmosphere frequently or

for long periods.

- (2) Primary grades of release (Zone 1)
 - (a) Seals of pumps, compressors and valves for flammable liquids or gases if release during normal operation is expected.
 - (b) Sample points and process equipment drains which may release flammable material into the atmosphere during normal operation
 - (3) Secondary grades of release (Zone 2)
 - (a) Seals of pumps, compressors and valves for flammable liquids or gases if release during normal operation is not expected.
- 3 Non-hazardous areas are areas which are other than hazardous areas.
- 4 Enclosed spaces are considered to be spaces bounded by bulkheads and decks which may have doors, windows or other similar openings.
- 5 Semi-enclosed spaces are considered to be spaces where natural conditions of ventilation are notably different from those on open decks due to the presence of structures such as roofs, wind breakers and bulkheads and which are arranged so that gas dispersion may not occur.
- 6 Flammable liquids are substances which are fire hazards similar to crude oil and petroleum products.
- 7 In the case of gas disposal systems like vents for large quantities of hydrocarbons from production systems, the extension of zones is to be based on dispersion calculations.

Fig. PS5.1 Primary Sources of Release in Semi-enclosed or Enclosed Spaces

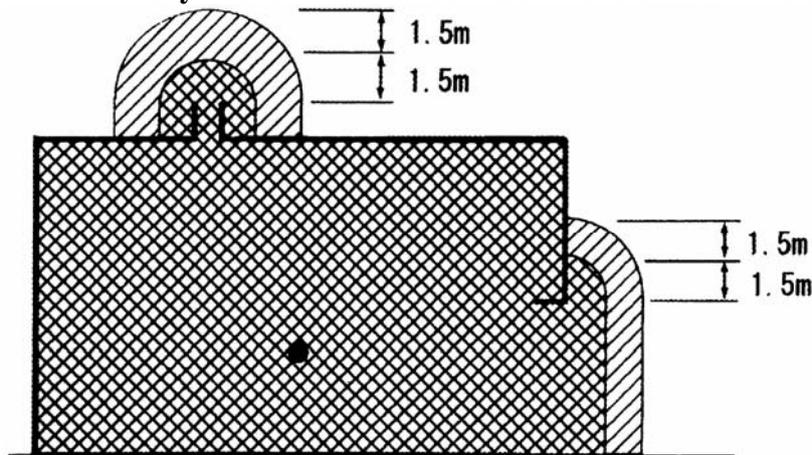


Fig. PS5.2 Secondary Sources of Release in Semi-enclosed or Enclosed Spaces

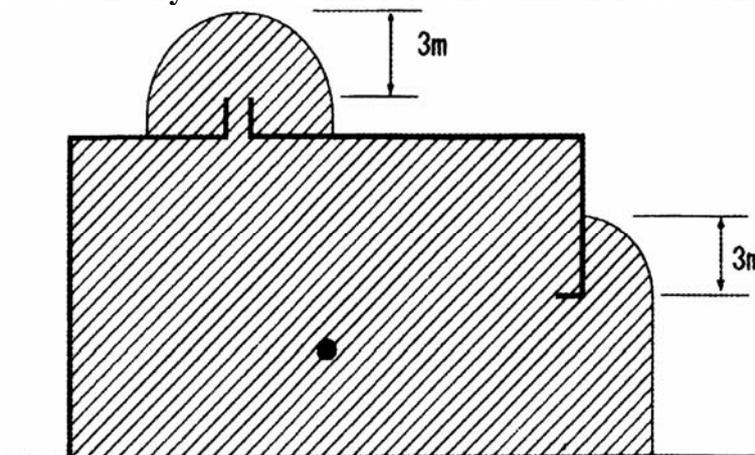


Fig. PS5.3 Extension of Hazardous Areas in Open Spaces from Primary Sources of Release

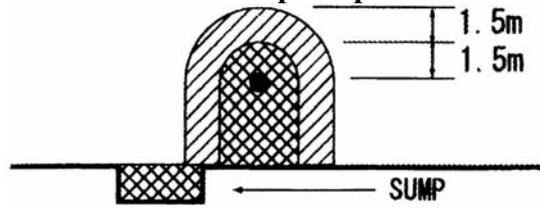


Fig. PS5.4 Extension of Hazardous Areas from Secondary Sources of Release

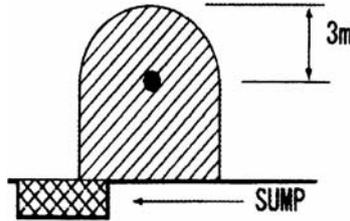
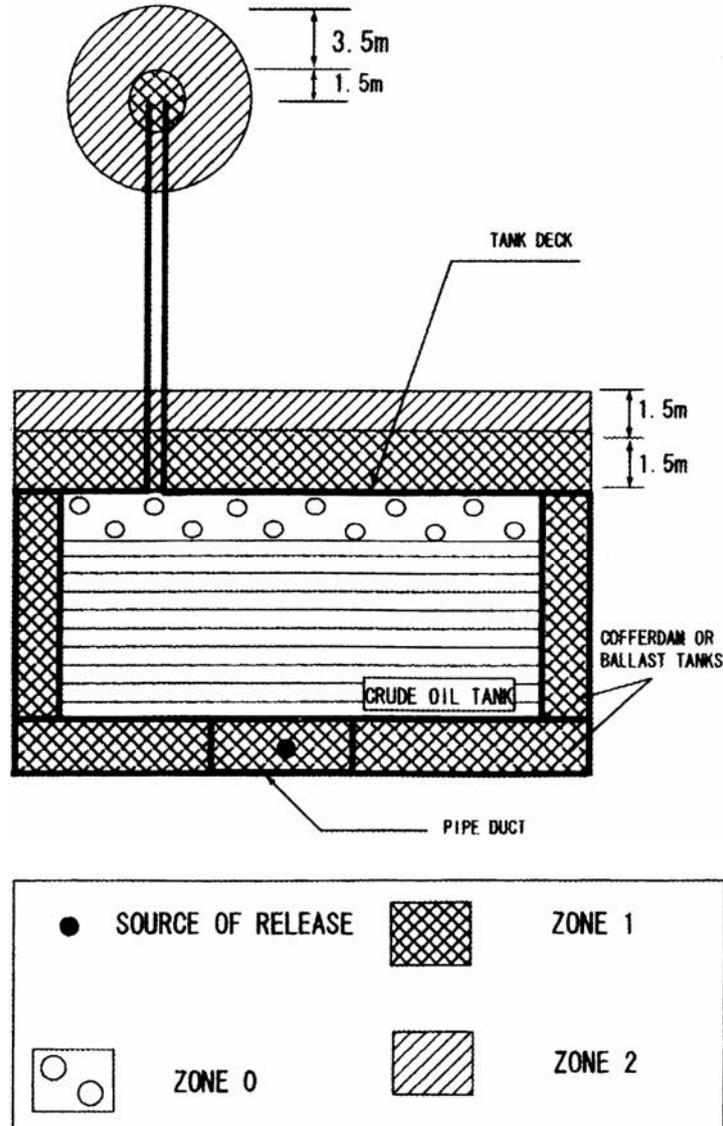


Fig. PS5.5 Example of Hazardous Areas Adjacent to Crude Oil Tanks and Extensions of Hazardous Areas from Ventilation Outlets



5.2.2 Openings, Access and Ventilation Conditions Affecting the Extent of Hazardous Areas

1 Except in cases where necessary for the safety and operation of Floating Offshore Facilities and as provided in -2, access doors or other openings are not to be provided in the location specified in the following (1) and (2).

- (1) Between Zone 1 spaces and Zone 2 spaces
- (2) Between hazardous areas and non-hazardous areas

2 In cases where access doors or other openings having direct access to any Zone 1 or Zone 2 hazardous area are provided in enclosed spaces, such areas are regarded as being areas of the same hazard as those areas they directly access through such access doors or other openings, except for those indicated in the following (1) to (3) and as provided in 5.2.1.

- (1) Enclosed spaces with direct access to any Zone 1 location can be considered as Zone 2 if:
 - (a) The access is a self-closing gas-tight door that opens into the Zone 2 space;
 - (b) Ventilation is such that the air flow with the door open is from the Zone 2 space into the Zone 1 location; and
 - (c) Loss of ventilation activates alarms at manned control stations. (See **Fig. PS5.6**)
- (2) Enclosed spaces with direct access to any Zone 1 location are not considered hazardous if:
 - (a) Self-closing gas tight type access doors are provided in duplicate to form air locks. However, in cases where, the Society recognizes that the ventilation system for the space is sufficient to prevent the inflow of gases from the Zone 1 space, single self-close gas tight type access doors may be provided. Such doors are to be opened into the space only and no holding devices to keep doors open are to be provided;
 - (b) Spaces have ventilation overpressure in relation to hazardous spaces; and
 - (c) Loss of ventilation activates alarms at manned control stations. (See **Fig. PS5.8**)
- (3) Enclosed spaces with direct access to any Zone 2 location are not considered hazardous if:
 - (a) The access is a self-closing gas-tight door that opens into the non-hazardous location;
 - (b) Ventilation is such that the air flow with the door open is from the non-hazardous space into the Zone 2 location; and,
 - (c) Loss of ventilation activates alarms at manned control stations. (See **Fig. PS5.7**)

3 Piping systems are to be designed to preclude direct communication between hazardous areas of different classifications and between hazardous and non-hazardous areas.

Fig. PS5.6 Arrangement of Ventilation and Doors for Zone 1 and Zone 2 Spaces

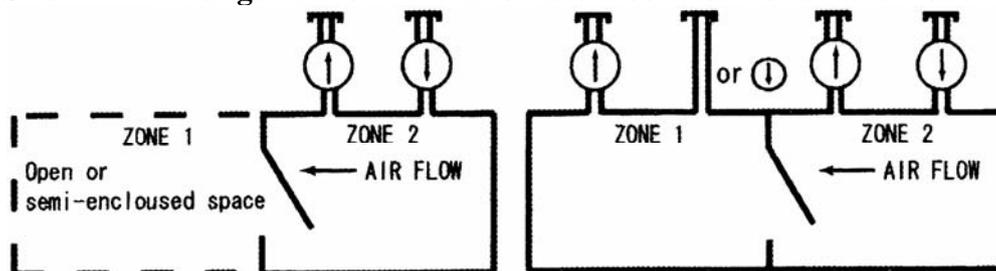


Fig. PS5.7 Arrangement of Ventilation and Doors for Zone 2 and Non-hazardous Spaces

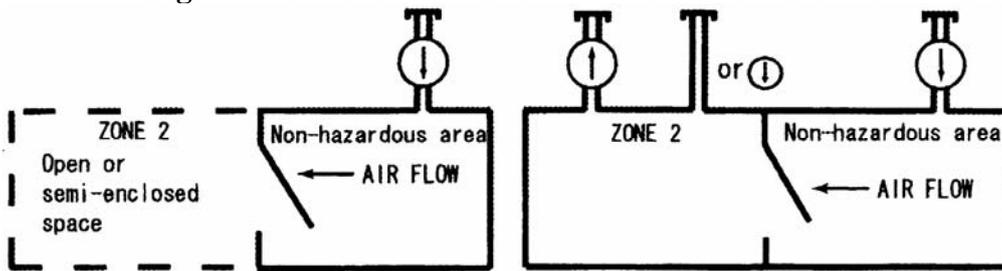
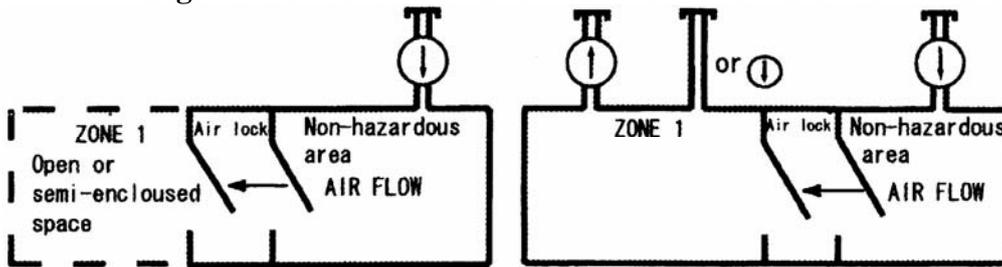


Fig. PS5.8 Arrangement of Ventilation and Doors for Zone 1 and Non-hazardous Spaces



5.2.3 Ventilation

- 1 All areas are to be adequately ventilated. Hazardous enclosed spaces are to be ventilated with underpressure in relation to adjacent non-hazardous locations. To ensure that a negative pressure condition exists in any enclosed Zone 1 and Zone 2, supply and exhaust fans are to be interlocked so that supply fans cannot be activated without first engaging exhaust fans.
- 2 Ventilation air inlets are to be at least 3m from hazardous areas and are to be located as high as possible and practicable. In cases where inlet ducts pass through hazardous areas, such inlet ducts are to have overpressure in relation to such areas.
- 3 Each air outlet is to be located in outdoor areas which, in the absence of the considered outlet, are of the same or lesser hazard than the ventilated space.
- 4 The outlet air from Zone 1 and Zone 2 spaces is to be led in separate ducts to outdoor locations. The internal spaces of such ducts belong to the same Zone as the ventilated space.
- 5 Attention is to be given to ventilation inlet and outlet locations and airflow in order to minimize the possibility of cross contamination.
- 6 The arrangement of ventilation inlet and outlet openings in spaces is to be such that the entire space is efficiently ventilated, with special consideration given to the location of equipment which may release gas and to spaces where gas may accumulate.
- 7 Air inlet ducts designed for constant relative underpressure are to be rigidly constructed to avoid air leaks. Fans are to be designed so as to minimize the risk of sparks.
- 8 Ventilation of hazardous areas is to be kept separate from the ventilation of non-hazardous areas by separate ducts.
- 9 Crude oil pump rooms are to be ventilated in accordance with 4.5.4, Part R.

Chapter 6 FIRE PROTECTION, DETECTION AND EXTINCTION

6.1 General

6.1.1 Application

1 Unless otherwise especially required in this Chapter, the fire detection and extinguishing arrangements of Floating Offshore Facilities handling crude oil and hydrocarbon gas having a flash point not exceeding 60°C and other substances which are similar fire hazards are to comply with the requirements for the fire detection and extinguishing arrangements of tankers carrying crude oil and petroleum products having a flashpoint not exceeding 60°C and other liquid cargo which are a similar fire hazard specified in **Part R**. (The terms “cargo” and “cargo oil” are to be construed as “crude oil”, “carry” and “transport” are to be construed as “process/store”, “ship” and “tanker” are to be construed as “Floating Offshore Facility”.)

2 In the case of Floating Offshore Facilities exclusively handling crude oil and hydrocarbon gas having a flashpoint exceeding 60°C, the requirements for the fire detection and extinguishing arrangements of tankers carrying petroleum products having a flashpoint exceeding 60°C specified in **Part R** as well as the requirements specified in **6.4.1-1** are to be applied, except that in lieu of the fixed fire-extinguishing system required in **10.4, Part R** they are to be fitted with a fixed deck foam system which is to comply with the provisions given in **6.4.2**. (The terms “cargo” and “cargo oil” are to be construed as “crude oil”, “carry” and “transport” are to be construed as “process/store”, “ship” and “tanker” are to be construed as “Floating Offshore Facility”.)

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

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 crude oil 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, crude oil storage and crude oil 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 Floating Offshore Facilities, personnel or equipment.
- 7 Flare and vent systems are to be in accordance with the standards deemed appropriate by the Society. 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 clothing: 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 Crude Oil Areas

- 1 Cofferdams are to be provided between crude oil tanks and adjacent non-hazardous areas. Spaces where cofferdams may be accepted are specified **6.2.4-2** and **-3**.
- 2 Fuel oil bunker tanks are normally not to be located within crude oil areas. Such tanks may, however, be located at forward and aft end of crude oil areas instead of cofferdams.
- 3 The lower portion of crude oil pump rooms may be recessed into machinery spaces of Category *A* in order to accommodate pumps, provided that the top plating of the recess is not more than one third of the depth of the Floating Offshore Facility above the keel.
- 4 Crude oil tanks are not to have a common boundary with machinery spaces.
- 5 Entrances, air inlets and openings to accommodation, service and machinery spaces and control stations are not to face crude oil areas. They are to be located on end bulkheads not facing crude oil areas and/or on the outboard sides of superstructures or deckhouses at a distance of at least 4% of the Length (*L*) of the Floating Offshore Facility as specified in **1.2.5, Part P**, but not less than 3m from the end of superstructures or deckhouses facing crude oil areas. This distance,

however, need not exceed 5m.

Furthermore, the following necessary conditions apply to boundaries facing crude oil areas:

- (1) Bolted plates for removal of machinery may be fitted in such boundaries. Signboards giving instruction that such plates are to be kept closed unless the Floating Offshore Facility is gas-free are to be posted on board.
 - (2) Windows in navigation bridges may be accepted on the condition that such windows are non-opening types and provided with inside covers of steel, or alternatively rated to the same fire and explosion rating as the boundary.
- 6 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.
- 7 Chain lockers and chain pipes are to be arranged in non-hazardous areas.

6.2.3 Location and Separation of Crude Oil and Slop Tanks

- 1 Hatches, openings for ventilation, ullage plugs or other deck openings for crude oil tanks are not to be arranged in enclosed compartments.
- 2 At least two slop tanks are to be provided for the collection of oil contaminated water, primarily from the water washing of oil storage tanks.
- 3 Slop tanks are to be designed particularly with respect to decantation.
- 4 Slop tanks may be used as drain tanks for drainage from production areas on the condition that such drainage is pumped in closed piping to the slop tanks.
- 5 Tanks are to have means for inert gas, gas-freeing and venting in accordance with the applicable parts of **4.5** and **11.6, Part R**.
- 6 Anodes, washing machines and other permanently attached equipment in tanks and cofferdams are to be securely fastened to the structure. Such equipment and their supports are to be able to withstand the sloshing in tanks and vibratory loads as well as other loads which may be imposed in service.

When selecting the construction materials for the permanently attached equipment of tanks and cofferdams, due consideration is to be paid to their contact spark-producing properties.

6.2.4 Location and Separation of Pump rooms, cofferdams and pipe tunnels

- 1 Cofferdams are to be of sufficient size for easy access to parts, and they are to cover the entire adjacent tank bulkhead. Minimum distance between bulkheads is to be 600mm.
- 2 Pump rooms and ballast tanks will be accepted as cofferdams. Pump room entrances are to be arranged from open decks.
- 3 In cases where non-hazardous spaces and crude oil tank meet in corner to corner configurations, diagonal plates or angles across corners may be accepted as cofferdams. Such cofferdams are to be:
 - (1) Ventilated if accessible
 - (2) Filled with a suitable compound if not accessible
- 4 Pipe tunnels are to have ample space for pipe inspections.
- 5 The pipes in pipe tunnels are to be situated as high as possible above the vessel's bottom. There are to be no connections between pipe tunnels and engine rooms.
- 6 Access to pipe tunnels is normally to be made through pump rooms, similar hazardous areas or from open decks. Access openings from crude oil pump rooms are to be provided with watertight closures.

6.3 Construction for Fire Protection

6.3.1 General

1 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 crude oil 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 crude oil areas and the production areas, however, Class *A-0* insulation or Class *A* insulation deemed appropriate by the Society may be applied.

2 Bulkheads between crude oil pump rooms and machinery spaces are to be Class *A*, and are to have no penetrations which are less than Class *A-0*, other than crude oil pump shaft glands and similar glanded penetrations.

3 Windows are not to be installed in bulkheads and decks between machinery spaces and crude oil pump rooms.

6.3.2 Bulkheads within Accommodation Spaces and Service Spaces and Details of Construction

1 In applying the requirements given in 5.3 and 9.2.3, Part R to Floating Offshore Facilities, only method IC as defined in 9.2.2-1, Part R is to be used.

2 Skylights to crude pump rooms are to be made of steel, but are not to be fitted with glass. Such skylights are to be capable of being closed from outside pump rooms.

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 PS6.1 and Table PS6.2 instead of 9.2.4, Part R.

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 m², drying rooms and laundries
- (6) Machinery spaces of Category *A*
Spaces as defined in 3.2.31, Part R
- (7) Other machinery spaces

- Machinery spaces excluding machinery spaces of Category A
- (8) Crude oil areas
Spaces as defined in **1.2.7, Part R**
- (9) Production areas
Spaces containing production systems, spaces for extracting crude oil 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

Table PS6.1 Fire Integrity of Bulkheads Separating Adjacent Spaces

Spaces	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)**	(10)	(11)	(12)	(13)
Control stations (1)	A-0 ^c	A-0	A-60	A-0	A-15	A-60	A-15	A-60	H-60	A-60	A-60	*	A-0
Corridors (2)		C	B-0	A-0 ^a B-0	B-0	A-60	A-0	A-60	H-60	A-60	A-0	*	B-0
Accommodation spaces (3)			C	A-0 ^a B-0	B-0	A-60	A-0	A-60	H-60	A-60	A-0	*	C
Stairways (4)				A-0 ^a B-0	A-0 ^a B-0	A-60	A-0	A-60	H-60	A-60	A-0	*	A-0 ^a B-0
Service spaces with low risk of fire (5)					C	A-60	A-0	A-60	H-60	A-60	A-0	*	B-0
Machinery spaces of Category A (6)						*	A-0	A-60	H-60	A-0 ^d	A-60	*	A-0
Other machinery spaces (7)							A-0 ^b	A-0	H-0	A-0	A-0	*	A-0
Crude oil areas (8)								-	-	A-60	A-60	*	A-60
Production areas** (9)									-	H-60	H-60	*	H-60
Hazardous areas (10)										*	A-60	*	A-0
Service spaces with high risk of fire (11)											A-0 ^b	*	A-0
Spaces on open decks (12)												-	*
Sanitary spaces (13)													C

Notes)

The superscripts to the notation for fire integrity and asterisks in **Table PS6.1** are as specified below:

- a : For clarification of application, refer to **9.2.3-1** and **9.2.3-6, Part R**.
- 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.
- d : Bulkheads and decks between cargo pump rooms and machinery spaces of Category A may be penetrated by cargo pump shaft glands and similar glanded penetrations, provided that gastight seals with efficient lubrication or other means of ensuring the performance of gas seals are fitted in way of the bulkhead or deck.
- * : In cases where an asterick 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 asterick appears in the table, the required "H" Class may be modified in cases where deemed appropriate by the Society.

Table PS6.2 Fire Integrity of Decks Separating Adjacent Spaces

Spaces above deck		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)**	(10)	(11)	(12)	(13)
Spaces below deck														
Control stations	(1)	A-0	A-0	A-0	A-0	A-0	A-60	A-0	A-60	H-60	-	A-0	*	A-0
Corridors	(2)	A-0	*	*	A-0	*	A-60	A-0	A-60	H-60	-	A-0	*	*
Accommodation spaces	(3)	A-60	A-0	*	A-0	*	A-60	A-0			-	A-0	*	*
Stairways	(4)	A-0	A-0	A-0	*	A-0	A-60	A-0	A-60	H-60	-	A-0	*	A-0
Service spaces with low risk of fire	(5)	A-15	A-0	A-0	A-0	*	A-60	A-0	A-60	H-60	-	A-0	*	A-0
Machinery spaces of Category A	(6)	A-60	A-60	A-60	A-60	A-60	*	A-60 _e	A-60	H-60	A-0	A-60	*	A-0
Other machinery spaces	(7)	A-15	A-0	A-0	A-0	A-0	A-0	*	A-60	H-60	A-0	A-0	*	A-0
Crude oil areas	(8)	H-60	H-60		H-60	H-60	H-60	H-60	*	A-0	-	H-60	-	H-60
Production areas**	(9)	H-60	H-60		H-60	H-60	H-60	H-60	A-0	*	-			
Hazardous areas	(10)	-	-	-	-	-	A-0 ^d	A-0	A-60	H-60	*	-	*	A-0
Service spaces with high risk of fire	(11)	A-60	A-0	A-0	A-0	A-0	A-60	A-0	A-60	H-60	-	A-0 ^b	*	A-0
Spaces on open decks	(12)	*	*	*	*	*	*	*	-	-	*	*	-	*
Sanitary spaces	(13)	A-0	A-0	*	A-0	*	A-0	A-0	A-60	H-60	A-0	*		*

Notes)

The superscripts to the notation for fire integrity and asterisks in **Table PS6.2** are as specified below:

The colored sections in the table mean that a deck cannot be installed.

b and d: As specified In the Notes to **Table PS6.1**, “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 PS6.1**.

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 External boundaries which are required in **11.2.1, Part R** to be made of steel or other equivalent material may be pierced for the fitting of windows and sidescuttles provided that there is no requirements for such boundaries to have *A* class integrity elsewhere. Similarly, in such boundaries which are not required to have *A* class integrity, doors may be constructed of other suitable materials.

4 The required division of steel between control stations and open decks may, in the case of emergency generators, be provided with openings for the intake of combustion air to diesel engines and for intake of cooling air in the case of air cooled diesel engines. These openings need not be fitted with means for closure for fire integrity purposes, unless a fixed gas fire fighting system for emergency generator spaces is fitted.

5 Approved gastight lighting enclosures for illuminating crude oil pump rooms may be permitted in bulkheads and decks separating crude oil pump rooms and other spaces provided they are of adequate strength and the integrity and gastightness of the bulkhead or deck is maintained.

6.4 Fire Detection and Extinction

6.4.1 Fire-extinguishing Arrangements

1 Isolation valves are to be fitted on fire mains at poop fronts in protected positions and on tanks

deck at intervals of not more than 40m to preserve the integrity of fire main systems in the case of fire or explosion.

2 Fire-extinguishing arrangements for crude oil pump rooms

The fire-extinguishing arrangements for crude oil pump rooms are to comply with the following (1) to (3):

- (1) Crude oil pump rooms are to be provided with one of the following fixed fire-extinguishing systems operated from readily accessible positions outside such pump rooms. Crude oil pump rooms are to be provided with systems suitable for machinery spaces of Category A.
 - (a) Carbon dioxide systems complying with **Chapter 25, Part R** and with the following:
 - i) The alarms referred to in **25.2.1-3(2), Part R** are to be safe for use in flammable crude oil vapor/air mixtures;
 - ii) A notice is to be exhibited at the controls stating that due to electrostatic ignition hazards, the system is to be used only for fire extinguishing and not for inerting purposes.
 - (b) A high expansion foam system complying with **Chapter 26, Part R** provided that the foam concentrate supply is suitable for extinguishing fires involving the crude oil stored.
 - (c) A fixed pressure water-spraying system complying with **Chapter 27, Part R**.
- (2) In cases where the extinguishing medium used in crude oil pump room systems is also used in systems serving other spaces, the quantity of medium provided or its delivery rate need not be more than the maximum required for the largest compartment.
- (3) In addition, two portable foam extinguishers or equivalent are to be provided: one at the pumps and one at pump room entrances.

3 Fire-extinguishing arrangements in crude oil areas

- (1) The protection of crude oil tank deck areas and crude oil tanks is to be achieved by fixed deck foam systems and fixed inert gas systems in accordance with **6.4.2** and **Chapter 35, Part R** respectively, except that in lieu of the above installations, after having given consideration to Floating Offshore Facility arrangements and equipment, other combinations of fixed installations may be accepted if they afford protection equivalent to the above.
- (2) Fixed gas or steam fire-extinguishing systems are not to be provided in crude oil spaces.

4 Alternative means

- (1) To be considered equivalent, systems proposed in lieu of deck foam systems are:
 - (a) To be capable of extinguishing spill fires and also preclude ignition of spilled oil not yet ignited; and
 - (b) To be capable of combating fires in ruptured tanks.
- (2) To be considered equivalent, systems proposed in lieu of fixed inert gas systems are:
 - (a) To be capable of preventing dangerous accumulations of explosive mixtures in intact crude oil tanks during normal service throughout necessary in-tank operations; and
 - (b) To be so designed as to minimize the risk of ignition from the generation of static electricity by the system itself.

6.4.2 Fixed Deck Foam Systems

1 The arrangements for providing foam are to be capable of delivering foam to the entire crude oil tanks deck area as well as into any crude oil tank whose deck has been ruptured.

2 Deck foam systems are to be capable of simple and rapid operation. The main control stations for such systems are to be suitably located outside crude oil areas, adjacent to accommodation spaces and readily accessible and operable in the event of fire in the areas protected.

3 The rate of supply of foam solution is to be not less than the greater of the following:

- (1) 0.6 l/min per square meter of crude oil tank deck areas, in cases where “crude oil tank deck area” means the maximum breadth of the Floating Offshore Facility multiplied by the total

longitudinal extent of the crude oil tank spaces ;

- (2) 6 *l/min per square meter* of the horizontal sectional area of the single tank having the largest such area; or
- (3) 3 *l/min per square meter* of the area protected by the largest monitor, such area being entirely forward of the monitor, but not less than 1250 *l/minute*.

4 Sufficient foam concentrate is to be supplied to ensure at least 20 *minutes* of foam generation in Floating Offshore Facilities fitted with inert gas installations or 30 *minutes* of foam generation in Floating Offshore Facilities not fitted with inert gas installation in cases where using the solution rates stipulated in **-3(1), (2), (3)** above, whichever is the greatest. The foam expansion ratio (i.e. the ratio of the volume of foam produced to the volume of the mixture of water and foam-making concentrate supplied) is generally not to exceed 12 to 1. In cases where systems essentially produce low expansion foam, but at expansion ratios slightly in excess of 12 to 1, the quantity of foam solution available is to be calculated as for 12 to 1 expansion ratio systems. In cases where medium expansion ratio foam (between 50 to 1 and 150 to 1 expansion ratio) is employed, the application rate of the foam and the capacity of monitor installation is to be to the satisfaction of the Society.

5 Foam from fixed foam systems is to be supplied by means of monitors and foam applicators. At least 50% of the foam solution supply rate required in **-3(1)** and **(2)** above is to be delivered from each monitor.

6 The number and position of monitors are to be such as to comply with **-1** above. The capacity of any monitor is to be at least 3 *l/minute* of foam solution *per square meter* of deck area protected by that monitor, such areas being entirely forward of the monitor. Capacity is to be not less than 1250 *l/minute*.

The distance from a monitor to the farthest extremity of the protected area forward of such monitor is not to be more than 75% of the monitor throw in still air conditions.

7 Monitor and hose connections for foam applicators are to be situated both port and starboard at the front of the poop or accommodation spaces facing crude oil tank decks.

8 Applicators are to be provided to ensure flexibility of action during fire-fighting operations and to cover areas screened from monitors. The capacity of any applicator is to be not less than 400 *l/minute* and the applicator throw in still air conditions is to be not less than 15 *m*. The number of foam applicators provided is to be not less than 4. The number and disposition of foam main outlets are to be such that foam from at least 2 applicators can be directed on to any part of crude oil tanks deck areas.

9 Valves are to be provided on foam mains, and on fire mains in cases where they are integral parts of deck foam systems, immediately forward of any monitor position to isolate damaged sections of such mains.

10 Operation of deck foam systems at required output is to permit the simultaneous use of the minimum required number of water jets at the required pressure from fire mains.

11 Foam concentrates are to be considered appropriate by the Society.

12 Foam applicator units are to be provided with fire horses complying with **10.2.3-1, Part R**.

6.4.3 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 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*.

4 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.

5 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.

6 Automatically operated water protection systems are to be provided with local manual override functions.

7 Water main supplies to deluge systems or water monitors are to be arranged so that damage to any single section of the main due to fire within a protected area is not to disrupt water supplies to deluge systems or fire fighting equipment in adjacent areas.

8 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 20 *seconds* of demand.

9 Two separate supplies to automatically operated water protection system pipes are to be provided, the main supply being from deluge valves. The deluge valve bypass can be manually activated. The bypass supply is preferably to be from the other side of the ring main and as a minimum be from another section of the ring main, i.e. separated by sectioning valves in the ring main.

10 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.

11 Deluge valve systems are to be designed to allow isolation and maintenance without isolation of ring mains.

12 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.

6.4.4 Fire-extinguishing Arrangements in Engine and Boiler Rooms in cases where Boilers, Turbines and Diesel Engines are fuelled by crude oil or 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, turbines and diesel engines are fuelled by crude oil or 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.

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

1 Fire extinguishing system of helicopter decks

The following fire extinguishing systems are to be provided and stored in close proximity to helicopter decks:

- (1) At least two dry powder extinguishers having a total capacity of not less than 45kg;
- (2) Carbon dioxide extinguishers of a total capacity of not less than 18kg or equivalent;
- (3) Foam application systems complying with the following requirements:

- (a) In the case of helicopter landing decks, such systems are to be capable of delivering foam to all parts of the helicopter deck in all weather conditions in which helicopters can operate and capable of delivering a discharge rate as required in **Table PS6.3** for at least *5 minutes*.
 - (b) In the case of winching helicopter decks, such systems are to be capable of delivering foam at a rate of not less than *120 l/min* for circular areas at least *5m* in diameter for at least *5 minutes*.
- (4) At least two nozzles complying with the requirements given in **10.2.3, Part R** and being sufficient to reach any part of the helicopter deck;
 - (5) In addition to those required by **10.10, Part R**, two sets of fireman outfits; and
 - (6) At least the following equipment, stored in a manner that allows immediate use and provides protection from the elements:
 - (a) Adjustable wrench;
 - (b) Blanket (fire resistant);
 - (c) Bolt cutters of *60cm* in length;
 - (d) Hooks, grabs or launch and recovery systems;
 - (e) Heavy duty hacksaw complete with 6 spare blades;
 - (f) Ladder;
 - (g) Lifeline of *5 mm* diameter \times *15 m* in length;
 - (h) Side cutting pliers;
 - (i) Set of assorted screwdrivers; and
 - (j) Harness knife complete with sheath

2 Drainage facilities of helicopter landing decks

Drainage facilities in way of the helicopter landing decks are to be constructed of steel and lead directly overboard independent of any other system and designed so that drainage does not fall on to any part of the Floating Offshore Facility (excluding drain pipes that lead directly overboard from exposed decks).

3 Helicopter refueling and hanger facilities

If helicopter refueling and hanger facilities are provided, the following requirements are to be complied with:

- (1) Designated areas complying with the following (a) and (b) are to be provided for the fuel tank storage areas:
 - (a) They are to be as far as practicable from accommodation spaces, and the escape routes and embarkation stations required by **Chapter 13, Part R**; and
 - (b) They are to be isolated from areas containing sources of vapor ignition.
- (2) Fuel storage areas are to be provided with arrangements such as oil spill coaming or oil transferring systems whereby fuel spillage may be collected and drained to safe locations.
- (3) Tanks and associated equipment are to be protected against physical damage and from fires in adjacent spaces or areas.
- (4) In cases where portable fuel storage tanks are used, only portable fuel storage tanks which consider the following are to be used.
 - (a) Design of tanks regarding their intended purpose
 - (b) Installation and fixing means
 - (c) Electrical bounding (grounding)
 - (d) Inspection procedures
- (5) Storage tank fuel pumps are to be provided with means which permit shutdown from safe remote locations in the event of a fire. In cases where gravity fed fuel systems are installed, equivalent closing arrangements are to be provided to isolate fuel sources.
- (6) Fuel pumping units are to be connected to one tank at a time. The piping between tanks and

pumping units is to be made of steel or equivalent material, be as short as possible, and be protected against damage.

- (7) Electrical fuel pumping units and associated control equipment are to be of types suitable for their installation location and potential hazards.
- (8) Fuel pumping units are to incorporate devices such as pressure release valves which will prevent over pressurization of delivery or filling hoses.
- (9) All equipment used in refueling operations is to be electrically bonded.
- (10) Signs indicating “NO SMOKING” are to be displayed at appropriate locations.
- (11) Hangers, refueling and maintenance facilities are to be handled as machinery spaces of Category *A* with regard to structural fire protection, fixed fire extinguishing and detection system requirements.
- (12) If closed hanger facilities or closed spaces containing refueling installations are to be provided, the requirements given in **20.3, Part R** for Ro-Ro cargo spaces are to be complied with.

Table PS6.3 Discharge Rate Foam Solution of Foam Application Systems

Category	Helicopter overall length <i>D(m)</i>	Discharge rate foam solution <i>(l/min)</i>
H1	$D < 15$	250
H2	$15 \leq D \leq 24$	500
H3	$24 \leq D \leq 35$	800

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., incinerators, pressure vessels, auxiliaries, piping systems and their control systems (hereinafter referred to as “machinery installations”) of 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 of process systems are to be regarded as auxiliary machinery for specific use.

4 Auxiliary machinery and pumps, etc. handling crude oil other than that specified in **-3** above are to be regarded as auxiliary machinery for cargo handling.

5 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 Floating Offshore Facility (the processing of crude oil, etc. extracted from seabeds.), relevant requirements given in **Part D** listed in the following **(1)** to **(46)** as well as the requirements given in this Chapter are to be applied. (The terms “cargo” and “cargo oil” are to be construed as “crude oil”, “carry” and “transport” are to be construed as “process/store”, “ship” and “tanker” are to be construed as “Floating Offshore Facility”.)

- (1) **1.1.2, Part D** General - General - Equivalency
- (2) **1.1.3, Part D** General - General - Machinery Installations with Novel Design Features
- (3) **1.1.4, Part D** General - General - Modification of Requirements
- (4) **1.1.6, Part D** General - General - Terminology
- (5) **1.2, Part D** General - Materials
- (6) **1.3.4, Part D** General - General Requirements for Machinery Installations - Fire protections
- (7) **1.3.5, Part D** General - General Requirements for Machinery Installations - Ventilating Systems for Machinery Spaces
- (8) **1.3.6, Part D** General - General Requirements for Machinery Installations - Protection against Noise
- (9) **Chapter 2, Part D** Diesel Engines
- (10) **Chapter 3, Part D** Steam Turbines
- (11) **Chapter 4, Part D** Gas Turbines

- (12) **Chapter 5, Part D** Power Transmission Systems
- (13) **Chapter 6, Part D** Shaftings
- (14) **Chapter 8, Part D** Torsional Vibration of Shaftings
- (15) **Chapter 9, Part D** Boilers, etc. and Incinerators
- (16) **Chapter 10, Part D** Pressure Vessels
- (17) **Chapter 11, Part D** Welding for Machinery Installations
- (18) **Chapter 12, Part D** Pipes, Valves, Pipe Fittings and Auxiliaries
- (19) **13.1, Part D** Piping Systems - General
- (20) **13.2, Part D** Piping Systems - Piping
- (21) **13.3, Part D** Piping Systems - Sea Suction Valves and Overboard Discharge Valves
- (22) **13.4, Part D** Piping Systems - Scuppers and Sanitary Discharges, etc.
- (23) **13.6, Part D** Piping Systems - Air Pipes
- (24) **13.7, Part D** Piping Systems - Overflow Pipes
- (25) **13.8, Part D** Piping Systems - Sounding Pipes
- (26) **13.9.1, Part D** Piping Systems - Fuel Oil Systems - General
- (27) **13.9.2, Part D** Piping Systems - Fuel Oil Systems - Fuel Oil Filling Pipes
- (28) **13.9.4, Part D** Piping Systems - Fuel Oil Systems - Drip Trays and Drainage System
- (29) **13.9.5, Part D** Piping Systems - Fuel Oil Systems - Fuel Oil Heaters
- (30) **13.10.1, Part D** Piping Systems - Lubricating Oil Systems and Hydraulic Oil Systems - General
- (31) **13.11, Part D** Piping Systems - Thermal Oil Systems
- (32) **13.13, Part D** Piping Systems - Pneumatic Piping System
- (33) **13.14, Part D** Piping Systems - Steam Piping Systems and Condensate Systems
- (34) **13.15.3, Part D** Piping Systems - Feed Water Systems for Boilers - Distilling Plant
- (35) **13.15.4, Part D** Piping Systems - Feed Water Systems for Boilers - Pipes passing through Tanks
- (36) **13.16, Part D** Piping Systems - Exhaust Gas Piping Arrangement
- (37) **13.17, Part D** Piping Systems - Tests
- (38) **14.1.1-1, Part D** Piping Systems for Tankers - General - Scope
- (39) **14.1.2, Part D** Piping Systems for Tankers - General - Drawings and Data
- (40) **14.2, Part D** Piping Systems for Tankers - Cargo Oil Pumps, Cargo Oil Piping Systems, Piping in Cargo Oil Tanks, etc.
- (41) **14.3, Part D** Piping Systems for Tankers - Piping Systems for Cargo Oil Pump Rooms, Cofferdams and Tanks adjacent to Cargo Oil Tanks
- (42) **14.4, Part D** Piping Systems for Tankers - Ships only carrying Oils having a Flashpoint above 60°C
- (43) **14.6, Part D** Piping Systems for Tankers - Tests
- (44) **Chapter 17, Part D** Refrigerating Machinery and Controlled Atmosphere Systems
- (45) **Chapter 18, Part D** Automatic and Remote Control
- (46) **Chapter 21, Part D** Spare Parts, Tools and Instruments

2 With respect to machinery installations used solely for a specific operation which is the purpose of the Floating Offshore Facility (the processing of crude oil, etc. extracted from seabeds.), relevant requirements given in **Part D** 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 terms “cargo” and “cargo oil” are to be construed as “crude oil”, “carry” and “transport” are to be construed as “process/store”, “ship” and “tanker” are to be construed as “Floating Offshore Facility”.)

- (1) **1.1.2, Part D** General - General - Equivalency
- (2) **1.1.3, Part D** General - General - Machinery Installations with Novel Design Features
- (3) **1.1.4, Part D** General - General - Modification of Requirements

- (4) **1.1.6, Part D** General - General - Terminology
- (5) **1.2, Part D** General - Materials
- (6) **1.3.4, Part D** General - General Requirements for Machinery Installations - Fire Protections
- (7) **1.3.5, Part D** General - General Requirements for Machinery Installations - Ventilating Systems for Machinery Spaces
- (8) **1.3.6, Part D** General - General Requirements for Machinery Installations - Protection against Noise
- (9) **2.2.2-4, Part D** Diesel Engines - Materials, Construction and Strength - Construction, Installation and General
- (10) **2.2.2-5, Part D** Diesel Engines - Materials, Construction and Strength - Construction, Installation and General
- (11) **2.2.2-6, Part D** Diesel Engines - Materials, Construction and Strength - Construction, Installation and General
- (12) **2.4, Part D** Diesel Engines - Safety Devices
- (13) **2.5.4, Part D** Diesel Engines - Associated Installations - Fuel Oil Arrangements
- (14) **3.3, Part D** Steam Turbines - Safety Devices
- (15) **4.3, Part D** Gas Turbines - Safety Devices
- (16) **5.2.5, Part D** Power Transmission Systems - Materials and Construction - Lubricating Oil Arrangements
- (17) **Chapter 9, Part D** Boilers, etc. and Incinerators
- (18) **Chapter 10, Part D** Pressure Vessels
- (19) **Chapter 11, Part D** Welding for Machinery Installations
- (20) **13.9.1, Part D** Piping Systems - Fuel Oil Systems - General
- (21) **13.9.2, Part D** Piping Systems - Fuel Oil Systems - Fuel Oil Filling Pipes
- (22) **13.9.4, Part D** Piping Systems - Fuel Oil Systems - Drip Trays and Drainage System
- (23) **13.9.5, Part D** Piping Systems - Fuel Oil Systems - Fuel Oil Heaters
- (24) **13.10.1, Part D** Piping Systems - Lubricating Oil Systems and Hydraulic Oil Systems - General
- (25) **13.11, Part D** Piping Systems - Thermal Oil Systems

3 With respect to machinery installations used for positioning systems, relevant requirements given in **Part D** listed in the following **(1)** to **(6)** as well as the requirements given in **-1** above are to be applied. (The terms “cargo” and “cargo oil” are to be construed as “crude oil”, “carry” and “transport” are to be construed as “process/store”, “ship” and “tanker” are to be construed as “Floating Offshore Facility”.)

- (1) **1.3.8, Part D** General - General Requirements for Machinery Installations - Engineers’ Alarm
- (2) **13.9, Part D** Piping Systems - Fuel Oil Systems (except **13.9.1, 13.9.2, 13.9.4** and **13.9.5**)
- (3) **13.10, Part D** Piping Systems - Lubricating Oil Systems and Hydraulic Oil Systems (except **13.10.1**)
- (4) **13.12, Part D** Piping Systems - Cooling Systems
- (5) **Chapter 15, Part D** Steering Gears
- (6) **Chapter 16, Part D** Windlasses and Mooring Winches

7.1.3 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 this Chapter) in accordance with relevant requirements given in **Part D**.

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 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 Systems or equipment essential for the safety of Floating Offshore Facilities are to be subjected to performance tests after being installed on board.

5 Remote control devices and automatic control devices attached to boilers are to be subjected to performance tests after being installed on board.

6 The emergency shutdown systems (ESD) required in **7.6** are, as a rule, to be subjected to performance tests after being installed on board.

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

7.1.4 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 crude oil is not to exceed 200°C.

2 The prime movers for generators as well as auxiliary machinery and the prime movers for such machinery fitted onto Floating Offshore Facilities are to be designed to operate under the static conditions given below. The Society may permit deviation from the angles given below after taking into consideration the type and size of the Floating Offshore Facility.

(1) In the case of column-stabilized Floating Offshore Facilities:

Static inclination up to 15 *degrees* in any direction

(2) In the case of ship-type Floating Offshore Facilities:

List static inclination up to 15 *degrees* either way, and, simultaneously, trim up to 5 *degrees* at the bow or stern

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 more than the angles listed below.

(1) In the case of column-stabilized Floating Offshore Facilities:

Static inclination of 25 *degrees* in any direction

(2) In the case of ship-type Floating Offshore Facilities:

List static inclination of 22.5 *degrees* either way and, simultaneously, 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**.

Table PS7.1 Temperature

	Installed location	Temperature (°C)
Air	In enclosed spaces	0~45* ¹
	In spaces subject to temperatures exceeding 45°C, and below 0°C	According to specific local conditions
	On open decks	-25~45* ¹
Seawater	-	32* ¹

Note)

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

7 With respect to the machinery installations of 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.)

7.1.6 Sea Suction Valves and Overboard Discharge Valves

In the case of the Floating Offshore Facilities listed in the following **(1)** and **(2)**, each seawater inlet and discharge in spaces below assigned load lines or designed maximum load lines are to be provided with 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.

- (1) Column-stabilized Floating Offshore Facilities
- (2) Other Floating Offshore Facilities in cases where spaces containing such valves are normally unattended and are not provided with high bilge water level alarms

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 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.

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

d' : Internal diameter (mm) of branch bilge suction pipes

A : Wetted surface area (m^2) 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 : Required quantity (m^3/hour)

d : 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** 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**.

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 suction 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 crude oil, 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 Bilge Piping of Column-stabilized Floating Offshore Facilities

The bilge piping of the column-stabilized Floating Offshore Facilities is to comply with the requirements given in the following (1) to (3) as well as the requirements given in **7.1.8**.

(1) Chain lockers which, if flooded, could substantially affect Floating Offshore Facility stability are to be provided with remote means to detect flooding and to provide audible and visual alarms at central ballast control stations.

(2) At least one of the pumps specified in **7.1.8-5** and pump room bilge suction valves are to be capable of both remote and local operation.

(3) Machinery spaces and pump rooms in lower hulls are to be provided with two independent high bilge water level alarms providing audible and visual alarms at central ballast control stations.

7.1.11 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**.

7.1.12 Ballast Piping of Column-Stabilized Floating Offshore Facilities

1 Ballast piping of column-stabilized Floating Offshore Facilities is to comply with the following requirements as well as the requirements given in **7.1.11**.

2 Ballast systems are to provide the capability to bring Floating Offshore Facilities, while in an intact condition, from their maximum normal operating draught to their maximum design loaded draught, or to a greater distance, as may be specified by the Society, within 3 *hours*.

3 Ballast systems are to be arranged to provide at least two independent self-priming type power pumps or equivalent thereto so that the system remains operational in the event of the failure of any one such pump. Any pumps provided need not be dedicated ballast pumps, but are to be readily available for such use at all times.

4 Ballast systems are to be capable of operating after the occurrence of any of the damage specified in **Chapter 3** and have the capability of restoring Floating Offshore Facilities to a level trim and safe draught condition without taking on additional ballast, with any one pump inoperable.

The Society may permit counter-flooding as an operational procedure.

5 Ballast systems are to be arranged and operated so as to prevent the inadvertent transfer of ballast water from one tank or lower hull to another, which could result in moment shifts leading to excessive angles of heel or trim. Systems are also to be arranged so that the transfer of ballast water from one tank to any other tank through single valves is not possible except in cases where such transfers will not adversely affect Floating Offshore Facility stability.

6 It is to be possible to supply each ballast pump required by **-3** above from emergency sources of electrical power. Arrangements are to be such that systems are capable of restoring Floating Offshore Facilities from the inclinations specified in **7.1.2-4** to a level trim and safe draught condition after the loss of any single component in power supply systems.

7 All valves and operating controls are to be clearly marked to identify the function they serve. Means are to be provided locally to indicate whether valves are open or closed.

8 Central ballast control stations providing the control systems, indicating systems, indicators and communication systems specified in **(1)** to **(8)** below are to be provided. They are to be located above worst damage waterlines and in spaces not within the assumed extent of damage referred to in **Chapter 3** and adequately protected from the weather.

- (1)** Ballast pump control systems (including ballast pump status-indicating systems)
- (2)** Ballast valve control systems for ballasting and deballasting (including ballast valve position-indicating systems)
- (3)** Ballast tank level indicating systems
- (4)** Draught indicating systems
- (5)** Heel and trim indicators
- (6)** Power availability indicating systems (main and emergency)
- (7)** Ballast system hydraulic or pneumatic pressure-indicating systems
- (8)** Communication systems as specified in **8.4.2-2**

9 The control and indicating systems listed in **-8** above are to function independently of one another, or have sufficient redundancy, such that a failure in one system does not jeopardize the operation of any of the other systems.

10 The ballast tank level indicating systems required by **-8** above are to provide the means specified in **(1)** and **(2)** below.

- (1)** Means to indicate liquid levels in all ballast tanks. Secondary means of determining levels in ballast tanks, for example sounding pipes, are to be provided. Tank level sensors are not to be situated in tank suction lines.
- (2)** Means to indicate liquid levels in other tanks, such as crude oil, fresh water or liquid storage tanks, the filling or emptying of which, in the view of the Society, could affect Floating Offshore Facility stability. Tank level sensors are not to be situated in tank suction lines.

11 Draught indicating systems are to indicate the draught at each corner of Floating Offshore Facilities or at representative positions deemed appropriate by the Society.

12 In addition to the remote control of ballast pumps and valves from central ballast control stations, all ballast pumps and valves are to be fitted with independent local controls operable in the event of remote control failure. The independent local control of each ballast pump and of its associated ballast tank valves are to be in the same location.

13 Power-actuated ballast valves are to fail to their closed position upon loss of control power. Upon reactivation of control power, such valves are to remain closed until system reactivation has been confirmed. The Society may accept ballast valve arrangements that do not fail to their closed position upon loss of power provided that it is satisfied that the Floating Offshore Facility safety is not impaired.

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

15 Means are to be provided at central ballast control stations to isolate or disconnect ballast pump controls and ballast valve control systems from their sources of electrical, pneumatic or hydraulic power.

7.1.13 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.

7.1.14 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.

7.1.15 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.

7.1.16 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 Floating Offshore Facility safety, only one feed water system may be acceptable notwithstanding the requirement given in **-1** above.

7.2 Dual Fuel Diesel Engines

7.2.1 General

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**.

7.3 Dual Fuel Boilers and Gas Turbines

7.3.1 General

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** and standards, etc. deemed appropriate by the Society.

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 **Chapter 13, Part N**.

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**. Master gas fuel valves required by **16.3.7, Part N** 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**.

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**, 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**. Master gas fuel valves required by **16.3.7, Part N** 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** 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 valve is to be 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** 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** and are on open decks outside crude oil 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 crude oil 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 Crude Oil Burning Boilers and Diesel Engines

7.4.1 Application

Boilers and diesel engines using fuel oils, crude oils or slop oils with flash points not exceeding 43°C as fuel (hereinafter referred to as “fuel oil”) are to comply with the requirements given in this Paragraph in addition to any other relevant requirements given in this Chapter. However, special consideration will be given to crude oil burning diesel engines.

7.4.2 Drawings and Data to be Submitted

The drawings and data to be submitted are generally as follows:

- (1) Fuel oil burning specifications
- (2) Machinery space, boiler room and pump room fuel oil piping diagrams
- (3) Hood, duct and ventilation structural details and arrangements
- (4) Gas detector arrangements
- (5) Electrical equipment and control system data

(6) Other data considered necessary by the Society

7.4.3 Boilers

- 1** The whole surface of boilers is to be gas-tight and separated from engine rooms.
- 2** Means are to be provided for boilers to be automatically purged before firing.
- 3** Warning notices describing measures to be taken in cases where the gas detectors specified in **7.4.7** are activated is to be fitted in easily visible locations near boiler controls.
- 4** One pilot burner in addition to the one used for normal burning control is required.

7.4.4 Fuel Supply Systems

- 1** Fuel oil is to be directly sucked into fuel injection pumps from storage tanks, slop tanks or other suitable tanks. However, in cases where the oil in storage tanks is used for fuel oil, such oil is to be subjected to suitable treatment.
- 2** The tanks specified in **-1** above are to be fitted in crude oil areas and are to be separated from non-hazardous areas by means of cofferdams with gas-tight bulkheads.
- 3** The whole system of pumps, strainers and heaters, if any, is to be fitted in crude oil pump rooms or in other rooms considered to be hazardous areas and separated from engine and boiler rooms by gas-tight bulkheads.
- 4** In cases where fuel oil is heated by steam or hot water, heating coil outlets are to lead to separate observation tanks.
- 5** The observation tanks specified in **-4** above are to be closed tanks installed in positions specified in **-3** above except in cases where fuel oil tanks are heated by the steam pipes specified in **14.2.9-1** to **-3, Part D**. Such closed tanks are to be fitted with air pipes.
- 6** The electric, internal combustion and steam prime movers of pumps, etc. are to be fitted in engine rooms or in the non-hazardous areas specified in **Chapter 6**.
- 7** In cases where drive shafts pass through pump room bulkheads or deck plating, the gas-tight stuffing boxes specified in **4.5.10(1), Part R** are to be fitted.
- 8** Pumps are to be fitted with pressure relief bypasses from the delivery to suction sides.
- 9** Pumps are to be capable of being remotely stopped from the following positions:
 - (1) Near boilers or machinery control rooms
 - (2) Outside engine rooms
- 10** In cases where it is necessary to preheat fuel oil, automatic temperature control devices and high temperature alarm devices are to be fitted.
- 11** Fuel oil pipes in engine rooms and boiler rooms are to be fitted within metal ducts. Such ducts are to be gas-tight and tightly connected to the fore bulkheads separating pump rooms and to the trays specified in **-18**. These ducts are to be at an incline rising towards boilers so that oil naturally returns towards pump room in the case of leakage, etc.
- 12** Duct are to be fitted with gas-tight inspection doors in way of the pipe connections within such ducts, with automatic closing drain traps placed on the pump room side which are set in such a way as to discharge any fuel oil leakage into pump rooms.
- 13** Ducts are to be fitted with air pipes.
- 14** Ducts are to be permanently connected to inert gas systems or steam pipes in order to make possible:
 - (1) The injection of inert gas or steam in the duct in case of fire or leakage
 - (2) The purging of the duct before carrying out work on the piping in case of leakage
- 15** Shutoff valves remotely controlled from positions near boiler fronts or machinery control rooms are to be provided on the on pump room side of fuel pipes passing through pump room bulkheads. Remote control valves are to be interlocked with hood exhaust fans to ensure that whenever fuel oil is circulating the fans are running.
- 16** Emergency shutdown valves are to be fitted on the fuel oil supply to each boiler manifold.

17 Boilers are to be fitted with suitable drip trays placed in such a way as to collect any possible oil leakage from burners, valves and connections. Such drip trays are to be fitted with removable flame arresting wire gauze.

18 Fuel pipes within the metal ducts specified in **-11** are to pass through drip trays by means of tight penetrations and are to then be connected to oil supply manifolds. Drip trays are to be fitted with drain pipes discharging into drain tanks in pump rooms.

19 Drain tanks are to be fitted with air pipes. Additionally, liquid level indicators and alarm systems are to be provided in order to detect leaks.

20 Drain pipes are to be fitted with arrangements to prevent the return of gas into boiler or engine rooms.

21 Burning systems are to be equipped with suitable mechanical interlocking devices so that running on normal fuel oil automatically excludes running on other fuel oils and vice versa.

22 The air pipes specified in **-5**, **-13** and **-19** are to be led to the positions specified in **4.5.3-4(1)(c)**, **Part R** and to be fitted with the flame arresting wire gauze specified in **14.3.2-4**, **Part D** or equivalent thereto.

7.4.5 Ventilation Hoods

1 Boilers are to be fitted with suitable hoods placed in such a way as to enclose as much of the burners, valves and fuel oil pipes as possible without blocking combustion air inlets.

2 Hoods are to be fitted with suitable doors placed in such a way as to enable the inspection of and access to fuel oil pipes and valves.

3 Hoods are to be fitted with ducts. Such ducts are to be led to the positions specified in **4.5.3-4(1)(c)**, **Part R** and to be fitted with the flame arresting wire gauze specified in **14.3.2-4**, **Part D** or equivalent thereto.

4 At least two non-sparking mechanical ventilation systems are to be fitted so that the pressure inside hoods is less than that in boiler rooms. Ventilation systems are to be capable of automatic change-overs in the case of stoppages or failures.

5 The prime movers of the ventilation systems specified in **-4** above are to be placed outside ducts and gastight bulkhead penetrations are to be arranged for shafts.

7.4.6 Ventilation Systems

Boiler compartments are to be fitted with mechanical ventilation systems and are to be designed in such a way as to avoid the formation of gas pockets. Ventilation systems are to be separated from those intended for other spaces.

7.4.7 Gas Detectors

1 The gas detectors specified in **Chapter 13, Part N** are to be fitted with intakes in the ducts specified in **7.4.4**, in the ventilation hoods specified in **7.4.5** and in all spaces where gas dispersion may not occur.

2 The following gas concentration alarm devices are to be provided:

- (1) Gas concentration visual alarm devices near boiler fronts and in machinery control rooms
- (2) Gas concentration audible alarm devices in machinery spaces and control rooms

7.5 Monitoring and Remote Control Systems

7.5.1 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 **(7)** 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 crude oil areas and production areas
- (7) Monitoring systems for production 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).

7.6 Emergency Shutdown (ESD) Systems

7.6.1 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.

2 Manual emergency shutdown equipment is to be installed in the following locations:

- (1) Control stations
- (2) Strategically positioned stations located around the installation (e.g. escape routes, helicopter decks, etc.)

3 The automatic ESD of production systems is to take place under the following conditions:

- (1) Fire is detected in production areas and crude oil areas
- (2) Gas with a maximum concentration of 60% LEL is detected in production areas and crude oil areas

4 The automatic ESD of ventilation systems is to take place under the following conditions:

- (1) Gas with a maximum concentration of 25% LEL is detected in the air inlets to non-hazardous areas
- (2) Fire is detected in enclosed non-hazardous areas, unless such a shutdown is in conflict with overall smoke control strategy

5 ESD systems 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.

6 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.

7 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.

8 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.

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

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

7.7 Machinery Installations in Hazardous areas

7.7.1 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 to be 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 Rules) of Floating Offshore Facilities, the requirements given in this Chapter are to be applied.

8.1.2 General

1 In the case of electrical installations other than those used solely for the specific operation which is the purpose of Floating Offshore Facility (the processing of crude oil, etc. extracted from seabeds.), relevant requirements given in **Part H** listed in the following **(1)** to **(8)** as well as the requirements given in this Chapter are to be applied. (The terms “cargo” and “cargo oil” are to be construed as “crude oil”, “carry” and “transport” are to be construed as “process/store”, “ship” and “tanker” are to be construed as “Floating Offshore Facilities”.)

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

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

- (1) **1.1.2, Part H** General - General - Equivalency
- (2) **1.1.3, Part H** General - General - Electrical Installations with Novel Design Features
- (3) **1.1.5, Part H** General - General - Definitions
- (4) **Chapter 2, Part H** Electrical Installations and System Design
- (5) **Chapter 6, Part H** 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 Floating Offshore Facilities or for the positioning of 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** 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

2 In 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.

3 Electrical installations used for systems or the equipment essential for the safety of Floating Offshore Facilities or for the positioning of 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.

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

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

5 Among the electrical equipment used solely for the specific operation which is the purpose of the 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.

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

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

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

9 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 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**.

3 Electrical installations are to be designed to operate smoothly under the temperature conditions given in **Table PS7.1**.

8.2 Main Source of Electrical Power and Lighting Systems

8.2.1 Main Source of Electrical Power

1 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 Floating Offshore Facilities and the positioning of 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 **(f)** 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
 - (f)** Ballast pumps for column-stabilized Floating Offshore Facilities
- (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 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.

4 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, 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 **8.5.1-3(3)** 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 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 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** and **8.5.1-4**, 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** and **8.5.1-4**, 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** so that sources of electrical power are available at all times for the services required by **8.3.2** and **8.5.1-4**.
- (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 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 **(8)** 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 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 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 **7.6**.
- (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) On column-stabilized Floating Offshore Facilities, for a period of 24 *hours*, the services listed in the following **(a)** and **(b)**:
 - (a) Any of the ballast pumps required by **7.1.12-3**. Only one of the connected pumps need be considered to be in operation at any time.
 - (b) The ballast controls and indicating systems required by **7.1.12-8**.
- (8) 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 subject within a maximum period of 45 *seconds*.
- (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;
 - (b) Automatically connecting to emergency switchboards in the event of the failure of main sources of electrical power; and
 - (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; 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 **8.3.2-1(5)** and **8.5.1-4(2)(b)** 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

2 Emergency alarm systems are to be installed to be clearly perceptible in all parts of 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** 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 20*m* from any location in corridors on each deck, and their height is to be not less than 1.2*m* or more than 1.5*m* 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.

3 In the case of column-stabilized Floating Offshore Facilities, permanently installed internal means of communication, independent of Floating Offshore Facility main sources of electrical

power, are to be provided between central ballast control stations and spaces that contain ballast pumps or valves, or other spaces deemed necessary by the Society for the operation of ballast systems.

8.5 Electrical Installations in Hazardous areas

8.5.1 General

- 1** Electrical equipment of at least temperature class *T3* (maximum 200°C) is to be used in areas considered hazardous due to hydrocarbon gases.
- 2** Except for small spaces such as air-locks, paint stores, battery rooms, etc., lighting systems in hazardous enclosed spaces are to be divided between at least two independent circuits. One of the circuits may be for supplying power to emergency lights.
- 3** Electrical equipment in the double wall piping systems, ducts or hoods specified in **7.3.5**, **7.4.4** and **7.4.5** respectively are to be intrinsically safe types.
- 4** In Zone 0, the following certified electrical equipment may be accepted:
 - (1) Category '*ia*' intrinsically safe type electrical equipment.
 - (2) Electrical equipment especially certified for Zone 0.
 - (3) Electrical deep well pumps in crude oil tanks may be accepted by the Society.
 - (4) Cables with metal screens, braids or armour associated with category '*ia*' intrinsically safe type electrical equipment.
- 5** In Zone 1 the following certified electrical equipment may be accepted:
 - (1) The electrical equipment and cables specified in -**4** above.
 - (2) Category '*ib*' intrinsically safe type electrical equipment.
 - (3) Flameproof type electrical equipment.
 - (4) Increased safety type electrical equipment.
 - (5) Pressurized protected type electrical equipment.
 - (6) Other types of specially protected electrical equipment may be accepted as Zone 1 by the Society.
 - (7) Cables with metal screens, braids or armour.
- 6** In Zone 2, the following certified electrical equipment may be accepted:
 - (1) The electrical equipment and cables specified in -**5** above.
 - (2) Electrical equipment certified especially for Zone 2
 - (3) Non-sparking devices such as squirrel cage motors, lighting systems, connection boxes etc.
- 7** Electrical equipment in cofferdams, ballast tanks, etc. adjacent to crude oil tanks are to be limited to flameproof types or pressurized protected types lighting systems and intrinsically safe type electrical equipment. Cable for other services which have to pass through the above spaces are to be installed in seamless steel pipes with wall thicknesses not less than the minimum given in **Table D12.6, Part D**.

8.5.2 Cables

- 1** Feeder cables to equipment being supplied from both main and emergency power sources are to follow different routes which are to be as far apart as practicable.
- 2** The cables for intrinsically safe circuits associated with intrinsically safe type electrical equipment are to be of exclusive use, being installed separately from the cables for general circuits.
- 3** Cables for SCR-fed D.C. motors are preferably to be non-braid types and are to be shielded with regard to electrical interference as well as to be mechanically protected in hazardous enclosed spaces. If cables with metal braids or armour are used, such braids or armour is to be earthed in hazardous areas only.

8.5.3 Warning Notices

1 In cases where lighting fittings are provided in hazardous areas, warning notices are to be posted at each entrance or each individual lighting fitting. Such warning notices are to specify that electrical power supply circuits to lighting fittings are to be disconnected before lighting fittings are opened.

2 In cases where portable electrical installations supplied by flexible cables are provided near socket-outlets in crude oil areas or areas adjacent to crude oil areas, warning notices are to be posted near such socket-outlets. Warning notices are to specify that electrical installations are not to be used in areas where flammable vapor may be present.

3 In cases where socket-outlets for welding apparatus are provided in areas adjacent to crude oil areas, warning notices are to be posted near such socket-outlets. Such warning notices are to specify that welding apparatuses are not to be used unless working spaces and adjacent spaces are gas-free.

Chapter 9 PRODUCTION SYSTEMS

9.1 General

9.1.1 Application

1 The requirements given in this Chapter apply to production systems consisting of the systems specified in (1) to (7) below which may be installed on Floating Offshore Facilities which comply with the requirements given in **Chapter 1 to 8**.

- (1) Riser compensating and tensioning systems
- (2) Oil processing systems and water processing systems
- (3) Flare/gas disposal systems
- (4) Safety systems
- (5) Control systems
- (6) Production support systems
- (7) Water injection systems (only for production systems)
- (8) Gas injection systems (only for production systems)
- (9) 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 Floating Offshore Facilities)
- (4) Shutdown valves at crude oil outlets from production systems to crude tanks or storage units, etc. provided outside 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 Floating Offshore Facilities are located during operation.

9.2 Recognized Codes and Standards

9.2.1 General

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

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 entirety, selection from two or more codes or standards may be made, but only after proper consideration is given to any possible contradictions.

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 (including oil processing systems, water processing systems, flare/gas disposal systems and crude oil tanks)
 - (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 safety systems
 - (g) 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) Activation logic of pressure relief systems
 - (e) Process shutdown system philosophy
 - (f) Injection shutdown system philosophy
 - (g) Corrosion/erosion monitoring and maintenance systems
 - (h) Summary data for control systems and emergency shutdown systems
 - (i) 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 ins addition to the requirements given in the survey specified in **Chapter 14, Part B**.

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 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 All equipment is 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 pipes 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 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 crude oil and hydrocarbon gas leakages in the case of rupture
- (3) Ensure the safe collection and discharge of released crude oil and hydrocarbon gas

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 closed drain system for crude oil, 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 containing crude oil are to be led to exclusive facilities for cleaning.

4 Separation systems for effectively separating crude oil from water to acceptable oil pollution levels are to be provided.

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 are to 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
- (2) Heat exchangers
- (3) Thermal fluid heaters
- (4) Pressure containing components which can be regarded as pressure vessels
- (5) Atmospheric vessels

EFFECTIVE DATE AND APPLICATION

- 1.** The effective date of the amendments is 30 October 2009.
- 2.** Notwithstanding the amendments to the Rules, the current requirements may apply to ships for which the date of contract for construction is before the effective date.

GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

Part PS Floating Offshore Facilities for Crude Oil/
Petroleum Gas Production, Storage and
Offloading

GUIDANCE

Notice No.62 30th October 2009
Resolved by Technical Committee on 24th June 2009

Notice No.62 30th October 2009

AMENDMENT TO THE GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

“Guidance for the survey and construction of steel ships” has been partly amended as follows:

Part PS has been added as follows.

Part PS FLOATING OFFSHORE FACILITIES FOR CRUDE OIL/PETROLEUM GAS PRODUCTION, STORAGE AND OFFLOADING

PS1 GENERAL

PS1.1 General

PS1.1.1 Application

1 Production systems, storage facilities, off loading systems and relevant equipment such as piping or electrical equipment for gasses are to be designed in accordance with the fundamental concepts of the requirements given in **Part PS and Part N of the Rules**.

2 In cases where tankers are converted to Floating Offshore Facilities, relevant requirements given in **Part PS of the Rules** 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, Part PS of the Rules**.
- (2) In the cases of scantlings (net scantlings) obtained by subtracting the corrosion margins specified in **Table PS3.3 of the Rules** 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, Part PS of the Rules**. 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, Part PS of the Rules**.
 - (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, Part PS of the Rules**. In such cases, the design life of Floating Offshore Facilities specified in **3.7.1-3, Part PS of the Rules** is the period that the Floating Offshore Facility age at the time of conversion adds to the assumed service period after conversion or 25 years, whichever is longer.

3 In the case of the periphery facilities for positioning defined in **1.2.5, Part PS of the Rules**, it is to be indicated that a Floating Offshore Facility can be adequately moored in accordance with relevant requirements given in **Part PS of the Rules** and the statutory requirements of the National Authority having jurisdiction in the waters where 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 Floating Offshore Facilities.

4 In the case of systems (e.g. riser connections to seabed pipeline end manifolds) covered under **9.1.1-3, Part PS of the Rules**, it is to be indicated that such systems are to comply with the statutory requirements of the National Authority having jurisdiction in the waters where Floating Offshore Facilities are located during operation or codes/standards deemed appropriate by the Society as well as the requirements given in **Part PS of the Rules**. In such cases, relevant documents for reference are to be submitted to the Society. In cases where classification applications for such systems are submitted, such systems may be classified separately from Floating Offshore Facilities.

PS1.2 Definitions

PS1.2.4 Positioning Systems

The wording “other type of positioning system” specified in **1.2.4-4, Part PS of the Rules** means those systems specified in **10.2.2(2), (4), (5)** and **10.2.3, Part P of the Rules** and are to be compliance with relevant requirements given in **Part P of the Rules**.

PS3 HULL CONSTRUCTION AND EQUIPMENT

PS3.7 Fatigue Strength

PS3.7.2 Fatigue Strength Evaluation

Fatigue Strength may be estimated using cumulative fatigue damage ratio in correspondance to **Appendix P1, Part P of the Guidance** 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.

- (1) In the case of longitudinal stiffeners
 - (a) **Annex C1.1.23-1, Part C of the Guidance**, in cases where correction coefficients are 1.0.
 - (b) **Appendix C, Part CSR-T of the Rules**
- (2) In the case of the members, excluding longitudinal stiffeners, of ship-type Floating Offshore Facilities, **Appendix C, Part CSR-T of the Rules**

PS3.9 Hull Equipment, etc.

PS3.9.2 Guardrails, Fenders, etc.

With respect to the application of **3.9.2-4, Part PS of the Rules**, the requirements of permanent means of access (PMA) specified in Regulation 3.6, Chapter II-1 of *SOLAS* do not apply to 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 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**.

PS4 POSITIONING SYSTEMS

PS4.1 General

PS4.1.1 General

1 The mooring systems and constructions of periphery facilities for positioning deemed appropriate by the Society specified in **4.1.1-2, Part PS of the Rules** refer to the following:

- (1) Periphery facilities for positioning classified according to **PS1.1.1-3**
- (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 **Part PS of the Rules**.
- (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 **Part PS of the Rules**.

2 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

PS4.2 Mooring Analysis

PS4.2.1 General

The dynamic analytical method deemed appropriate by the Society specified in **4.2.1-6, Part PS of the Rules** refer to ones such as API RP 2SK (American Petroleum Institute (API), Recommended Practice for Design and Analysis of Stationkeeping Systems for Floating Structures, 1996).

PS4.2.3 Maximum Offset

Maximum offset may be determined using an analysis method that uses dynamic response analysis of Floating Offshore Facilities in irregular waves to simultaneously determine low frequency components and high frequency components and to calculate the 1/1000 maximum expected value.

PS6 FIRE PROTECTION, DETECTION AND EXTINCTION

PS6.2 Location and Separation of Spaces

PS6.2.1 Location and Separation of Production System

The standards deemed appropriate by the Society specified in **6.2.1-7, Part PS of the Rules** refer to ones such as API RP521 (American Petroleum Institute, Guide for Pressure-Relieving and Depressurizing Systems, 4th Edition, March 1997)

PS6.4 Fire Detection and Extinction

PS6.4.2 Fixed Deck Foam Systems

In cases where the deck foam systems specified in **6.4.2, Part PS of the Rules** cannot be provided on tank decks due to the arrangements of equipment on such decks, foam systems satisfying the capabilities specified in **6.4.2, Part PS of the Rules** are to be provided on appropriate decks (e.g. deck installed production systems which are to be provided on tank decks).

PS7 MACHINERY INSTALLATIONS

PS7.3 Dual Fuel Boilers and Gas Turbines

PS7.3.1 General

The standards deemed appropriate by the Society specified in **7.3.1, Part PS of the Rules** refer to **Annex 2 “Guidance For Dual Fuel Boilers”, Part N of the Guidance** for dual fuel boilers and the following for gas turbines:

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

PS8 ELECTRICAL INSTALLATIONS

PS8.1 General

PS8.1.3 Tests

1 The wording “subject to Society approval” in **8.1.3-2, Part PS of the Rules** means **Part 5 of the “Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use”**. Equipment and cables approved for use are made public on the “List of Approved Materials and Equipment”.

2 The wording “to be subject to type tests” in **8.1.3-3, Part PS of the Rules** means **Part 8 of the “Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use”**. Equipment and cables approved for use are made public on the “List of Approved Materials and Equipment”.

3 Cables requiring type approval are as follows:

- (1) Cables used for power feeding systems and power distribution circuits for power, lighting and internal communications and used for control circuits
- (2) Flexible cords used for feeding power systems, power distribution circuits and control circuits
- (3) Multicore vinyl insulated cables for 150V electronic equipment

4 Type tests may be carried out for flexible cords, vinyl sheathed cords, insulated cables for switchboards and control equipment, coaxial cables, etc., other than those specified in **-3** above in cases where requests for such tests are made by manufactures.

5 With respect to the electrical appliances and cables specified in **8.1.3-3, Part PS of the Rules**, 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.

PS8.2 Main Source of Electrical Power and Lighting Systems

PS8.2.1 Main Source of Electrical Power

1 In **8.2.1-2, Part PS of the Rules**, 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, Part PS of the Rules**
- (2) Refrigerating compressors for air conditioning installations
- (3) Others as deemed acceptable by the Society

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

3 The capacities of the transformers specified in **-2** 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,

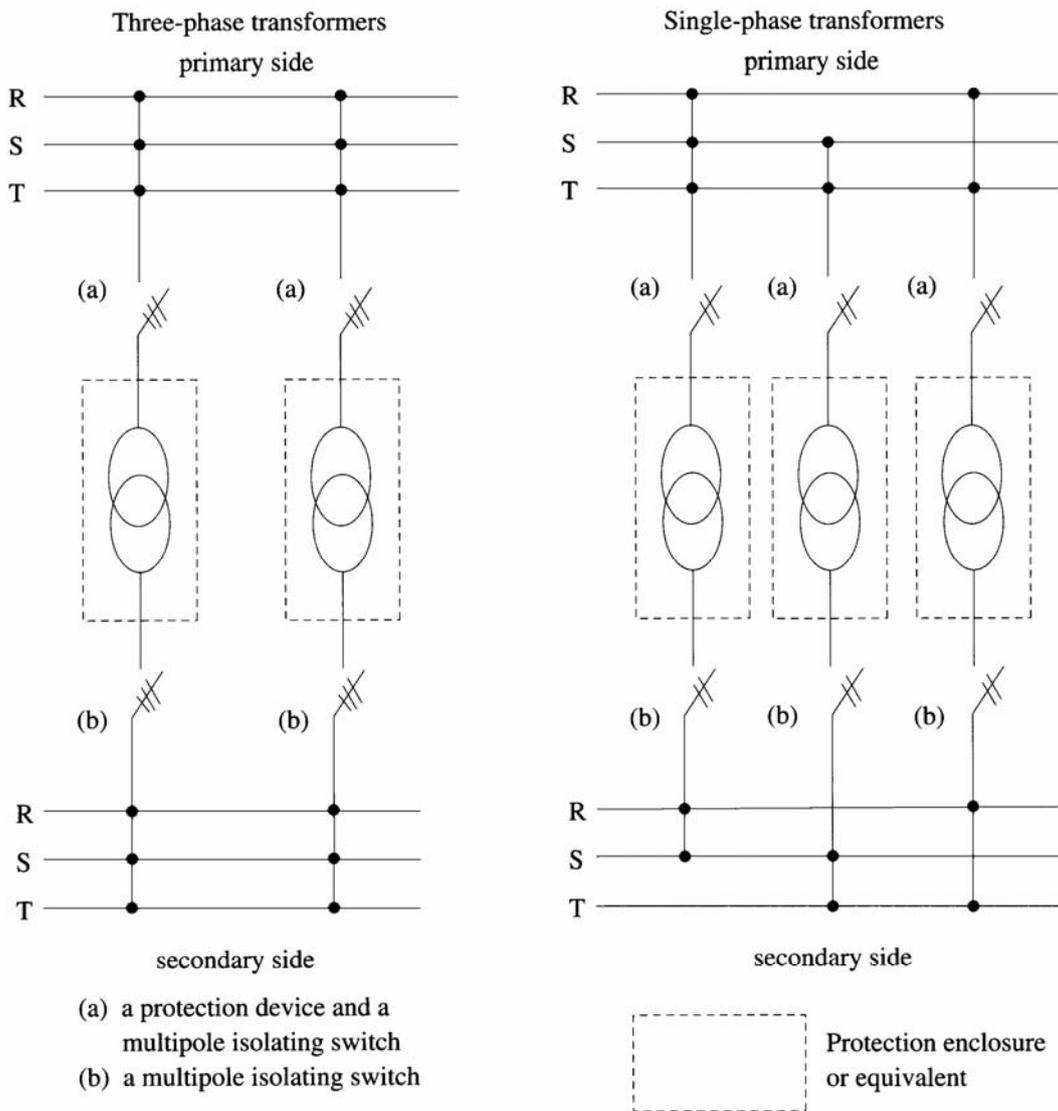
provision refrigeration, mechanical ventilation, sanitary and fresh water services.

4 Notwithstanding the requirements given in -2 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.

5 The arrangements of transformers are to be as follows: (See Fig. PS8.2.1-1)

- (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.

Fig. PS8.2.1-1 Arrangement of Transformers



PS8.2.2 Lighting Systems

The passageways, stairways and exist specified in **8.2.2-3(2), Part PS of the Rules** include those leading to muster stations and launching stations required to be illuminated by the lighting specified in **8.2.2-3(1), Part PS of the Rules**.

PS8.3 Emergency Source of Electrical Power

PS8.3.1 General

1 With respect to the application of **8.3.1-5, Part PS of the Rules**, 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 alarms and automatic trips specified in **18.5.2, Part D of the Rules** (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 sufficient fuel oil capacity for emergency services for the period of time required by **8.3.2, Part PS of the Rules**. 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** 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.

PS8.3.3 Kind and Performance of Emergency Sources of Electrical Power

1 The automatic starting systems specified in **8.3.3(1)(c), Part PS of the Rules** are to comply with the following requirements given in (1) to (3):

- (1) Sources of stored energy are to have capacities which are capable of starting prime movers at least six times.
- (2) In cases where automatic starting systems are consecutive start types, the number of starts is to be three or less.
- (3) 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 With respect to the requirements given in **8.3.3(2)(a), Part PS of the Rules**, 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** respectively, notwithstanding any battery voltage drops.

PS8.3.4 Transitional Source of Emergency Electrical Power

With respect to the requirements given in **8.3.4(1), Part PS of the Rules**, in cases where

inverters or converters are connected to the output circuits of batteries (consumer side), the requirements specified in **PS8.3.3-2** may be applied.

PS8.4 Emergency Alarm Systems and Internal Means of Communication

The emergency alarm systems specified in **8.4.1-1, Part PS of the Rules** are to comply with the statutory requirements of National Authorities having jurisdiction in the waters where Floating Offshore Facilities are located during operation in addition to the requirements given in *Code on Alarms and Indicators (IMO Res. A.830(19))*

PS9 PRODUCTION SYSTEMS

PS9.1 General

PS9.1.1 Application

1 Systems (systems to transfer products extracted from seabed wells (crude oil, etc.) to Floating Offshore Facilities such as sub-sea systems, flow-line systems, risers, floating hoses, etc. and which satisfy boundaries specified in **9.1.1-2, Part PS of the Rules**), excluding production systems, are to take into account the following items in addition to those considered to be prerequisites for such systems to comply with standards deemed appropriate by the Society (OCIMF, API, etc.).

2 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 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 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 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.

3 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 Floating Offshore Facilities or periphery facilities for positioning both under the operating conditions of moored Floating Offshore Facilities and the design conditions of unmoored Floating Offshore Facilities.
- (2) The motion of riser system components
- (3) The external forces on risers (current forces, tension from 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 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 Floating Offshore Facilities or periphery facilities for positioning.

4 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.

5 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 crude oil from periphery facilities for positioning to Floating Offshore Facilities, special hoses (tanker rail hoses, etc.) are to be provided at the moored Floating Offshore Facility end to accommodate 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 as well as tanker rail hoses to accommodate 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, and to minimize the hazard of oil pollution even in emergency situations.
- (3) Floating hoses are to comply with standard 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 Floating Offshore Facilities or periphery facilities for positioning. (bolting, gaskets, etc. and their designs) are to be suitable for their intended services.

6 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 to be subjected 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.

PS9.2 Recognized Codes and Standards

PS9.2.1 General

1 The recognized codes or standards approved by the Society stipulated in **9.2.1-1** and **9.7.1-2**, **Part PS of the Rules** refer to the following:

- (1) Production Systems
 - (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) 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
- (3) Heat exchangers
 - (a) Tabular Exchanger Manufacturers Association (TEMA) Class R Heat Exchanger Tubing
 - (b) API 661 Air Cooled Heat Exchanger for General Refinery Services

2 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.

EFFECTIVE DATE AND APPLICATION

- 1.** The effective date of the amendments is 30 October 2009.
- 2.** Notwithstanding the amendments to the Guidance, the current requirements may apply to ships for which the date of contract for construction is before the effective date.