Rules and Regulations for the Classification of Mobile Offshore Units

Part 3
Functional Unit Types and Special Features
June 2013
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Rule application

1.1 General

1.1.1 This Part is applicable to all types of mobile offshore units as defined in Pt 1, Ch 2,2, including their positional mooring systems. Units of unconventional type or form will receive individual consideration based on the general standards of these Rules.

1.1.2 In addition to the Rule requirements for Classification, attention is to be given to the relevant statutory Regulations of the National Administration of the country of registration and in the area of operation, as applicable, see Pt 1, Ch 2,1.1.

1.1.3 In general, a unit which due to its design and function is intended to remain and operate at one location for long periods of its working life will be considered as a mobile unit in accordance with these Rules, provided the unit can be moved to a new location without carrying out major works or structural modifications. See also Ch 3,1.

1.1.4 Hull scantlings of surface type units are to comply with LR's Rules and Regulations for the Classification of Ships (hereinafter referred to as the Rules for Ships), but all aspects which relate to the specialised offshore function of the unit will be considered on the basis of these Rules. See Chapter 2 and Pt 4, Ch 4,4.

1.1.5 Lifting appliances are to comply with the requirements of LR's Code for Lifting Appliances in a Marine Environment (hereinafter referred to as LAME), see also Chapter 11.

1.1.6 The requirements stated in this Part for the particular unit types and special features class notations are supplementary to those stated in other Parts of these Rules.
Section 3
Operations Manual

3.1 General

3.1.1 A manual of operating instructions is to be prepared and placed on board each unit and should be made readily available to all concerned in the safe operation of the unit, see also 3.2.4.

3.1.2 It is the responsibility of the Owner to provide in the Operations Manual all the necessary instructions and limits on the operation of the unit to ensure that the environmental and operating loading conditions on which the classification is based will not be exceeded in service.

3.1.3 Where a National Administration has a specific requirement regarding the contents of the Operations Manual, it is the responsibility of the Owner to comply with such Regulations.

3.1.4 The Operations Manual is to be submitted when the plans of the unit are being approved by LR. The Operations Manual will be reviewed and noted in respect of those aspects covered by Classification only.

3.1.5 Where a unit is modified during its service life, it is the Owner's responsibility to update the Operations Manual, as necessary, and advise LR of any changes which may affect the Classification of the installation.

3.2 Information to be included

3.2.1 In general, the Operations Manual should include the following minimum information, as applicable:

- General description and particulars of the unit.
- Chain of command and general responsibilities during all normal operating modes and emergency operations.
- Limiting design data for each approved mode of operation, including design and variable loading, draughts, air gap, wave height, wave period, wind, current, minimum sea and air temperatures, assumed sea bed conditions, orientation, and any other applicable environmental factors, such as icing.
- A description of any inherent operational limitations for each mode of operation and for each change in mode of operation. For surface type units, see also 3.2.4.
- Permissible deck loading plan.
- General arrangement plans showing watertight and weathertight boundaries.
- The location and type of watertight and weathertight closures, vents, air pipes, etc., and the location of down-flooding points.
- The location, type and weights of permanent ballast installed on the unit.
- A description of the signals used in the general alarm, public address, fire and gas alarm systems.
- Hydrostatic curves or equivalent data.
- A capacity plan showing the capacities and the centres of gravity of tanks and bulk material stowage spaces.
- Tank sounding tables or curves showing capacities, the centres of gravity in graduated intervals and the free surface data of each tank.
- Plans and description of the ballast system and instructions for ballasting.
- Plan indicating hazardous areas.
- Fire control and safety/evacuation plans.
- Light ship data based on the results of an inclining experiment, etc.
- Stability information in the form of maximum KG versus draught curve, or other suitable parameters, based upon compliance with the required intact and damaged stability criteria.
- Representative examples of loading conditions for each approved mode of operation, together with the means for evaluation of other loading conditions. For surface type units, see also 3.2.4.
- Positional mooring system and limiting conditions of operation.
- Description and limitations of any onboard computer used in operations such as ballasting, anchoring, dynamic positioning and in trim and stability calculations.
- Plan of towing arrangements and limiting conditions of operation.
- Description of the main power system and limiting conditions of operation.
- Details of emergency shut-down procedures.
- Identification of the helicopter used for the design of the helicopter deck.

3.2.2 Instructions for the operation of the unit are to include precautions to be taken in adverse weather, changing mode of operation, any inherent limitations of operations, approximate time required for meeting severe storm conditions and mooring pattern/heading.

3.2.3 For self-elevating units, the manual is to include instructions on safety during jacking-up and jacking-down of the hull and over the period of time the unit is in the elevated position, and during extreme weather conditions while in transit, including the positioning and securing of legs, cantilever drill floor structures and heavy cargo and equipment which might shift position. Limitations on the maximum permissible rigid body motions of the unit, and allowable sea states whilst elevating or lowering the legs.

3.2.4 For surface type units, sufficient information is to be supplied to the Master/Operator to enable him to arrange loading and ballasting in such a way as to avoid the creation of unacceptable stresses in the unit’s structure. This information is to be provided by means of a Loading Manual and in addition, where required, by means of an approved loading instrument, see Pt 1, Ch 2.1. The Loading Manual may form part of the Operations Manual, or may be a separate document.
4.1 General

4.1.1 The Requirements are intended for units to be constructed of materials manufactured and tested in accordance with the Rules. Where it is intended to use materials manufactured by different processes or having different properties, their use will be specially considered by LR.

4.1.2 Units should be constructed from steel or other suitable material having properties acceptable to LR, taking into consideration the temperature extremes in the areas in which the unit is intended to operate.

4.1.3 The materials used for the construction and repair of units and installed machinery are to be manufactured and tested in accordance with the requirements of the Rules for Materials.

4.1.4 As an alternative, materials which comply with National or proprietary specifications may be accepted provided that these specifications give reasonable equivalence to the requirements of the Rules for Materials or are approved for a specific application. Generally, survey and certification are to be carried out in accordance with the requirements of the Rules for Materials.

4.1.5 Materials for specialised areas of the unit, related to its function or special features notation, are to be in accordance with the relevant Chapters of this Part, see also 4.3.

4.1.6 Consideration should be given to the minimisation of hazardous substances used in the design and construction of the unit. The design and construction should facilitate recycling and removal of hazardous materials.

4.1.7 Materials which contain asbestos shall be prohibited.

4.2 Material selection

4.2.1 Materials are to be selected in accordance with the requirements of the design in respect of static strength, fatigue strength, fracture resistance and corrosion resistance, as appropriate.

4.2.2 The grades of steel to be used in the construction of the unit are to be related to the thickness of the material, the location on the unit and the minimum design temperature, see 4.4.

4.2.3 The grades of steel to be used for the drilling plant and the production and process plant are to be in accordance with the requirements of Chapters 7 and 8 respectively.

4.2.4 The effects of corrosion, either from the environment or from the products handled on the unit or its associated plant and machinery, are to be taken into account in the design.

4.3 Structural categories

4.3.1 The structural categories for the hull construction and the corresponding grades of steel used in the structure are to be in accordance with Pt 4, Ch 2.

4.3.2 The structural categories for supporting structures for drilling plant and production and process plant are to be in accordance with Chapters 7 and 8 respectively.

4.4 Minimum design temperature

4.4.1 The minimum design temperature is a reference temperature used as a criterion for the selection of the grade of steel to be used.

4.4.2 The minimum design air and sea temperatures for exposed structure are to be taken as the lowest daily mean temperature for the unit's proposed areas of operation based on the 50 year average return period. The temperature is to be rounded down to the nearest degree Celsius.

4.4.3 The minimum design temperature (MDT) for drilling plant and production and process plant is to be defined by the designers/BUILDERS but when appropriate the MDT should not be higher than the MDT for the exposed structure defined in 4.4.2.

4.5 Aluminium structure, fittings and paint

4.5.1 The use of aluminium alloy is permitted for secondary structure as defined in Pt 4, Ch 2.

4.5.2 Where aluminium alloy is used for secondary structure, the material is to conform with the requirements of Chapter 8 of the Rules for Materials.

4.5.3 The use of aluminium alloy for primary structure will be specially considered.

4.5.4 Where aluminium alloy is used in the construction of fire divisions, it is to be suitably insulated in accordance with the requirements of the appropriate National Administration, see 1.1.2.

4.5.5 Since aluminium alloys may, under certain circumstances, give rise to incendive sparking on impact with steel, the following requirements are to be complied with:

(a) Aluminium fittings in tanks used for the storage of oil and in cofferdams and pump-rooms in oil storage units are to be avoided wherever possible.

(b) Where fitted, aluminium fittings, anodes and supports in tanks used for the storage of oil, cofferdams and pump-rooms are to satisfy the requirements specified in Pt 8, Ch 2.5 for aluminium anodes.

(c) The danger of mistaking aluminium anodes for zinc anodes must be emphasised. This gives rise to increased hazard if aluminium anodes are inadvertently fitted in unsuitable locations.
6.1 General

5.1 The corrosion control of steelwork is to be in accordance with Part 8. The corrosion protection of mooring systems is to comply with Chapter 10.

5.1.2 The basic Rule scantlings of the external submerged steel structure of units which are derived from Pt 4, Ch 5 assume that appropriate coatings and an external cathodic protection system will be fitted. If the corrosion protection system of the submerged structure is not in accordance with the Rules the scantlings are to be suitably increased.

5.1.3 Surface type units with hull scantlings derived from LR's Rules for Ships which are assigned an OIWS notation are to be fitted with external cathodic protection and external coating systems in accordance with Part 8.

6.1.4 If marking is to be carried out by welding, the welds should be made with continuous runs and the quality of the workmanship should be to an equivalent standard as the main hull structure. Substantial runs should be laid, continuously, using large diameter electrodes and avoiding light runs as these are more likely to promote cracking. Sharp corners in the letters are to be avoided. Marking by welding is not permitted in highly stressed areas or over existing butts or seams. The welding procedures and consumables are to be submitted for approval.

6.1.5 On steel of Grade D or E or on higher tensile steel, low hydrogen electrodes should be used, of a grade suitable for the steel. In the case of higher tensile steel, see Ch 3.3 of the Rules for Materials, pre-heating to about 100°C should be adopted.

6.2 Physical features

6.2.1 The following physical features are to be incorporated into the unit's design in order to facilitate the underwater inspection. When verified, they will be noted in the unit's Classification for reference at subsequent surveys.

6.2.2 Stern bearing. For self-propelled units, means are to be provided for ascertaining that the seal assembly on oil lubricated bearings is intact and for verifying that the clearance or weardown of the stern bearing is not excessive. For oil-lubricated bearings, this may only require accurate oil-loss-rate records and a check of the oil for contamination by sea-water or white metal. For wood or rubber bearings, an opening in the top of the rope guard and a suitable gauge or wedge would be sufficient for checking the clearance by a diver. For oil-lubricated metal stern bearings, weardown may be checked by external measurements between an exposed part of the seal unit and the stern tube bossing, or by use of the unit's weardown gauge, where the gauge wells are located outboard of the seals, or the unit can be tipped. For use of the weardown gauges, up-to-date records of the base depths are to be maintained on board. Whenever the stainless steel seal sleeve is renewed or machined, the base readings for the weardown gauge are to be re-established and noted in the unit's records and in the survey report.

6.2.3 Rudder bearings. For self-propelled units with rudders, means and access are to be provided for determining the condition and clearance of the rudder bearings, and for verifying that all parts of the pintle and gudgeon assemblies are intact and secure. This may require bolted access plates and a measuring arrangement.

6.2.4 Sea suctions. Means are to be provided to enable the diver to confirm that the sea suction openings are clear. Hinged sea suction grids would facilitate this operation.

6.2.5 Sea valves. For the Dry-docking Survey (Underwater Inspection) associated with the Special Survey, means must be provided to examine any sea valve.

6.2.6 Alternative arrangements to facilitate In-water Surveys will be considered; details are to be submitted to LR for approval.
Section 7
Permanent means of access

7.1 General

7.1.1 Each space within the unit should be provided with at least one permanent means of access to enable, throughout the life of a unit, overall and close-up inspections and thickness measurements of the unit’s structures to be carried out by LR, the company, and the unit’s personnel and others, as necessary. Such means of access should comply with the provisions of MODU Code 2009, paragraph 2.2 and with the Technical provisions for means of access for inspections, adopted by the Maritime Safety Committee by Resolution MSC.133(76), as may be amended by the IMO.
Section 1

General

1.1 Application

1.1.1 The requirements of this Chapter apply to all drilling units engaged in drilling operations for the exploration and exploitation of petroleum, gas or other resources beneath the sea bed.

1.1.2 Surface type units are to comply with this Chapter, but reference should also be made to Pt 4, Ch 4.4.

1.1.3 Units engaged in rock drilling or other similar work operations not related to petroleum or gas resources will be specially considered but should comply with the general requirements of this Chapter as applicable to the unit.

1.2 Class notations

1.2.1 The Regulations for classification and the assignment of class notations are given in Pt 1, Ch 2, to which reference should be made.

1.2.2 In general, units complying with the requirements of this Chapter and the relevant Parts of the Rules will be eligible for the assignment of one of the following class type notations:

- Mobile drilling unit; or
- Drilling ship.

Other type notations may be assigned when considered appropriate by the Classification Committee.

1.2.3 Drilling units with an installed drilling plant facility which comply with the requirements of Chapter 7 will be eligible for the assignment of the special features class notation DRILL.

1.2.4 When a DRILL notation is not assigned to a unit with a drilling plant facility, classification of the unit will be subject to the drilling plant being certified by LR, or by another acceptable organisation.

1.2.5 When, at the request of an Owner, a unit is to be verified in accordance with the Regulations of a National Administration, a descriptive note will be included in the ClassDirect Live website.

1.3 Scope

1.3.1 The following additional topics applicable to the class type notation are covered by this Chapter:

- Structural arrangements of the unit related to drilling operations.
- Supporting structures for drilling equipment, bulk storage and raw water towers.
- Drill floor and derrick substructure.
- Drilling cantilevers.
- Structural arrangements in way of drilling wells.
- Structural mud tanks or pits.
- Deckhouses and modules related to drilling operations.
- Pipe racks and supports.
- Hazardous areas and ventilation.
- Pollution prevention.

1.4 Installation layout and safety

1.4.1 In principle, drilling units are to be divided into main functional areas to ensure that the following areas are separated and protected from each other:

(a) Drilling area:
   - Drill floor area
   - Mud circulation and treatment area.

(b) Auxiliary equipment area.

(c) Living quarters’ area.

1.4.2 Attention is to be given to the relevant Statutory Regulations for fire safety of the National Administration in the country of registration and the areas of operation as applicable, see Pt 1, Ch 2.1 and Pt 7, Ch 3.

1.4.3 Additional requirements for safety systems and hazardous areas are given in Part 7.

1.4.4 Living quarters, lifeboats and other evacuation equipment are to be located in non-hazardous areas and be protected and separated from the drilling area.

1.5 Plans and data submission

1.5.1 Plans, calculations and data are to be submitted as required by the relevant Parts of the Rules together with the additional plans and information listed in this Chapter.
2.2.9 When blast walls are fitted on the unit, the primary supporting structure in way of the blast walls is to be designed for the maximum design blast force with the permissible stress levels in accordance with Pt 4, Ch 5.2.1.1(c).

2.3 Well structure

2.3.1 The primary hull strength of the unit is to be maintained in way of drilling wells and other large deck openings and suitable compensation is to be fitted as necessary. For surface type units the minimum hull modulus in way of the drilling well is to satisfy the Rule requirements for longitudinal strength.

2.3.2 Arrangements are to be made to ensure continuity of strength at the ends of longitudinal and well side bulkheads. In general, the design should be such that the bulkheads are connected to bottom and deck girders by means of large, suitably shaped brackets arranged to give a good stress flow at their junctions with both the girders and bulkheads.

2.3.3 The boundary bulkheads of drilling wells are to be designed for the maximum forces imposed by the drilling operations. The minimum scantlings of well bulkheads are to comply with the requirements for tank bulkheads in Pt 4, Ch 6.7 using the load head measured to the top of the well, but in no case is the well plating to have a thickness less than 9.0 mm.

2.4 Permissible stresses

2.4.1 In general, the permissible stresses in the structure in operating, transit and survival conditions are to comply with Pt 4, Ch 5,2 but the minimum scantlings of the local structure are to comply with Pt 4, Ch 6. For surface type units, see also Pt 4, Ch 4.4.

2.4.2 Permissible stresses for lattice type structures may be determined from an acceptable code, see Part 3, Appendix A.

2.5 Mud tanks

2.5.1 The scantlings of structural mud tanks are not to be less than those required for tanks in Pt 4, Ch 6.7 using the design density of the mud. In no case is the relative density of wet mud to be taken less than 2.2 unless otherwise agreed with LR.

2.5.2 Divisions in mud tanks or pits are to be designed for one-sided loading and the scantlings are to comply with the requirements for tanks in Pt 4, Ch 6.7.

2.6 Deckhouses and modules

2.6.1 The scantlings of structural deckhouses are to comply with Pt 4, Ch 6.9. Where deckhouses support equipment loads they are to be suitably reinforced.
2.6.2 The strength of containerised modules which do not form part of the main hull structure will be specially considered in association with the design loadings.

2.6.3 When containerised modules can be subjected to wave loading the scantlings are not to be less than required by 2.6.1.

2.7 Pipe racks

2.7.1 The pipe rack is to be designed for the following normal operating loads as applicable:
- Gravity loads.
- Maximum dynamic loads due to wave-induced unit motions.
- Direct wind loads.
- Ice and snow loads.

2.7.2 The pipe rack supports are also to be designed for an emergency condition as defined in Ch 8.1.4.

2.7.3 In general, the pipe rack supports are to be aligned with the primary under-deck structure. Where this is not practicable additional under-deck supports are to be fitted. Deck girders and under-deck supports are to comply with Pt 4, Ch 6.4.

2.7.4 In the emergency condition arrangements are to be made to restrain the pipes in their stowed position and details are to be submitted for approval.

2.8 Bulk storage vessels

2.8.1 Free standing bulk storage vessels are to comply with the requirements of Ch 8.4.

2.8.2 The deck supports under free standing bulk storage vessels are to comply with the requirements for local structure in Pt 4, Ch 6, taking into account the maximum design reaction forces.

2.8.3 Where bulk storage vessels penetrate watertight decks and can be subjected to external hydrostatic pressure due to progressive flooding in hull damage conditions, the bulk storage vessel is to be suitably reinforced and the permissible stress is not to exceed the code stress in accordance with Ch 8.4.

2.9 Watertight and weathertight integrity

2.9.1 The general requirements for watertight and weathertight integrity are to be in accordance with Pt 4, Ch 7.

2.9.2 The integrity of the weather deck is to be maintained. Where items of plant equipment penetrate the weather deck and are intended to constitute the structural barrier to prevent the ingress of water to spaces below the deck, their structural strength is to be equivalent to the Rule requirements for this purpose. Otherwise such items are to be enclosed in superstructures or deckhouses fully complying with the Rules. Full details are to be submitted for approval.

2.9.3 Where items of plant equipment or pipes penetrate watertight boundaries, the watertight integrity is to be maintained and full details are to be submitted for approval.

2.9.4 Where free-standing bulk storage vessels penetrate watertight decks or flats the arrangements to ensure watertight integrity will be specially considered, see 2.8.3.

Section 3
Hazardous areas and ventilation

3.1 Hazardous areas and ventilation

3.1.1 For the application of hazardous area classification and ventilation requirements for drilling units, see Pt 7, Ch 2.

3.1.2 Ventilation in the vicinity of the mud tanks is to be specially considered to ensure adequate dilution of any dangerous gases.

3.1.3 For units using oil-based mud, the tanks are to be provided with special ventilating arrangements, and for open systems the maximum oil density in the air above the tanks is not to exceed 5 mg/m³. Ventilation of the enclosed spaces with open active mud tanks or pits is to be arranged for at least 30 air changes per hour for personnel comfort.

Section 4
Pollution prevention

4.1 General

4.1.1 When oil is added to the drilling mud, provision is to be made to limit the spread of oil on the unit, and to prevent the discharge of oil or oily residues into the sea by the provision of de-oilers and suitably alarmed oil monitoring devices.

4.1.2 Drilling bell nipples, flow lines, ditches, shale shakers, mud rooms and mud tanks and pumps are to be designed for maximum volume throughput without spillage. Equipment requiring maintenance is to have adequate spillage catchment arrangements.

4.1.3 Pollution prevention arrangements should be such that the unit can comply with the requirements of the relevant National Administrations in the country of registration and in the area of operation, as applicable.
Section 1

1 General

1.1 Application

1.1.1 In general, the requirements of this Chapter apply to mobile units engaged in production and/or crude oil bulk storage and off-loading in offshore locations. Production units have specialised structures and plant installed on board for production and/or processing crude oil or gas. In general, oil storage units have integral tanks for the storage of crude oil in bulk and the Rules are primarily intended for units which are to store flammable liquids having a flash point not exceeding 60°C (closed-cup test). Units with bulk storage tanks for liquefied gases or liquid chemicals will be specially considered, see 1.1.3 and 1.1.4.

1.1.2 Surface type units which operate at a fixed geographical location are not considered as Mobile Offshore Units and are to comply with LR's Rules and Regulations for the Classification of a Floating Offshore Installation at a Fixed Location.

1.1.3 Units required for the storage of liquefied gas in bulk are also to comply with LR's Rules and Regulations for the Construction and Classification of Ships for the carriage of Liquefied Gases in Bulk (hereinafter referred to as Rules for Liquefied Gases).

1.1.4 Units required for the storage of liquid chemicals in bulk are also to comply with LR's Rules and Regulations for the Construction and Classification of Ships for the carriage of Liquid Chemicals in Bulk (hereinafter referred to as Rules for Liquid Chemicals).

1.2 Class notations

1.2.1 The Regulations for classification and the assignment of class notations are given in Pt 1, Ch 2, to which reference should be made.

1.2.2 In general, units complying with the requirements of this Chapter and the relevant Parts of the Rules will be eligible for the assignment of one of the following class type notations:

- Production unit.
- Floating production unit.
- Floating production and oil storage unit.
- Oil storage unit.

Other type notations may be assigned when considered appropriate by the Classification Committee.

1.2.3 Type class notations for units with bulk storage tanks for liquefied gases or liquid chemicals will be specially considered by the Classification Committee.

1.2.4 When, at the request of the Owner, a unit is to be verified in accordance with the Regulations of a National Administration, a descriptive note will be included in the ClassDirect Live website, see Pt 1, Ch 2,7.

1.2.5 When a PPF notation is not assigned to a unit with a process plant facility, classification of the unit will be subject to the process plant being certified by LR, or by another acceptable organisation.

1.2.6 When a PPF notation is not assigned to a unit with an installed process plant facility, the process plant being certified by LR, or by another acceptable organisation.

1.2.7 Production units without an installed process plant facility are to comply with the general requirements of Chapter 8 as applicable.

1.2.8 Units with an installed drilling plant facility, which comply with the requirements of Chapter 7, will be eligible for the assignment of the special features class notation DRILL.

1.2.9 When a DRILL notation is not assigned to a unit with a drilling plant facility, classification of the unit will be subject to the drilling plant being certified by LR, or by another acceptable organisation.

1.3 Scope

1.3.1 The following additional topics applicable to the class type notation are covered by this Chapter:

- General arrangement.
- Structural arrangement of the unit.
- Supporting structures below production and process plant equipment, flare structures, and marine risers.
- Deckhouses and modules related to production operations.
- Loading of hot oils.
- Structural arrangement of oil storage tanks, cofferdams and pump-rooms.
- Access arrangements.
- Compartment minimum thickness.
- Hazardous areas and ventilation.
- Pollution prevention.

1.3.2 Where the unit is fitted with drilling equipment, the requirements of Chapter 2 are to be complied with.
Section 2
Structure

2.1 Plans and data submission

2.1.1 In addition to the structural plans and information as required by Ch 1,2 and Pt 4, Ch 1 the following additional plans and information are to be submitted:
- General arrangement.
- General arrangement plans of the production plant and process equipment layout.
- Structural supports below plant equipment.
- Structural plans of crude oil tanks, ballast tanks, cofferdams, void spaces, pump-rooms and machinery spaces.
- Deckhouses and modules.

2.1.2 When the unit is fitted with drilling equipment, the additional plans required by Ch 2,2 are to be submitted as applicable.

2.2 General

2.2.1 The general hull strength is to comply with the requirements of Part 4, taking into account the type of unit, the imposed equipment weights and forces from the production and process plant, mooring forces and drilling plant, when fitted. Attention should be paid to loads resulting from hull flexural effects at support points.

2.2.2 The supporting structure below equipment is to be designed for all operating conditions and the maximum design loadings from the production and process plant imposed on the structure are to be determined in accordance with Chapter 8.

2.2.3 Decks and other under-deck structure supporting the plant are to be suitable for the local loads at plant support points and an agreed uniformly distributed load acting on the deck, see Pt 4, Ch 6.2. The structure in way of marine risers is to be suitably reinforced for the imposed loads.

2.2.4 In general, all seatings, platform decks, girders and pillars supporting plant items are to be arranged to align with the main hull structure, which is to be suitably reinforced, where necessary, to carry the appropriate loads. Attention should be paid to the capability of support structures to withstand buckling, see Pt 4, Ch 5.4.

2.2.5 The strength of the unit in way of openings is to be maintained. Structure in way of openings of unusual size, configuration and/or shape may require investigation by structural analysis when requested by LR.

2.2.6 Insert plates of adequate thickness and steel grade, appropriate to the stress concentrations and locations, may be required in way of openings and structural discontinuities in primary structure.
2.2.7 Critical joints depending upon transmission of
tensile stresses through the thickness of the plating of one of
the members (which may result in lamellar tearing) are to be
avoided wherever possible. Where unavoidable, plate
material with suitable through-thickness properties will be
required, see Ch 3.8 of the Rules for Materials and Pt 4,
Ch 2.4.1.3.

2.2.8 When blast walls are fitted on the unit, the primary
supporting structure in way of the blast walls is to be
designed for the maximum design blast force with the
permissible stress levels in accordance with Pt 4, Ch 5.2.1.1(c).

2.3 Drilling structures

2.3.1 When a unit is fitted with a drilling derrick, the
requirements of Ch 2.2 are to be complied with, as
applicable.

2.3.2 The design loadings for the strength of the drill
floor and substructure are to be defined by the
designer/Builders and calculations are to be submitted.

2.4 Permissible stresses

2.4.1 In general, the permissible stresses in the structure
in operating, transit and survival conditions are to comply
with Pt 4, Ch 5.2 but the minimum scantlings of the local
structure are to comply with Pt 4, Ch 6. Surface type
units, see also Pt 4, Ch 4.

2.4.2 Permissible stresses for lattice type structures may
be determined for an acceptable Code, see Appendix A.

2.5 Well structure

2.5.1 The primary hull strength of the unit is to be
maintained in way of moonpools, turret openings, drilling
wells and other large deck openings and suitable
compensation is to be fitted, as necessary. For surface type
units, the continuity of longitudinal material is to be
maintained, as far as is practicable, in way of openings and
wells and the minimum hull modulus is to satisfy the Rule
requirements for longitudinal strength.

2.5.2 Arrangements are to be made to ensure continuity
of strength at the ends of moonpools and well side
bulkheads. In general, the design should be such that the
bulkheads are connected to bottom and deck girders by
means of large, suitably shaped brackets arranged to give a
good stress flow at their junctions with both the girders and
bulkheads.

2.5.3 The boundary bulkheads of moonpools and drilling
wells are to be designed for the maximum forces imposed on
the structure, see Pt 4, Ch 4.4.

2.6 Mud tanks

2.6.1 The scantlings of structural mud tanks are not to
be less than those required for tanks in Pt 4, Ch 6.7 using the
design density of the mud. In no case is the relative density of
wet mud to be taken less than 2.2 unless agreed otherwise
with LR.

2.6.2 Divisions in mud tanks or pits are to be designed
for one-sided loading and the scantlings are to comply with
the requirements for tanks in Pt 4, Ch 6.7.

2.7 Deckhouses and modules

2.7.1 The scantlings of structural deckhouses are to
comply with Pt 4, Ch 6.9. Where deckhouses support
equipment loads, they are to be suitably reinforced.

2.7.2 The strength of containerised modules, which do
not form part of the main hull structure, will be specially
considered in association with the design loadings.

2.7.3 When containerised modules can be subjected to
wave loading, the scantlings are not to be less than required
by 2.7.1.

2.8 Pipe racks

2.8.1 The pipe rack is to be designed for the following
normal operating loads as applicable:

- Gravity loads.
- Maximum dynamic loads due to wave induced unit
  motions.
- Direct wind loads.
- Ice and snow loads.
- Hull flexure due to hull girder bending

2.8.2 The pipe rack supports are also to be designed for
an emergency condition, as defined in Ch 8.1.4.

2.8.3 In general, the pipe rack supports are to be aligned
with the primary under-deck structure. Where this is not
practicable, additional under-deck supports are to be fitted.
Deck girders and under-deck supports are to comply with
Pt 4, Ch 6.4.

2.8.4 In the emergency condition, arrangements are to
be made to restrain the pipes in their stowed position and
details are to be submitted for approval.

2.9 Bulk storage vessels

2.9.1 Free-standing bulk storage vessels are to comply
with the requirements of Ch 8.4.

2.9.2 The deck supports under free-standing bulk
storage vessels are to comply with the requirements for local
structure in Pt 4, Ch 6 taking into account the maximum
design reaction forces.
2.9.3 Where bulk storage vessels penetrate watertight decks and can be subjected to external hydrostatic pressure due to progressive flooding in hull damage conditions, the bulk storage vessel is to be suitably reinforced and the permissible stress is not to exceed the Code stress in accordance with Ch 8, 4.

2.10 Watertight and weathertight integrity

2.10.1 The general requirements for watertight and weathertight integrity are to be in accordance with Pt 4, Ch 7.

2.10.2 The integrity of the weather deck is to be maintained. Where items of plant equipment penetrate the weather deck and are intended to constitute the structural barrier to prevent the ingress of water to spaces below the deck, their structural strength is to be equivalent to the Rule requirements for this purpose. Otherwise such items are to be enclosed in superstructures or deckhouses fully complying with the Rules. Full details are to be submitted for approval.

2.10.3 Where items of plant equipment or pipes penetrate watertight boundaries, the watertight integrity is to be maintained and full details are to be submitted for approval. Free flooding pipes, which penetrate shell boundaries, are to have a wall thickness not less than the adjacent shell plating.

2.10.4 Where bulk storage vessels penetrate watertight decks or flats, the arrangements to ensure watertight integrity will be specially considered, see 2.9.3.

2.11 Access arrangements and closing appliances

2.11.1 For requirements in respect of coamings and closing of deck openings, see Pt 4, Ch 7.6.

2.11.2 The access arrangements on surface type units are to comply with 2.12. For other unit types, the general requirements of 2.12 are to be complied with, as applicable.

2.11.3 Ladders and platforms in tanks, pump-rooms, cofferdams, access trunks and void spaces are to be securely fastened to the structure.

2.12 Access to spaces in the oil storage area

2.12.1 Access arrangements to tanks for the storage of oil in bulk and adjacent spaces, including cofferdams, voids, vertical wing and double bottom ballast tanks, is to be direct from the open deck and such as to ensure their complete inspection.

2.12.2 In column-stabilised units where access from the open deck is not practicable, access to oil storage tanks and adjacent spaces is to be from trunks which are mechanically ventilated in accordance with Section 3. Every space is to be provided with a separate access without passing through adjacent spaces.

2.12.3 Access to double bottom tanks in way of oil storage tanks, where wing ballast tanks are omitted, is to be provided by trunks from the exposed deck led down the bulkhead. Alternative proposals will, however, be considered, provided the integrity of the inner bottom is maintained.

2.12.4 Access to double bottom spaces may also be through a cargo pump-room, pump-room, deep cofferdam, pipe tunnel or similar compartments, subject to consideration of ventilation aspects.

2.12.5 Where a duct keel or pipe tunnel is fitted, and access is normally required for operational purposes, access is to be provided at each end and at least one other location at approximately mid-length. Access is to be directly from the exposed deck. Where an after access is to be provided from the pump-room to the duct keel, the access manhole from the pump-room to the duct keel is to be provided with an oiltight cover plate. Mechanical ventilation is to be provided and such spaces are to be adequately ventilated prior to entry. A notice board is to be fitted at each entrance to the pipe tunnel stating that before any attempt is made to enter, the ventilating fan must have been in operation for an adequate period. In addition, the atmosphere in the tunnel is to be sampled by a reliable gas monitor, and where an inert gas system is fitted in cargo tanks, an oxygen monitor is to be provided.

2.12.6 Every double bottom space is to be provided with separate access without passing through other neighbouring double bottom spaces.

2.12.7 Where the tanks are of confined or cellular construction, two separate means of access from the weather deck are to be provided, one to be provided at either end of the tank space.

2.12.8 For access through horizontal openings, hatches or manholes, the dimensions are to be sufficient to allow a person wearing a self-contained air-breathing apparatus and protective equipment to ascend or descend any ladder without obstruction and also to provide a clear opening to facilitate the hoisting of an injured person from the bottom of the space. The minimum clear opening is to be not less than 600 mm x 600 mm.

2.12.9 Where practicable, at least one horizontal access opening of 600 mm x 800 mm clear opening is to be fitted in each horizontal girder in all spaces and weather deck to assist in rescue operations.

2.12.10 For access through vertical openings, or manholes providing passage through the length and breadth of the space, the minimum clear opening is to be not less than 600 mm x 800 mm at a height of not more than 600 mm from the bottom shell plating, unless gratings or other footholds are provided.
2.12.11 In double hull construction where the wing ballast tanks have restricted access through the vertical transverse webs, permanent arrangements are to be provided within the space to permit access for inspection at all heights in each bay. These arrangements, which should comprise fixed platforms, or other means, are to provide sufficiently close access to carry out Close-Up Surveys, as defined in Pt 1, Ch 3, using limited portable equipment where appropriate. Details of these arrangements are to be submitted for approval.

2.12.12 On units with very large oil storage tanks, it is recommended that consideration be given to providing permanent facilities for staging the interior of tanks situated within the oil storage region and of large tanks elsewhere. Suitable provisions would be:
- Staging which can be carried on board and utilised in any tank, including power-operated lift or platform systems.
- Enlargement of structural members to form permanent, safe platforms, e.g., bulkhead longitudinals widened to form stringers (in association with manholes through primary members).
- Provision of inspection/rest platforms at intervals down the length of access ladders.
- Provision of manholes in upper deck for access to staging in cargo tanks.

2.13 Access hatchways to oil storage tanks
2.13.1 The general requirements of Pt 4, Ch 7.6 are to be complied with.

2.14 Loading of hot oil in storage tanks
2.14.1 Hot oil may be loaded in oil storage tanks at the temperatures given below, without the need for temperature distribution and thermal stress calculations, provided the following temperatures are not exceeded during operations:
(a) 65°C for sea temperatures of 0°C and below;
(b) 75°C for sea temperatures of 5°C and above; and
(c) by linear interpolation between (a) and (b) above, for sea temperatures between 0°C and 5°C.

2.14.2 Where the stored oil is to be loaded or heated to higher temperatures than those specified in 2.14.1 before unloading, temperature distribution investigations and thermal stress calculations may be required. For surface type units, see Pt 4, Ch 9.12 of the Rules for Ships.

2.15 Compartment minimum thickness
2.15.1 On semi-submersible units, within the oil storage tank region in oil storage units including wing ballast tanks and cofferdams at the ends of or between oil storage tanks, the thickness of primary member webs and face plates, hull envelope and bulkhead plating is to be not less than 7.5mm.

2.15.2 Pump-rooms and other adjacent compartments are also to comply with 2.15.1.

2.15.3 The minimum compartment thickness in deep draught caisson units and buoys will be specially considered but is not to be less than 7.5 mm.

2.15.4 The compartment minimum thickness in surface type units is to comply with Pt 4, Ch 9.10 of the Rules for Ships, but turret areas are to comply with 2.15.1.

Section 3
Hazardous areas and ventilation
3.1 General
3.1.1 For the application of hazardous area classification and related ventilation requirements, see Pt 7, Ch 2.

3.1.2 Adequate ventilation is to be provided for all areas and enclosed compartments associated with the oil storage production and process plant. The capacities of the ventilation systems are to comply, where applicable, with the requirements of Pt 7, Ch 2.6, or to an acceptable Code or Standard adapted to suit the marine environment and taking into account any additional requirements which may be necessary during start-up of the plant.

3.1.3 Ventilation in the vicinity of mud tanks is to be specially considered to ensure adequate dilution of any dangerous gases.

3.1.4 For units using oil-based mud, the tanks are to be provided with special ventilation arrangements, and for open systems, the maximum oil density in the air above the tanks is not to exceed 5 mg/m³. Ventilation of the enclosed spaces with open active mud tanks or pits is to be arranged for at least 30 air changes per hour for personnel comfort.

Section 4
Pollution prevention
4.1 General
4.1.1 Sumps and savealls are to be provided at potential spillage points, and drainage systems are to have adequate capacity and be designed for ease of cleaning.

4.1.2 Production manifolds are to be located and installed so that in the event of leakage in an enclosed area, a leakage detection and shut-down system will be activated. In open areas, arrangements are to be such that oil spillage will be contained, and that suitable drainage and recovery provisions are made.

4.1.3 Maintenance of production and process systems and equipment is to be governed by a permit-to-work system with rigid control on spillage prevention when opening up or testing is being carried out.
4.1.4 The arrangements for the onboard storage, and the disposal, of bilge and effluent from the production and process plant areas and spaces are to be submitted for consideration.

4.1.5 Oily water treatment systems are to have sufficient capacity for treatment of bilge and effluent water from the production and process plant areas and spaces.

4.1.6 When oil is added to the drilling mud, provision is to be made to limit the spread of oil on the unit, and to prevent the discharge of oil and oily residue into the sea by the provision of de-oilers and suitably alarmed oil monitoring devices.

4.1.7 Drilling bell nipples, flow lines, ditches, shale shakers, mud rooms and mud tanks and pumps are to be designed for maximum volume throughput without spillage. Equipment requiring maintenance is to have adequate spillage catchment arrangements.

4.1.8 Pollution prevention arrangements are to be such that the unit can comply with the requirements of the relevant National Administrations in the country of registration and in the areas of operation as applicable.
Section 1

General

1.1 Application

1.1.1 The requirements of this Chapter apply to accommodation and offshore support units as defined in Pt 1, Ch 2.2 whose primary function is to provide support services to offshore installations. Self-elevating accommodation units which are unmanned in transit conditions need not comply with Section 3.

1.1.2 The requirements in this Chapter are supplementary to those given in the relevant Parts of the Rules.

1.1.3 The requirements for fire-fighting units are given in Chapter 5.

1.1.4 Support vessels which have a diving complex on board are to have the diving installation approved in accordance with LR's Rules and Regulations for the Construction and Classification of Submersibles and Underwater Systems or an acceptable standard.

1.1.5 When accommodation units are to operate for prolonged periods adjacent to live offshore hydrocarbon exploration or production installations, it is the responsibility of the Owner/Operator to comply with the relevant regulations of the National Administrations in the country of registration and/or the area of operation, as applicable. Special consideration will be given to the safety requirements for classification purposes, see Pt 1, Ch 2.1.1.

1.2 Class notations

1.2.1 The Regulations for classification and the assignment of class notations are given in Pt 1, Ch 2, to which reference should be made.

1.2.2 Class notations for fire-fighting units are to be in accordance with Chapter 5.

1.2.3 In general, units complying with the requirements of this Chapter and the relevant Parts of the Rules will be eligible for the assignment of one of the following class type notations, as appropriate:

- Accommodation unit.
- Crane unit.
- Diving support unit.
- Support unit.
- Multi-purpose support unit.
- Pipe laying unit.

1.2.4 Units engaged in more than one function may be assigned a combination of class type notations at the discretion of the Committee.

1.2.5 Support units engaged in more than two functions may be assigned the type notation multi-purpose support unit.

1.2.6 Lifting appliances are to comply with LR’s Code for Lifting Appliances in a Marine Environment, see also Chapter 11.

1.2.7 When the type notation Crane unit is assigned to a unit, the main deck lifting appliances on the unit are considered to form an essential feature and therefore are to be included in the class.

1.2.8 Where the lifting appliances form an essential feature of a classed unit, the special feature class notation LA will be assigned, see Chapter 11.

1.2.9 Other special features class notations associated with lifting appliances may be assigned, see Chapter 11.

1.3 Scope

1.3.1 The following additional topics applicable to the class type notation are covered by this Chapter:

- Strength of structure for accommodation.
- Supports for accommodation modules.
- Structure in way of diving installations.
- Structure in way of cranes.
- Structure in way of pipe laying equipment.
- Bilge systems and cross-flooding arrangements on accommodation units.
- Electrical installations on accommodation units.

1.4 Installation layout and safety

1.4.1 Living quarters, lifeboats and other evacuation equipment are to be located in non-hazardous areas.

1.4.2 The requirements for fire safety are to be in accordance with the requirements of a National Administration, see Pt 1, Ch 2.1 and Pt 7, Ch 3.

1.4.3 Additional requirements for safety and communication systems are given in Part 7.
2.2.6 The connections of containerised modules are also to satisfy an emergency static condition with an applied horizontal force $F_H$ in any direction as follows:

$$F_H = W \sin \theta \text{ N (tonne-f)}$$

where

- $\theta = 25^\circ$ for semi-submersible units
- $\theta = 17^\circ$ for self-elevating units
- $W =$ weight of the modules supported in N (tonne-f).

2.2.7 In the emergency static condition defined in 2.2.6 the permissible stress levels are to be in accordance with Pt 4, Ch 5,2.1.1(c).

2.3 Watertight and weathertight integrity

2.3.1 The general requirements for watertight and weathertight integrity are to be in accordance with Pt 4, Ch 7.

### Section 3

#### Bilge systems and cross-flooding arrangements for accommodation units

3.1 Application

3.1.1 The requirements of this Section are only applicable to units with accommodation for more than 12 persons who are not crew members. For self-elevating units, see also 1.1.1.

3.2 Location of bilge main and pumps

3.2.1 The general requirements of Pt 5, Ch 12 and Ch 13 are to be complied with as applicable unless otherwise specified in this Section.

3.2.2 The bilge main is to be arranged so that no part is situated nearer to the side of the unit than the damage penetration zone.

3.2.3 Where any bilge pump or its pipe connection to the bilge main is situated outboard of the damage penetration zone, a non-return valve is to be fitted at the pipe connection junction with the bilge main.

3.2.4 The emergency bilge pump and its connections to the bilge main are to be situated inboard of the damage penetration zone.

3.2.5 At least three power bilge pumps are to be provided. Where practicable, these pumps are to be placed in separate watertight compartments which will not be readily flooded by the same damage. In units where engines and auxiliary machinery are located in two or more watertight compartments, the bilge pumps are to be distributed throughout these compartments.
3.2.6 The bilge pumping units are to be such that at least one power pump will be available in all circumstances in which the unit may be flooded after damage. This requirement will be satisfied if:
(a) one of the pumps is an emergency pump of the submersible type having a source of power situated above the bulkhead deck or maximum anticipated damage load line; or
(b) the pumps and their power sources are located throughout the length of the unit so that, under any conditions of flooding that the unit is required to withstand by Statutory Regulation, at least one pump in an unaffected compartment will be available.

3.3 Arrangement and control of bilge system valves

3.3.1 The valves and distribution boxes associated with the bilge pumping system are to be arranged to enable any one of the bilge pumps to pump out any compartment in the event of flooding. All the necessary valves for controlling the bilge suction are to be capable of being operated from above the bulkhead deck or maximum anticipated damage load line. The controls for these valves are to be clearly marked and a means provided at their place of operation to indicate clearly whether they are open or closed.

3.3.2 Where, in addition to the main bilge pumping system, an emergency bilge pumping system is provided, it is to be independent of the main system and so arranged that a pump is capable of pumping out any compartment under flooding conditions. In this case, only the valves necessary for the operation of this emergency system need to be operable from above the bulkhead deck or maximum anticipated damage load line.

3.4 Prevention of communication between compartments in the event of damage

3.4.1 Provision is to be made to prevent any compartment served by a bilge suction pipe being flooded in the event of the pipe being damaged by collision or grounding in any other compartment. For this purpose, where any part of the pipe is situated outboard of the damage penetration zone, or in a duct keel, a non-return valve is to be fitted to the pipe in the compartment containing the open end.

3.5 Cross-flooding arrangements

3.5.1 Cross-flooding arrangements are not permitted as a means of attaining the damage stability criteria in accordance with Pt 4, Ch 7.

3.5.2 Cross-flooding arrangements may be used under control to restore a situation after damage. Such arrangements are not to be automatic or self-acting. Controls are to be situated above the worst anticipated damage waterline.

Section 4

Additional requirements for the electrical installation

4.1 General

4.1.1 In general, electrical installations are to comply with the requirements of Pt 6, Ch 2.

4.1.2 The requirements of this Section are applicable to units with accommodation for more than 50 persons, who are not crew members.

4.2 Emergency source of electrical power

4.2.1 A self-contained emergency source of electrical power is to be provided.

4.2.2 The emergency source of electrical power, associated transforming equipment, if any, transitional source of emergency power, emergency switchboard and emergency lighting switchboard are to be located above the uppermost continuous deck and be readily accessible from the open deck. They are not to be located forward of the collision bulkhead, where fitted on surface type units.

4.2.3 The location of the emergency source of electrical power and associated transforming equipment, if any, the transitional source of emergency power, the emergency switchboard and the emergency lighting switchboard in relation to the main source of electrical power, associated transforming equipment, if any, and the main switchboard is to be such as to ensure that a fire or other casualty in spaces containing the main source of electrical power, associated transforming equipment, if any, and the main switchboard is not to interfere with the supply, control and distribution of emergency electrical power. The space containing the emergency source of electrical power, associated transforming equipment, if any, the transitional source of emergency electrical power and the emergency switchboard is not to be contiguous to the boundaries of machinery spaces of Category A (see Pt 7, Ch 3) will not interfere with the supply, control and distribution of emergency electrical power. The space containing the emergency source of electrical power, associated transforming equipment, if any, and the main switchboard or in any machinery space of Category A (see Pt 7, Ch 3) will not interfere with the supply, control and distribution of emergency electrical power. The space containing the emergency source of electrical power, associated transforming equipment, if any, the transitional source of emergency electrical power and the emergency switchboard is not to be contiguous to the boundaries of machinery spaces of Category A, see Pt 7, Ch 3, and those spaces containing the main source of electrical power, associated transforming equipment, if any, or the main switchboard. Where this is not practicable, details of the proposed arrangements are to be submitted.

4.2.4 Provided that suitable measures are taken for safeguarding independent emergency operation under all circumstances, the emergency generator may be used exceptionally, and for short periods, to supply non-emergency circuits.
4.2.5 The 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 as may have to be operated simultaneously. The emergency source of electrical power is to be capable, having regard to starting currents and the transitory nature of certain loads, of supplying simultaneously at least the following services for the periods specified hereinafter, if they depend upon an electrical source for their operation:

(a) For a period of 36 hours, emergency lighting:
   (i) in all service and accommodation alleyways, stairways and exits, personnel lift cars;
   (ii) in alleyways, stairways and exits, giving access to the muster and embarkation stations;
   (iii) in the machinery spaces and main generating stations including their control positions;
   (iv) in all control stations, machinery control rooms, and at each main and emergency switchboard;
   (v) at all stowage positions for fireman’s outfits;
   (vi) at the steering gear;
   (vii) at the fire pump, the sprinkler pump and the emergency bilge pump and at the starting position of their motors;
   (viii) at every survival craft, muster and embarkation station;
   (ix) on column-stabilised units; ballast valve control system and the largest single ballast pump;
   (x) on helicopter decks.

(b) For a period of 36 hours:
   (i) the navigation lights, other lights and sound signals required by the International Regulations for the prevention of Collisions at Sea, in force;
   (ii) the radio communications as required by Amendments to SOLAS 1974 chapter IV as applicable;
   (iii) the navigational aids as required by Amendments to SOLAS 1974 Regulation V/19 as applicable;
   (iv) general alarm and communication systems as required in an emergency;
   (v) intermittent operation of the daylight signalling lamp and the unit’s whistle;
   (vi) the fire and gas detection systems and their alarms;
   (vii) emergency fire pump; the automatic sprinkler system and the characteristics of the prime mover;
   (viii) the fire and gas detection systems and their alarms;
   (ix) provided with a transitional source of emergency electrical power according to 4.2.7.

(c) For a period of 24 hours:
   (i) permanently installed diving equipment necessary for the safe conduct of diving operations, if dependent upon the unit’s electrical power;
   (ii) the capability of closing the blow out preventer and of disconnecting the unit from the wellhead arrangements, if electrically controlled, unless it has an independent supply from an accumulator battery suitably located for use in an emergency and sufficient for the period of 24 hours.

(d) The steering gear for the period of time required by Pt 5, Ch 19.6.

(e) For a period of four days, any signalling lights or sound signals which may be required for marking offshore structures.

(f) For a period of half an hour:
   (i) any watertight doors if electrically operated together with their control, indication and alarm circuits;
   (ii) the emergency arrangements to bring the lift cars to deck level for the escape of persons. The lift cars may be brought to deck level sequentially in an emergency.

4.2.6 The emergency source of electrical power may be either a generator or an accumulator battery, which are to comply with the following:

(a) Where the emergency source of electrical power is a generator, it is to be:
   (i) driven by a suitable prime mover with an independent supply of fuel having a flashpoint (closed-cup test) of not less than 43°C;
   (ii) started automatically upon failure of the electrical supply from the main source of electrical power and is to be automatically connected to the emergency switchboard; those services referred to in 4.2.5 are then to be transferred automatically to the emergency generating set. The automatic starting system and the characteristics of the prime mover are to be such as to permit the emergency generator to carry its full rated load as quickly as is safe and practicable, subject to a maximum of 45 seconds; and
   (iii) provided with a transitional source of emergency electrical power according to 4.2.7.

(b) Where the emergency source of electrical power is an accumulator battery, it is to be capable of:
   (i) carrying the emergency electrical power without recharging while maintaining the voltage of the battery throughout the discharge period within 12 per cent above or below its nominal voltage;
   (ii) automatically connecting to the emergency switchboard in the event of failure of the main source of electrical power; and
   (iii) immediately supplying at least those services specified in 4.2.7.

4.2.7 The transitional source of emergency electrical power required by 4.2.6 is to consist of an accumulator battery suitably located for use in an emergency, which is to operate without recharging while maintaining the voltage of the battery throughout the discharge period within 12 per cent above or below its nominal voltage and be of sufficient capacity and so arranged as to supply automatically in the event of failure of either the main or emergency source of electrical power at least the following services, if they depend upon an electrical source for their operation:

(a) For half an hour:
   (i) the lighting required by 4.2.5(a) and 4.2.5(b)(i);
   (ii) all services required by 4.2.5(b)(ii), (iv) and (v) unless such services have an independent supply for the period specified from an accumulator battery suitably located for use in an emergency.
(b) Power to operate the watertight doors at least three times, (i.e. closed-open-closed), against an adverse list of 15°, but not necessarily all of them simultaneously, together with their control, indication and alarm circuits as required by 4.2.5(f)(i).

4.2.8 The emergency switchboard is to be installed as near as is practicable to the emergency source of electrical power.

4.2.9 Where the emergency source of electrical power is a generator, the emergency switchboard is to be located in the same space unless the operation of the emergency switchboard would thereby be impaired.

4.2.10 No accumulator battery except for engine starting, fitted in accordance with this Section, is to be installed in the same space as the emergency switchboard. An indicator is to be mounted in a suitable place on the main switchboard or in the machinery control room to indicate when the batteries constituting either the emergency source of electrical power or the transitional source of emergency electrical power are being discharged.

4.2.11 The emergency switchboard is to be supplied during normal operation from the main switchboard by an interconnector feeder which is to be adequately protected at the main switchboard against overload and short-circuit and which is to be disconnected automatically at the emergency switchboard upon failure of the main source of electrical power. Where the system is arranged for feedback operation, the interconnector feeder is also to be protected at the emergency switchboard at least against short-circuit.

4.2.12 In order to ensure ready availability of the emergency source of electrical power, arrangements are to be made where necessary to disconnect automatically non-emergency circuits from the emergency switchboard to ensure that power will be available to the emergency circuits.

4.2.13 Provision is to be made for the periodic testing of the complete emergency system and is to include the testing of automatic starting arrangements.
Section 1

1.1 Application

1.1.1 The requirements of this Chapter apply to units intended for fire-fighting operations and are additional to those applicable in other Parts of the Rules.

1.1.2 A unit provided with fire protection and fire-fighting equipment in accordance with these Rules will be eligible for an appropriate class notation.

1.1.3 Requirements additional to these Rules may be imposed by the National Authority with whom the unit is registered and/or by the Administration within whose territorial jurisdiction the fire-fighting unit is intended to operate.

1.2 Class notations

1.2.1 The Regulations for classification and the assignment of class notations are given in Pt 1, Ch 2, to which reference should be made.

1.2.2 Units complying with the requirements of this Chapter and the relevant Parts of the Rules will be eligible for the assignment of one of the following class notations as applicable:

- **Fire-fighting unit 1** (total monitor discharge capacity in brackets).
- **Fire-fighting unit 2** (total monitor discharge capacity in brackets).
- **Fire-fighting unit 3** (total monitor discharge capacity in brackets).

1.2.3 The notation **Fire-fighting unit 1** or **Fire-fighting unit 2** or **Fire-fighting unit 3** signifies that a unit complies with these Rules and is provided with the appropriate fire-fighting equipment described in Table 5.1.1, with the total discharge capacity of monitors in m³/h shown in brackets.

1.2.4 The addition of the words *with water spray* to the notations referred to in 1.2.3 signifies that a unit is provided with a water spray system which will provide an effective cooling spray of water over the vertical surfaces of the unit to enable it to approach a burning installation for fire-fighting purposes. The requirements for such a system are set out in Section 4.

1.2.5 Support units may be assigned additional class type notations when appropriate, see Ch 4.1.2.

1.3 Surveys

1.3.1 The requirements for surveys are given in Pt 7, Ch 3.1.3 of the Rules for Ships, which are to be complied with where applicable.

1.4 Plans and data submission

1.4.1 The requirements for submission of plans are given in Pt 7, Ch 3.1.4 of the Rules for Ships, which are to be complied with where applicable.

1.5 Definitions

1.5.1 The requirements for definitions are given in Pt 7, Ch 3.1.5 of the Rules for Ships, which are to be complied with where applicable.

### Table 5.1.1 Fire-fighting equipment

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Fire-fighting unit 1</th>
<th>Fire-fighting unit 2</th>
<th>Fire-fighting unit 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum total pump capacity, m³/h</td>
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<td>7200</td>
<td>10 000</td>
</tr>
<tr>
<td>Minimum number of water monitors</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Minimum discharge rate per monitor, m³/h</td>
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<td>1800</td>
<td>1800</td>
</tr>
<tr>
<td>Minimum height of trajectory of jets of monitors above sea level, metres</td>
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<td>70</td>
<td>70</td>
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<tr>
<td>Minimum range of monitor jets, metres</td>
<td>120</td>
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<td>150</td>
</tr>
<tr>
<td>Minimum fuel capacity for monitors, hours</td>
<td>24</td>
<td>96</td>
<td>96</td>
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<tr>
<td>Number of hose connections each side of unit</td>
<td>4</td>
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</tr>
<tr>
<td>Number of fireman’s outfits</td>
<td>4</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>
Section 2
Construction

2.1 General

The requirements for construction are given in Pt 7, Ch 3.2 of the Rules for Ships, which are to be complied with where applicable.

Section 3
Fire-extinguishing

3.1 General

The requirements for fire-extinguishing are given in Pt 7, Ch 3.3 of the Rules for Ships, which are to be complied with where applicable.

Section 4
Fire protection

4.1 General

The requirements for fire protection are given in Pt 7, Ch 3.4 of the Rules for Ships, which are to be complied with where applicable.

Section 5
Lighting

5.1 General

The requirements for lighting are given in Pt 7, Ch 3.5 of the Rules for Ships, which are to be complied with where applicable.
Section 1
Strengthening standard for navigation in first-year ice conditions – Application of requirements

1.1 General

1.1.1 Where additional strengthening is fitted in accordance with the requirements given in Section 2, an appropriate special features notation will be assigned. It is the responsibility of the Owner to determine which notation is most suitable for his requirements.

1.1.2 The requirements for strengthening for navigation in ice as given in Section 2 are intended for units operating in first-year ice irrespective of whether assistance from ice breakers is anticipated. They are not intended for units designed to operate in multi-year ice conditions.

1.1.3 For semi-submersible units with twin lower hulls the ice strengthening, as required by this Chapter, is to be carried out to both hulls. Where the exposed deck of the lower hulls is situated below the upper limit of the ice belt, the strengthening of the deck will be subject to special consideration and the deck thickness is not to be less than the shell plating in the main ice belt.

1.1.4 General requirements for units intended for operation in ice are given in Pt 8, Ch 1 of the Rules for Ships.

1.1.5 The machinery requirements for navigating in first year ice conditions are given in Pt 8, Ch 2,7 and 9 of the Rules for Ships.

Section 2
Strengthening requirements for navigation in first-year ice conditions

2.1 General

2.1.1 The strengthening requirements for navigation in first-year ice conditions are given in Pt 8, Ch 2,6 and 8 of the Rules for Ships, which are to be complied with where applicable.

Section 3
Operation in ice at a fixed location

3.1 General requirements

3.1.1 When a unit is required to operate at a fixed location in ice conditions the designer/Builder is required to submit a rational analysis for determining the maximum operating ice pressures on the structure based on acceptable environmental data.

3.1.2 The minimum design temperature of the structure and steel grades will be specially considered, see also Pt 4, Ch 2.

3.1.3 The extent of additional strengthening will be specially considered by LR and an additional structural analysis of the primary structure may be required.

3.1.4 When a unit operates in areas where there is the possibility of collision with icebergs, appropriate data is to be submitted and the structure suitably strengthened for the collision loads.

3.1.5 When units are fitted with riser systems the arrangements are to be designed to minimise the effect of ice loadings on the risers.

3.1.6 Suitable steam generating equipment, or an equivalent means, are to be provided with outlets and hoses, to keep designated areas free of ice and snow such that operation/maintenance operations may be conducted safely. Such equipment is to be capable of being used in at least the following locations:

- The working areas.
- The helicopter deck.
- Walkways and escape routes.
- Lifeboat embarkation station.

3.1.7 Special requirements will apply to sea inlet chests for machinery cooling and fire pump suction and reference should be made to the relevant text of Pt 8, Ch 2 of the Rules for Ships. The design and arrangement of sea inlet chests will be specially considered, as applicable to the type of unit.
3.1.8 In the case of self-elevating units where the design of the elevating machinery is required to operate in ice conditions, suitable de-icing equipment is to be provided.

3.1.9 The starting requirements of the emergency generators for low temperature operation is to be in accordance with Pt 5, Ch 2.9.4 of the Rules for Ships.

3.1.10 Electrical equipment and cables likely to be exposed to sustained low temperatures are to be suitably constructed for the ambient conditions in accordance with a recognised National or International Standard.

3.1.11 When a unit has been reinforced and approved by LR for operating in ice a suitable descriptive note will be included in the ClassDirect Live website.

3.2 Plans and data submission

3.2.1 Plans, calculations and data are to be submitted as required by the relevant Parts of the Rules together with the additional information required by this Section.
1.1.6 The limiting design criteria on which approval is based are to be stated in the unit’s Operations Manual.

1.2 Class notations

1.2.1 The Regulations for classification and the assignment of class notations are given in Pt 1, Ch 2, to which reference is to be made.

1.2.2 Units fitted with an installed drilling plant facility which complies with the requirements of this Chapter, or recognised Codes and Standards agreed with LR, will be eligible for the assignment of the special features class notation DRILL.

1.2.3 When a unit is to be verified in accordance with the Regulations of a Coastal State Authority, an additional descriptive note may be assigned in accordance with Pt 1, Ch 2.

1.2.4 The latest issue of the following referenced standards is to be used unless otherwise agreed beforehand. Other recognised Standards may be used provided it can be shown that they meet or exceed the requirements of the referenced standards in Appendix A. When other codes or standards are proposed, gap analysis and risk assessments are to be provided by the dutyholder to demonstrate an equivalent level of safety to the recognised Standards in this notation.

1.3 Scope

1.3.1 Goal:
(a) The drilling plant is to be designed, constructed, installed and maintained satisfactorily for the intended service conditions in order to minimise the risk to the unit, personnel on board and to the environment. The drilling plant is to be operated and maintained by competent personnel.
(b) All drilling plants, regardless of design, are to comply with this goal. The prescriptive requirements in this Section are considered to provide a route to meeting this goal. Alternative arrangements which are considered by LR also to meet this goal will be accepted.
(c) Apart from other hazards noted elsewhere in these Rules, examples of some hazards specifically related to drilling operations are as follows:
  • Blow out.
  • Hydrogen sulphide and other toxic gases.
  • Uncontrolled release of hydrocarbon gases.
  • Loss of position.
  • Fire or explosion.
  • Loss of positive pressurisation in hazardous spaces or equipment.
  • Ventilation in hazardous areas.
  • Dropped objects.
  • Failure of Zone management systems.
  • Punch through (bottom supported units).
  • Shallow gas (stability and fire risks).
  • Radioactivity.
  • Environmental spills.
Risk assessments are to be made by the dutyholder with regard to mitigating or limiting the effects of these and any other similar related hazards.

1.3.2 Any part, component or structure of the drilling system that is required to allow the rig to conduct drilling or well testing operations. This includes any outlet from hydrocarbon flares and vent systems, and includes the sub-sea blow out preventer stack, risers, conductors and any other subsea component that is required to allow drilling operations from the unit to be conducted but does not include subsea production equipment.

1.4 Plant design characteristics

1.4.1 The design and arrangement of the drilling plant, derricks and flare structures, etc., are to comply with the requirements of this Chapter and/or recognised Codes and Standards, see 1.5.

1.4.2 Attention is to be given to the relevant Statutory Regulations of the National Administrations in the country of registration and the area of operation, as applicable.

1.4.3 The plant and supporting structures above the deck are to be designed for all operating and transit conditions in accordance with recognised and agreed Codes and Standards, suitably modified to take into account the unit’s motions and marine environmental aspects. Except for the emergency condition, as detailed in 1.4.4, the total stress in any component of the plant is not to exceed the Code value at the temperature concerned, unless expressly agreed otherwise by LR, whether the plant is operative or non-operative, when subjected to any of the following loads, as applicable:

- Static and dynamic loads due to wave-induced motions of the unit.
- Loads resulting from hull flexural effects at the plant support points, as appropriate.
- Direct wind loads.
- Normal gravity and functional loads.
- Thermal loads, as appropriate.
- Ice and snow loads, as appropriate.

1.4.4 In general, the plant and supporting structures above the deck are to be designed for an emergency static condition with the unit inclined to the following angle:

- Column-stabilised units: 25° in any direction.
- Surface type units: 22.5° heel, port and starboard, and trimmed to an angle of 10° beyond the maximum normal operating trim.
- Self-lifting units: 17° in any direction in transit conditions only.

These angles may be modified by LR in particular cases as considered necessary. In no case is the inclined angle for the emergency static condition to be taken less than the maximum calculated angle in the worst damage condition in accordance with the appropriate damage stability criteria.

1.4.5 In the emergency condition defined in 1.4.4, the plant is to be assumed to have maximum operating weights, temperatures and pressures, unless agreed otherwise with LR. When applicable, the plant is also to be subjected to ice and snow loads. Wind loads need not be considered to be acting during this emergency condition. The total stress in any component of the plant or support structure above the deck is not to exceed the minimum yield stress of the material.

1.4.6 The permissible stresses in the primary hull structure below plant and equipment supports in transit, operating and emergency conditions are to be in accordance with Pt 4, Ch 5.

1.4.7 The design of the plant is to allow for adequate space and services for completion and intervention equipment, such as, but not limited to, wire line, logging, coiled tubing, snubbing, well completion, work over and well testing. The location is also to take into consideration the requirement for hazardous area classification of equipment and services. Communication and safety systems are also required to be considered in the design.

1.5 Recognised Codes and Standards

1.5.1 Installed drilling plant facilities designed and constructed to standards other than the Rule requirements will be considered for classification, subject to the alternative standards being agreed by LR to give an equivalent level of safety to the Rule requirements. It is essential that in such cases LR is informed of the Owner’s proposals at an early stage, in order that a basis for acceptance of the standards may be agreed. Refer to Appendix A for applicable international Codes and Standards considered by LR as an equivalent level of safety to Rule requirements.

1.5.2 In general, the requirements in this Chapter are based on internationally recognised Codes and Standards for the drilling plant structures and drilling related systems and equipment as defined in Appendix A. Other Codes and national Standards may be used after special consideration and prior agreement with LR. When considered necessary, additional Rule requirements are also stated in this Chapter.

1.5.3 Where necessary, the Codes and Standards are to be suitably modified and/or adapted to take into account all marine environmental aspects.

1.5.4 The agreed Codes and Standards may be used for design, construction and installation but where considered applicable by LR, compliance with the additional requirements stated in the Rules is required. Where there is any conflict, the Rules will take precedence over the Codes or Standards.

1.5.5 The mixing of Codes or Standards for each equipment item or system is to be avoided. Deviation from the Code or Standard must be specially noted in the documentation and approved by LR.
1.6 Equipment categories

1.6.1 The approval and certification of drilling equipment is to be based on equipment categories agreed with LR.

1.6.2 Drilling equipment, including its associated pipes and valves, is to be divided into equipment categories 1A, 1B and II, depending on the complexity of manufacture and its importance with regard to the safety of personnel and the installation and the possible effect on the environment.

1.6.3 The following equipment categories are used in the Rules:

1A Equipment of primary importance to safety for which design verification and survey during fabrication are considered essential. Equipment in this category is of complicated design/manufacture and is not normally mass produced.

1B Equipment of primary importance to safety for which design verification and witnessing the product quality are considered essential. Equipment in this category is normally mass produced and not included in category 1A.

II Equipment related to safety which is normally manufactured to recognised Codes and Standards and has proven reliability in service, but excludes equipment in category 1A and 1B.

1.6.4 A guide to equipment and categories is given in Appendix A. A full list of equipment categories for each drilling plant facility is to be agreed with LR before manufacture. Minor equipment components need not be categorised.

1.7 Equipment certification

1.7.1 Drilling equipment is to be certified in accordance with the following requirements:

(a) Category 1A
   - Design verification and issue of certificate of design strength approval.
   - Pre-inspection meeting at the suppliers with agreement and marking of quality plan and inspection schedule.
   - Survey during fabrication and review of fabrication documentation.
   - Final inspection with monitoring of function/pressure/load tests and issue of certificate of conformity.

(b) Category 1B
   - Design verification and issue of certificate of design strength approval, where applicable, and review of fabrication documentation.
   - Final inspection with monitoring of function/pressure/load tests and issue of certificate of conformity.

(c) Category II
   - Supplier’s/manufacturer’s works’ certificate giving equipment data, limitations with regard to the use of the equipment and the supplier’s/manufacturer’s declaration that the equipment is designed and fabricated in accordance with recognised Standards or Codes.

1.7.2 All equipment recognised as being of importance for the safety of personnel and the drilling plant installation is to be documented by a data book.

1.8 Fabrication records

1.8.1 Fabrication records are to be made available for Categories 1A and 1B equipment for inspection and acceptance by LR Surveyors. These records are to include the following:

   - Manufacturer’s statement of compliance.
   - Reference to design specification and plans.
   - Traceability of materials.
   - Welding procedure tests and welders’ qualifications.
   - Heat treatment records.
   - Records/details of non-destructive examination.
   - Load, pressure and functional test reports.

1.9 Installation of drilling plant equipment

1.9.1 The installation of drilling equipment on board the unit is to be controlled by LR in accordance with the following principles:

   - All Category 1A and 1B equipment delivered to the unit is to be accompanied by a certificate of design strength approval and an equipment certificate of conformity and all other necessary documentation.
   - All Category II equipment delivered to the unit is to be accompanied by equipment data and a works’ certificate.
   - Control and follow-up of non-conformities/deviations specified in design certificates and certificate of conformity.
   - Ongoing survey and final inspection of the installed production and process plant.
   - Monitoring of functional tests after installation on board in accordance with an approved test programme.
   - Issue of a plant installation report.

1.9.2 A test procedure, including acceptance criteria and functional description prior to the factory acceptance test of equipment, system or sub-system, is to be provided.

   Mechanical completion to the satisfaction of LR is to be completed prior to starting or testing of any drilling equipment or system. The commissioning procedures are to contain all necessary information required to ensure safe start-up and shut-down of each equipment or system. All equipment and system operating and maintenance manuals are to be made available to LR before final commissioning.

   The drilling package will undergo a final drilling trial before delivery, in accordance with Section 11. All drilling equipment and related systems will be required to operate simultaneously with simulated drilling loads and operate as close to the normal drilling operations design as possible. All drilling instrumentation and sensors will also be included in the trial. A guidance note on how to conduct final trials will be made available for the Owner.
1.10 Maintenance and repair

1.10.1 It is the responsibility of the Owners/Operators to ensure that installed drilling plant is maintained in a safe and efficient working condition in accordance with the manufacturer's specifications.

1.10.2 When it is necessary to repair or replace installed drilling plant, any repaired or spare part is to be subject to the equivalent certification as the original part.

1.10.3 The design and layout of the drilling systems are to provide safe working arrangements for operation and maintenance. Use of man-riding winches or baskets for routine maintenance should be discouraged.

1.10.4 Sufficient tools and test equipment to ensure safe and continued operation of the drilling plant are to be provided. Suitable tools and equipment for working at height and for use in hazardous areas are also be provided.

1.11 Plans and data submissions

1.11.1 Plans, calculations and data are to be submitted as required by the relevant Parts of the Rules, together with the additional plans and information listed in this Chapter. Plans are to be submitted in triplicate, but only a single copy of supporting documents and calculations is required.

2.3 Supporting structure interfaces

2.3.1 The design loadings for all structures supporting plant, including equipment skids, support stools, tanks and storage vessels, are to be defined by the designers/Builders and calculations are to be submitted in accordance with an appropriate Code or Standard, see Appendix A.

2.3.2 The design of supporting structures for drilling facilities is to integrate with the primary hull under-deck structure.

2.3.3 The permissible stresses in the hull structure below the drilling plant are to be in accordance with Pt 4, Ch 5 and the local strength is to comply with Pt 4, Ch 6.

2.3.4 The BOP frame, lifting points or supports are to meet the requirements of API RP 2A-WSD.

2.4 Derrick and masts

2.4.1 The structural design of drilling derricks is to be in accordance with a recognised Code of Practice, such as API Spec 4F or acceptable equivalent, see Appendix A. The design conditions defined in 1.4 are to be complied with.

2.4.2 When the unit is to operate in an area which could result in the build-up of ice on the drilling derrick, the effects of ice loading are to be included in the calculations, see Pt 4, Ch 3. The design criterion for this condition may be taken as a non-drilling condition with defined setback loading. The environmental criteria are to be agreed with LR, but in general may be based on five-year return criteria for the operating location.

2.4.3 The structural design of the drilling derrick may be required by LR to include the effect of fatigue loading, see Pt 4, Ch 5.

2.4.4 Fatigue damage calculations for individual components when required are to take account of the degree of redundancy and also the consequence of failure.

2.4.5 Where National Administrations give specific requirements with respect to fatigue design, it is the responsibility of the Owners to comply with such Regulations.
(a) The design of the derrick or mast and associated ancillary equipment is to incorporate features to reduce the risk to personnel during routine maintenance or operations.

(b) The design is to allow for suitable and safe access from deck or installed work platforms for operation, maintenance and inspection services. All items in the derrick are to be accessible for routine inspection, without the need for man-riding winches.

(c) Where direct access to lubrication points such as crown or deflector sheaves cannot be provided, the use of remote grease lines can be incorporated.

(d) The design is to also allow for extra hang off points for temporary equipment such as wire line units.

(e) Portable equipment such as catwalk samson posts are also to be fitted with padeyes to allow safe removal and re-location.

(f) All padeyes are to be designed, installed and tested to LR requirements, and all padeyes are to be identified and a record book kept, allowing for inspection records to be maintained.

(g) Consideration is to be given to providing access and means to fight a major fire at the monkey board level. The means to fight a fire at this level are to include portable and fixed fire-fighting systems.

(h) Modification to any part of the derrick or mast from original design will require OEM and LR design approval, followed by trials if necessary.

(i) Temporary installed structures, members or fittings are to undergo an assessment by the dutyholder to confirm they will not affect the original design; if the design is affected, details are to be submitted for approval.

(k) Casing stabbing boards are to comply with the following requirements:

- The hoisting system is to be designed and constructed to Codes and Standards approved by LR.
- Permanent safe access to the stabbing board for operators and maintenance personnel is to be provided.
- Any rack and pinion system is to be designed so that the working platform will not fall if the rack or pinion should fail, and a single or common mode failure cannot occur.
- Where winch systems are used, the rope is to spool evenly on the drum and there are to be at least three full turns of rope remaining on the drum at all times.
- The rope is to remain captive with the drum and sheave systems under all service conditions, including slack rope conditions.
- Upper and lower-level limit switches are to ensure that the hoist system does not operate beyond its specified range.
- Casing stabbing boards are to be clearly marked ‘SUITABLE FOR CARRYING PEOPLE’ and with the number of people they can carry.
- Casing stabbing boards and other working platforms that are raised and lowered by a powered or manually operated system are to provide users with a secure and safe means of travel and support at the point of work.

- The working platform is to be positively guided by rails or runners. The guidance system is to ensure that the platform remains captive to its rails or runners under all circumstances, including any wheel or roller failure or failure of the primary hoisting system.
- Rails/runners are to be securely attached to their supports and are to not open up under static operations, travelling or other dynamic operations, overload testing or operation of the secondary control/braking system.
- The working platform is to have non-slip standing surfaces, handrails, mid-rails and edge protection.
- The platform is to also have anchorage points for inertia-type safety harnesses.
- Control of the primary lifting system is to provide smooth movement of the working platform. The control lever is to spring to neutral on release, effectively braking the primary hoisting system.
- Where a manual system of raising or lowering the platform is used, a positive locking system such as a ratchet-and-pawl mechanism is to be provided in addition to the service brake.
- A secondary, inertia-type brake, acting at the rails, is to be provided in case there is any failure in the primary hoisting system. The secondary brake is to act independently of the primary brake and not require any power source (hydraulic, electrical or pneumatic) for its operation.
- Each braking system is to be capable of holding the full rated capacity of the loaded stabbing board plus allowances for dynamic effects. It is not to be possible to lower the working platform by brake operation only. Two locking devices are to be provided, such that one locking device operates when the lifting handle is at neutral and the other one operates if the hoist mechanism fails. Each device is to be independent.
- A speed controlling device is to prevent the raising and lowering speed of the platform exceeding tripping speed.
- Adequate safety gear of the progressive type is to be provided, designed to engage within freefall conditions.
- The platform is to be equipped with a latch lock mechanism which secures it when not in motion.

2.5 Water towers

2.5.1 Water towers on self-elevating units are to be designed in accordance with a recognised Code or Standard, modified to take into account the unit's motions and marine environmental aspects, see Appendix A. Provisions for effective securing of towers when the unit is in transit is also to be similarly designed. The design conditions defined in 1.4 are to be complied with.

2.5.2 The structural design of the tower is to include the effect of fatigue loading, see Pt 4, Ch 5.

2.5.3 Where National Administrations give specific requirements with respect to fatigue design, it is the responsibility of the Owners to comply with such Regulations.
2.5.4 For slender structures and components, the effects of wind induced cross-flow vortex vibrations are to be assessed.

2.5.5 Wind loads are to be calculated in accordance with LR’s Code for Lifting Appliances in a Marine Environment (hereinafter referred to as LAME Code), or a recognised Code or Standard, see Appendix A.

2.5.6 The permissible stresses in the hull structure below the tower are to be in accordance with Pt 4, Ch 5.

2.6 Flares structures

2.6.1 Flares structures are to be designed in accordance with the requirements of a recognised Code or Standard, see Appendix A. The design conditions defined in 1.4 are to be complied with.

2.6.2 The flare structures are also to be designed for the imposed loads due to handling the structure and when in the stowed position.

2.6.3 The designers/Builders are to specify the maximum weight of the burner and spreader and the design criteria defined in 1.4.

2.6.4 The structural design of flare structures is to include the effect of fatigue loading and the thermal loads during flaring, see Pt 4, Ch 5.

2.6.5 Where National Administrations give specific requirements with respect to fatigue design, it is the responsibility of the Owners to comply with such Regulations.

2.6.6 For slender structures and components, the effects of wind induced cross-flow vortex vibrations are to be assessed.

2.6.7 Wind loads are to be calculated in accordance with LR’s LAME Code or a recognised Code or Standard, see Appendix A.

2.6.8 Permissible stresses in the hull structure below the flare structure supports are to be in accordance with Pt 4, Ch 5.

2.7 Lifting appliances

2.7.1 Lifting appliances shall, as a minimum, meet the requirements of the following Standards and are to comply with LR’s LAME Code, and where applicable, PUWER Reg 4 and LOLER Reg 5. See also Chapter 11.

API Spec 2C Specification for offshore pedestal mounted cranes.

API RP 2D Operation and maintenance of offshore cranes.

ASME B30.20 Below-the-hook lifting devices.

BOP handling systems will meet the minimum requirements of API Spec 7K.

Hoisting appliances are to be located such as to ensure safe operation, and must be suitably protected if for location in a hazardous area. Protection is to limit surface temperature to a maximum of 80 per cent of auto-ignition temperature. This temperature, if unknown, may be taken to be a maximum of 200°C.

Submitted design data for hoisting appliances is to include all load and hoisting/lowering speed combinations at the rope drum.

Man-riding winches are to be of an approved type and certified for offshore use, and they are to comply with the following requirements:

(a) Two fail safe brakes are to be provided, one automatic and the other manual.

(b) Hydraulic winches may be provided with a regenerative brake system with breaking valve, in place of a secondary manual brake.

(c) The operating lever is to be returned to neutral upon release in any position.

(d) Declutching devices are not to be fitted, unless otherwise agreed by LR, see (e).

(e) ‘Sprag’ type unidirectional bearings (freewheels) are acceptable subject to regular satisfactory in-service inspection.

(f) Lowering under normal operating conditions is to be through control of the motor.

(g) Means for prevention of overriding and underriding of the winch is to be provided, where reasonably practicable.

(h) Manufacturer’s label indicating operational parameters and approval for man-riding.

(i) A sign affixed to the winch, clearly indicating suitability for man-riding (for example, ‘SUITABLE FOR MAN-RIDING’).

(j) The winch operating lever must automatically return to neutral when released.

(k) An automatic brake that will engage upon returning the operating lever to neutral.

(l) A manual brake.

(m) A guide for spooling the wire rope onto the drum (manual or automatic).

(n) The ability to lower the rider in a controlled manner in the event of loss of power to the winch.

(p) An emergency disconnect from the power source (ESD) located within winch operator’s reach.

2.8 Guard rails and ladders

2.8.1 It is the Owners’ responsibility to provide permanent access arrangements and protection by means of Ladders and guard rails. It is recommended that such arrangements are designed in accordance with a recognised Code or Standard.
2.8.2 Dutyholders should be aware that the hoops of a ladder alone may not be effective in safely arresting a fall without injury. Dutyholders are therefore advised to review their risk assessments and consider if additional fall protection is required or alternative means of access is to be supplied.

Where dutyholders choose to use fall arrest equipment inside a hooped ladder to arrest a fall, they should be aware that hoops may interfere with the operation of some types of fall arrest equipment (for example, inertia reel devices). Dutyholders should contact their manufacturer or supplier for advice on the performance of such equipment when used in a hooped ladder.

Users of fall arrest equipment inside a caged ladder should also be aware of the possibility of injury from striking the cage following a fall. The use of climbing helmets to reduce the risk of injury may need to be considered (refer to HSE CCID 1-2012).

Where ladders are used as (or part of) an emergency escape route, they are to be fire resistant to comply with BS 476 part 7, 1989 or equivalent.

Ladders fixed and portable are to be suitable for use in the intended areas, and the Owner is to conduct risk assessments with regard to the use of wooden or aluminium ladders in an offshore drilling environment.

Ladders used as an escape to sea are also to be included in the unit’s inspection and maintenance planning.

2.9 Fire and blast loading

2.9.1 Particular consideration is to be given to the potential effects of fire and blast impinging on exposed boundary bulkheads of accommodation spaces and/or temporary refuge. Where boundary bulkheads can be subjected to blast loading, the scantlings are to comply with Pt 4, Ch 3.4.16 and Ch 6.9.1.6.

Other Standards which will apply to fire and blast loading include:

API RP 2FB ‘Recommended practice for design of offshore facilities against fire and blast loading.’

- Plans, including sufficient detail and dimensions to evaluate the design.
- Strength calculations as applicable.
- Material specifications and welding details.

Drilling equipment is to be designed in accordance with internationally recognised and agreed Codes and Standards and in accordance with the requirements of Section 1.

3.1.3 The generally recognised Codes and Standards frequently specified for drilling equipment are included in these Rules. These Codes and Standards may be used for certification but the additional requirements given in these Rules apply and will take precedence over the Codes and Standards wherever conflict occurs.

3.1.4 The selected materials are to be suitable for the purpose intended and must have adequate properties of strength and ductility. Materials used in welded construction are to be of known and documented weldable quality.

3.1.5 For selection of acceptable materials suitable for hydrogen sulphide-contaminated products (sour service), reference is made to NACE MR0175/ISO15156 – Petroleum and Natural Gas Industries – Materials for use in H2S-containing Environments in Oil and Gas Production, see Appendix A.

3.1.6 Grey iron castings are not to be used for critical components.

3.1.7 Proposals to use spheroidal graphite iron castings for critical components operating below 0°C will be specially considered by LR in each case.

3.1.8 In general, bolts and nuts are to comply with the Standards listed in Appendix A, A1.2.

3.1.9 Bolts and nuts for major structural and mechanical components are to have a tensile strength of not less than 600 N/mm². Galvanising of high tensile bolts and nuts is to be avoided. Where non high tensile bolts and nuts are galvanised, they are to follow the guidelines of ASTM B695.

3.1.10 The risk of galvanic corrosion is also to be considered in the selection of all types of fasteners.

3.1.11 For general service, the specified tensile strength of bolting material is not to exceed 1000 N/mm².

3.1.12 Where required, materials of high heat resistance are to be used and the ratings are to be verified.

3.1.13 All bolted structures are to have specific installation and tensioning design requirements made available to the Owner and LR for review before assembly.

3.2 General requirements for piping systems

3.2.1 The design and construction of the piping systems, piping and fittings forming part of such systems are to be in accordance with an acceptable Code or Standard, see 1.5, and are also to comply with the remainder of this Section.
3.2.2 Piping systems for the drilling and well-testing installations are, in general, to be separate and distinct from piping systems essential to the safety of the unit. Notwithstanding this requirement, this does not exclude the use of the installation’s main, auxiliary and/or essential services for drilling plant operations in suitable cases. Attention is drawn to the relevant Chapters of Part 5, Main and Auxiliary Machinery, when such services are to be utilised. Substances which are known to present a hazard due to a reaction when mixed are to be kept entirely separate.

3.2.3 Piping for services essential to the drilling operations, and piping containing hydrocarbon or other hazardous fluids, is to be of steel or other approved metallic construction. Piping material for H₂S-contaminated products (sour service) is to comply with the NACE MR0175/ISO15156 – Petroleum and Natural Gas Industries – Materials for use in H₂S-containing Environments in Oil and Gas Production, see Appendix A.

3.2.4 All piping systems are to be suitable for the service intended and for the maximum pressures and temperatures to which they are likely to be subjected.

3.2.5 In mud, cement or other systems where the piping is likely to be subjected to considerable erosion, a suitable erosion allowance is to be specified, and anticipated service conditions such as vibration, velocity, hydraulic hammer pressure pulsations are also to be taken into account.

3.2.6 The number of detachable pipe connections in the drilling piping systems is to be limited to those which are essential for mounting and dismantling. Non-critical auxiliary systems such as water and air service may be attached with approved detachable couplings.

3.2.7 Valves used for the shutting down and control of equipment in an emergency, such as choke manifolds and standpipe manifolds, are to be provided with indicators to show clearly whether they are open or closed.

3.3 Flexible piping

3.3.1 Flexible piping elements approved for their intended use may be installed in locations where rigid piping is unsuitable or impracticable. Such flexible elements are to be accessible for inspection and replacement, and are to be secured and protected so that personnel will not be injured in the event of failure.

3.3.2 All flexible hoses used during drilling operations are to be manufactured to a recognised Code or Standard and a prototype hose with end fittings attached is to have been burst-tested to the minimum pressure stipulated by the appropriate Standard. Transfer, mud, hydraulic and pneumatic hoses which may be liable to heavy external wear are to be specially protected. Protection against mechanical damage and from rushing/compression is to be provided where necessary.

3.3.3 Means are to be provided to isolate flexible hoses if used in systems where uncontrolled outflow would be critical.

3.3.4 Kill, choke and jumper hoses are to meet the minimum requirements of API 16C and API RP53.

3.3.5 Hydraulic control hoses serving well completion units and blow out preventers are to meet the requirements of API Spec 16E and API RP53.

3.3.6 Flexible piping is to meet the requirements of API RP 17B/ISO 13628-11:2007 Recommended Practice for Flexible Pipe. Inspection and maintenance procedures of flexible lines are to meet with requirements of API RP 7L.

3.3.7 Fiberglass and plastic pipe are to meet the requirements of the following main Standards and where applicable other standards in Appendix A:

API RP 15CLT Recommended practice for composite lined steel tubular goods.

API Spec 15HR Specification for high pressure fiberglass line pipe.

API Spec 15LE Specification for polyethylene line pipe (pe).

API Spec 15LR Specification for low pressure fiberglass line pipe.

3.4 Design and construction

3.4.1 The design strength of drilling equipment is to comply generally with LR agreed Codes and Standards.

3.4.2 Drilling equipment and systems are to be protected from excessive loads and pressures.

3.4.3 All drilling equipment is to be located in order to ensure safe operation, and must be suitably protected if for location in a hazardous area. Protection is to limit surface temperature to a maximum of 80 per cent of auto-ignition temperature. This temperature, if unknown, may be taken to be a maximum of 200°C.

3.4.4 The equipment is to be suitable for the design environmental conditions for the unit and the submitted design data for drilling equipment is to include all loading conditions, for each item, including the most unfavourable combination of loads, and any external loading conditions.

3.4.5 A dedicated area suitably sized and classified for well test equipment is to be provided. The area is to be suitably protected with bunding and drainage to prevent any oil spillage from spreading to other areas of the unit.

3.4.6 All areas that are intended to contain permanent or temporary equipment are to be designed with utilities such as electrical power, fresh water, compressed air, PA system, ESD, firewater and/or deluge system and communication system.
Drilling Plant Facility

3.4.7 The drilling plant will be designed and constructed with regard to safe handling and storage of heavy equipment.

3.4.8 Suitable drilling plant control systems are to be provided; as a minimum, these are to display drilling data, audible and visual alarms, anti-collision systems status, necessary process and storage systems data and are to control the mechanical and electrical equipment and other necessary utilities for safe drilling operations.

3.4.9 The drilling plant is to be equipped with sufficient emergency stops in critical areas. Details of the drilling plant emergency alarm system are to be submitted to LR for review.

3.4.10 The drilling plant will be designed to reduce the potential of ignitions arising from static, lightning and stray currents.

3.5 Drilling equipment

3.5.1 All drilling equipment shall, as a minimum, meet the requirements of the following main Standards and where applicable other standards referenced in Appendix A. Consideration is to be given during the design and installation of all drilling equipment to reducing the risk to personnel during routine maintenance or operations:

- API Spec 7-1 Specification for rotary drill stem elements.
- API Spec 7K Specification for drilling and well servicing equipment.
- API RP 7G Recommended practice for drill stem design and operating limits.
- API Spec 8A Specification for drilling and production hoisting equipment.
- API RP 8B Recommended practice for procedures for inspection, maintenance, repair, and remanufacture of hoisting equipment.
- API Spec 9A Specification for wire rope.
- API RP 9B Recommended practice on application, care and use of wire rope for oil-field service.
- API Spec 7F Oil-field chain and sprockets.
- API RP 7L Procedures for inspection, maintenance, repair, and remanufacture of drilling equipment.
- API Spec 8A Specification for drilling and production hoisting equipment.

3.6 Drilling well control equipment

3.6.1 Drilling well control equipment, including auxiliary well control equipment, is to meet the requirements of the following main Standards and where applicable other standards referenced in Appendix A.

3.6.2 Consideration during the design of the well control system to reducing the risk to personnel during routine maintenance or operations is to be undertaken.

3.6.3 Where surface BOPs are being used, a risk assessment on the need for an SID (sea bed isolation device) is to be submitted to LR for review.

3.6.4 The number of components and arrangement for the blow out preventer stack is to be presented to LR for review:

- API Spec 16C Specification for choke and kill systems.
- API Spec 16F Specification for marine drilling riser equipment.
- API RP 16Q Recommended practice for design, selection, operation and maintenance of marine drilling riser systems.
- API Spec 16RCD Specification for drill through equipment rotating control devices.
- API RP 16ST Coiled tubing well control equipment systems.
Section 4

**Bulk storage wet and dry systems**

### 4.1 General

4.1.1 The requirements for fired and unfired pressure vessels associated with the drilling plant and bulk storage vessels are to comply with the general requirements of Ch 8.4.

4.1.2 Pressure vessels are to comply with the design requirements in Ch 8.4.

4.1.3 Degasser and mud-gas separators are to be suitably constructed to handle the maximum design flow rate. All vented lines are to be of sufficient capacity and be vented to a safe location. Design particulars are to be submitted to LR for review.

4.1.4 Cementing units and associated high pressure pipes and manifolds are to be suitably designed and tested. If the cement unit is designed to be used as a kill unit, the components, specifications, capacities and power arrangements are to be supplied to LR for review.

4.1.5 The bulk system is to be designed to receive, store and deliver required volumes of bulk material to the mud and cementing system. Design capacities of the system are to be submitted for LR review.

4.1.6 Bulk storage vessels which penetrate watertight decks or flats are to be suitably reinforced, see Ch 3.2.10.

4.1.7 All bulk tanks, wet and dry, are to be designed for ease of cleaning and have adequate facilities for access and rescue of personnel.

### 4.2 Dry bulk systems

4.2.1 All dry bulk tanks are to be fitted with weight or volume indicators and a high level alarm. Provision for manual measurement is to also be made available.

4.2.2 The dry bulk vessels are to be designed for ease of cleaning and have adequate facilities for access and rescue of personnel.

4.2.3 All dry bulk lines (including ventilation lines) are to be designed for minimum flow resistance, minimum possible length and as few bends as possible. Connection points for purge air will be installed at critical flow areas in the bulk lines. Vent line outlets are to be kept as far as possible from HVAC inlets and normally manned areas.

4.2.4 The bulk air supply will be designed with redundancy and is to incorporate bulk air dryers. The compressors are to be located as close to the bulk storage tanks as possible.

4.2.5 The design is to prevent inadvertent mixing of cement and other bulk material.

4.2.6 All dry bulk storage vessels are to be equipped with safety valves or bursting discs to prevent damage due to overpressure. Bursting discs may only be used for vessels located in open areas or, if fitted in conjunction with a relief line, the discharge must be led to an open area.

4.2.7 For dry bulk storage vessels in enclosed areas, testable full open safety valves which can be vented out of the area are to be used. The enclosed areas where bulk storage vessels are located are to be ventilated such that a build-up of pressure will not occur in the event of a break or leak in the air supply system.

### 4.3 Wet bulk systems

4.3.1 Wet bulk storage tanks are to be suitably constructed with regard to the design maximum mud weight capacity of the vessel. All tanks are to be suitably equipped with equipment for preventing settling of mud.

4.3.2 The system will incorporate transfer systems with dedicated redundancy of pumps and manifolds. Sufficient by-passes with necessary valves for the liquid bulk in each storage tank are required. The systems are to be designed to transfer the relevant liquid bulk of design-specified weight and capacity to the liquid bulk tanks.

4.3.3 The design is to prevent inadvertent mixing of base oil and brine liquids.

4.3.4 High pressure mud pumps are to be fitted with pulsation dampers and relief valves set at the maximum allowable pressure of the system.

4.3.5 The mud pump relief line from the safety valve is to be self-draining and be as direct as possible with no bends and be suitably secured. The relief line after the relief valve is to be the same pressure rating as the pressure line before the relief valve. Facilities for flushing the vent lines are to be incorporated.

### 4.4 Mud mixing and storage system

4.4.1 The mud mixing and storage system is to be designed with sufficient capacity and structural strength to perform all planned mud mixing and storage operations with minimum risk of spillage or release of dust or fumes.
4.4.2 The entire mixing and storage system is to be designed for safe material handling and protection for personnel and the environment.

4.5 Mud treatment system

4.5.1 The mud treatment system is to be designed to operate without any risk to personnel with regard to spillage or exposure to hazardous substances.

Section 5

Offshore safety and pollution

Dutyholders are to meet the requirements of the following main Standards and, where applicable, other standards referenced in Appendix A., or equivalent, as a minimum to ensure adequate safety to personnel and the environment.


API RP 14B/ISO 10417:2004 Recommended practice for design, installation, repair and operation of subsurface safety valve systems.

API RP 14C Recommended practice for analysis, design, installation and testing of basic surface safety systems on offshore production platforms.

API RP 14E Recommended practice for design and installation of offshore production platform piping systems.

API RP 14F Recommended practice for design and installation of electrical systems for fixed and floating offshore petroleum facilities for unclassified and class I, division 1, and division 2 locations.

API RP 14FZ Recommended practice for design and installation of electrical systems for fixed and floating offshore petroleum facilities for unclassified and class I, zone 0, zone 1, and zone 2 locations.

API RP 14G Recommended practice for fire prevention and control on fixed open type offshore production platforms.

API RP 14J Recommended practice for design and hazards analysis for offshore production facilities.

API RP 49 Recommended practice for drilling and well servicing operations involving hydrogen sulfide.

API RP 54 Recommended practice for occupational safety and health for oil and gas well drilling and servicing operations.

API Std 2000 Venting atmospheric and low-pressure storage tanks.

API RP 76 Contractor safety management for oil and gas drilling and production operations.

API RP 75 Recommended practices for development of a safety and environmental management program for offshore operations and facilities.

Section 6

Competence

Dutyholders are to ensure all their personnel are suitably trained and assessed with regard to their competence in performing their routine work and also with regard to emergency drills and duties.

Section 7

Electrical installations

7.1 General

7.1.1 In general, electrical installations are to comply with the requirements of Pt 6, Ch 2.

7.1.2 Electrical equipment installed in areas where an explosive gas atmosphere may be present is to be in accordance with Pt 7, Ch 2 and Section 9 or an equivalent standard acceptable to LR.

Section 8

Control systems

8.1 General

8.1.1 In general, control engineering systems are to comply with the requirements of Pt 6, Ch 1 and/or with the appropriate Codes or Standards defined in Appendix A, as applicable.

8.1.2 The control aspects of the blow out preventer stack are to be in accordance with the requirements of 3.6.

8.1.3 Emergency shut-down systems and other safety and communication systems are to comply with the requirements of Pt 7, Ch 1.
Section 9
Fire, hazardous areas and ventilation

9.1 General

9.1.1 Hazardous areas and ventilation are to comply with Ch 3.3 and Pt 7, Ch 2.

9.1.2 The general requirements for fire safety are to comply with Pt 7, Ch 3.

9.1.3 A general arrangement drawing(s) of the unit, showing hazardous zones and spaces as well as the design philosophy is to be submitted to LR for review. The drawing is to refer to the requirements of Pt 7, Ch 2 and equivalent standards, for example:

API RP 14F  Recommended practice for design and installation of electrical systems for fixed and floating offshore petroleum facilities for unclassified and class I, division 1, and division 2 locations.

API RP 14FZ  Recommended practice for design and installation of electrical systems for fixed and floating offshore petroleum facilities for unclassified and class I, zone 0, zone 1, and zone 2 locations.

API RP 505  Recommended practice for classification of locations for electrical installations at petroleum facilities classified as class 1, zone 0, zone 1, and zone 2.

API RP 500  Recommended practice for classification of locations for electrical installation at petroleum facilities classified as class I, division 1 and division 2.

IP Model code P15.

Section 10
Risks to personnel from dropped objects

10.1 Goal

10.1.1 The requirements of this Section are to ensure that risks to personnel from dropped objects, hereinafter referred to as DROPS, are continuously addressed, in so far as they affect the objectives of classification.

10.2 Class notation

10.2.1 Where the requirements of this Section are met to the satisfaction of LR, units will be eligible to be assigned the DROPS class notation. This notation will be retained as long as the preventive measures to protect personnel from hazards from dropped objects are found, upon examination at the prescribed surveys, to be maintained to the satisfaction of LR.

10.3 Scope

10.3.1 Each unit is required to have a DROPS management system in place and be relevant to the design and specifics of the unit.

10.3.2 The Builder or Owner will create a general arrangement drawing of critical DROPS areas which will be clearly displayed in general information areas throughout the unit and accommodation.

10.3.3 The DROPS GA drawing will identify each area with colour coding and will clearly indicate the criticality levels within areas of the unit. The colour criticality coding is to be assigned as follows:

(a) Green Zone: Where the layout and activities of the area present little likelihood of personnel being exposed to potential dropped objects under normal circumstances.

(b) Yellow Zone: Where the layout and activities of the area present some risk of personnel being exposed to potential dropped objects under normal circumstances.

(c) Red Zone: Where the layout and activities of the area present significant risk of personnel being exposed to potential dropped objects under normal circumstances.

10.3.4 Zones are to be clearly displayed at all access points to the respective areas. All signs are to be pictorial to eliminate potential issues with different languages. Refer to BS EN IEC 62079:2001 Section 4.7.3.2 for further information.

10.3.5 All third party equipment, permanent or temporary, is to undergo a design risk assessment before installation. Records and methods of inspecting the third party equipment are to be maintained and available for LR review.

10.3.6 Suitable equipment and hand tools for working at height are to be provided. Details and records of inspection of such tools and equipment are to be maintained and available for LR review.

10.3.7 When the use of DROPS shelters are incorporated into the safety management system, full structural and installation details of the shelters, including the intended level of safety, are to be presented for LR review.

10.3.8 The preventive maintenance systems of the unit are to indicate where specialised work at height tooling is required for routine maintenance.
10.3.9 An inventory of permanent fixed equipment is to be created and maintained by the unit; the inventory is to include photographs and a description of each item. The photographs are to be taken from a distance and also from close up to avoid confusion with identification. Each individual item of equipment is to be identified by permanent marking or by the use of suitably attached durable labels.

10.3.10 An inventory of temporarily installed equipment is to be created and maintained by the unit. This will incorporate scheduled routine inspections to verify that no modifications, changes or damage to the equipment has occurred since the initial inspection on installation, or previous scheduled inspection.

10.3.11 A program of scheduled surveys and inspection will be created; methods and records of inspection and any remedial actions are to be maintained and available for LR review.

10.3.12 A record of failed items, with reason for failure, is to be maintained and is to be available for review by LR.

11.2 Approved technical organisation

11.2.1 An approved technical organisation, for the purposes of this Section, is one that can demonstrate that the trials are witnessed by competent experienced personnel with a minimum of 10 years’ offshore operational drilling plant experience. CVs are to be submitted to LR for review. The approved technical organisation is to be acceptable to the Owner and LR.

11.1 General

11.1.1 Before a new drilling plant (or any alteration or addition to an existing plant) is put into service, final drilling plant trials are to be carried out by an approved technical organisation, as defined in 11.2, to demonstrate that the integral drilling plant is suitable for safe operation and can operate as per the design.

11.1.2 The operational philosophy of the drilling plant is to be submitted for consideration. The operational philosophy is to include:
(a) each task to be performed, e.g., drilling operations, equipment inspection/maintenance, cleaning and instrument observation;
(b) a robust identification of the hazards associated with each task;
(c) the methods used to manage the identified hazards.

11.1.3 Where the operational aspects of the drilling plant have an effect on the overall safety of the drilling unit, the personnel on board or the environment, these aspects are to be to the satisfaction of LR.

11.1.4 The final drilling plant trials are in addition to any acceptance tests which may have been carried out at the manufacturers’ works and are to be based on an approved test schedule. The test schedule is to be submitted to LR for approval.
Process Plant Facility

Section 1

1.1 Application

1.1.1 The requirements of this Chapter apply to the process plant facility on board production and oil storage units as defined in Chapter 3. The process plant facility includes the equipment and supporting structure and systems used for oil and gas production including separation, treating and processing systems and equipment and systems used in support of production operations. The requirements of this Chapter are considered to be supplementary to the requirements in the relevant Parts of the Rules.

1.1.2 The Rules cover the design strength and safety aspects of the process plant facility installed on board production and oil storage units.

1.1.3 The operational aspects and reliability of the production and process plant facility are not covered by class except when they have an effect on the overall safety of the production unit, the personnel on board or the environment.

1.1.4 The Rules are framed on the understanding that a unit with an installed production and process plant facility will not be operated in environmental conditions more severe than those for the design basis and class approval.

1.1.5 It is the responsibility of the Owners/Operators to ensure that the production and process plant facility is properly maintained and operated by qualified personnel and that the test and operational procedures are clearly defined and complied with.

1.1.6 The limiting design criteria on which approval is based are to be stated in the unit's Operations Manual.

1.2 Class notations

1.2.1 The Regulations for classification and the assignment of class notations are given in Pt 1, Ch 2, to which reference should be made.

1.2.2 Production units with an installed process plant facility which comply with the requirements of this Chapter, or recognised Codes and Standards agreed with LR, will be eligible for the assignment of the special features class notation PPF.

1.2.3 When a production unit is to be verified in accordance with the Regulations of a Coastal State Authority, an additional descriptive note may be assigned in accordance with Pt 1, Ch 2.

1.3 Scope

1.3.1 The following additional topics applicable to the special features class notation are covered by this Chapter:

- Major equipment and structures of the production and process plant.
- Oil or gas processing system, including flowlines from the riser termination flanges, manifolds, production swivels, separators, heaters and coolers, relief and blow-down systems and water treatment systems.
- Production plant safety systems.
- Production plant utility systems.
- Riser compensating and tensioning system.
- Relief and flare system.
- Well control system.

1.3.2 Unless agreed otherwise with LR the Rules consider the following as the main boundaries of the production and process plant facility:

- Any part of the production and process system located on the unit including the riser connecter valve or christmas tree but excluding the risers is considered part of the facility.
- The shut-down valve at the export outlet from the production or process plant to the storage or offloading facility.
- The outlet from hydrocarbon flare and vent system.

1.4 Plant design characteristics

1.4.1 The design and arrangements of the process plant are to comply with the requirements of this Chapter and with recognised Codes and Standards, see 1.5.

1.4.2 Attention is to be given to the relevant Statutory Regulations of the National Administration in the country of registration and the area of operation, as applicable.
1.4.3 The plant and supporting structures above the deck are to be designed for all operating and transit conditions in accordance with recognised and agreed Codes or Standards, suitably modified to take into account the unit’s motions and marine environmental aspects. Except for the emergency condition, as detailed in 1.4.4, the total stress in any component of the plant is not to exceed the Code value at the temperature concerned, unless expressly agreed otherwise by LR, whether the plant is operative or non-operative, when subjected to any possible combination of the following loads, as applicable:

(a) Static and dynamic loads due to wave-induced unit motions.
(b) Loads resulting from hull flexural effects at the plant support points, as appropriate.
(c) Direct wind loads.
(d) Normal gravity and functional loads.
(e) Thermal loads, as appropriate.
(f) Ice and snow loads, as appropriate.

1.4.4 In general, the plant and supporting structures above the deck are to be designed for an emergency static condition with the unit inclined to the following angle:
- Column-stabilised units:
  - 25° in any direction.
- Surface type units:
  - 22.5° heel, port and starboard, and trimmed to an angle of 10° beyond the maximum normal operating trim.
- Self-elevating units:
  - 17° in any direction in transit conditions only.

These angles may be modified by LR in particular cases as considered necessary. In no case is the inclined angle for the emergency static condition to be taken less than the maximum calculated angle in the worst damage condition in accordance with the appropriate damage stability criteria.

1.4.5 In the emergency condition defined in 1.4.4, the plant is to be assumed to have maximum operating weights, temperatures and pressures unless agreed otherwise with LR. When applicable, the plant is also to be subjected to ice and snow loads. Wind loads need not be considered to be acting during this emergency condition. The total stress in any component of the plant or support structure above the deck is not to exceed the minimum yield stress of the material.

1.4.6 The permissible stresses in the primary hull structure below plant and equipment supports are to be in accordance with Pt 4, Ch 5.

1.5 Recognised Codes and Standards

1.5.1 Installed process plant facility designed and constructed to standards other than the Rule requirements will be considered for classification, subject to the alternative standards being agreed by LR to give an equivalent level of safety to the Rule requirements. It is essential that in such cases LR is informed of the Owner’s proposals at an early stage in order that a basis for acceptance of the standards may be agreed. See Appendix A for applicable international Codes and Standards considered by LR as an equivalent level of safety to Rule requirements.

1.5.2 In general, the requirements in this Chapter are based on internationally recognised Codes and Standards for the production and process plant as defined in Appendix A. Other Codes and National Standards may be used after special consideration and prior agreement with LR. When considered necessary, additional Rule requirements are also stated in this Chapter.

1.5.3 Where necessary, the Codes are to be suitably modified and/or adapted to take into account all marine environmental aspects.

1.5.4 The agreed Codes and Standards may be used for design, construction and installation but where considered applicable by LR, compliance with the additional requirements stated in the Rules is required. Where there is any conflict the Rules will take precedence over the Codes or Standards.

1.5.5 The mixing of Codes or Standards for each equipment item or system is to be avoided. Deviation from the Code or Standard must be specially noted in the documentation and approved by LR.

1.6 Equipment categories

1.6.1 The approval and certification of production and process plant equipment are to be based on equipment categories agreed with LR.

1.6.2 Production and process plant equipment including its associated pipes and valves is to be divided into equipment Categories 1A, 1B and II, depending on the complexity of manufacture and its importance with regard to the safety of personnel and the installation and the possible effect on the environment.

1.6.3 The following equipment categories are used in the Rules:
- **1A** Equipment of primary importance to safety, for which design verification and survey during fabrication are considered essential. Equipment in this category is of complicated design/manufacture and is not normally mass produced.
- **1B** Equipment of primary importance to safety for which design verification and witnessing the product quality are considered essential. Equipment in this category is normally mass produced and not included in category 1A.
- **II** Equipment related to safety which is normally manufactured to recognised Codes and Standards and has proven reliability in service but excludes equipment in category 1A and 1B.

1.6.4 A guide to equipment and categories is given in Appendix A. A full list of equipment categories for each production and process plant facility is to be agreed with LR before manufacture. Minor equipment components need not be categorised.
1.7 Equipment certification

1.7.1 Equipment is to be certified in accordance with the following requirements:

(a) Category 1A
   - Design verification and issue of certificate of design strength approval.
   - Pre-inspection meeting at the suppliers with agreement and marking of quality plan and inspection schedule.
   - Survey during fabrication and review of fabrication documentation.
   - Final inspection with monitoring of function/pressure/load tests and issue of a certificate of conformity.

(b) Category 1B
   - Design verification and issue of certificate of design strength approval, where applicable, and review of fabrication documentation.
   - Final inspection with monitoring of function/pressure/load tests and issue of a certificate of conformity.

(c) Category II
   - Supplier's/manufacturer's works certificate giving equipment data, limitations with regard to the use of the equipment and the supplier's/manufacturer's declaration that the equipment is designed and fabricated in accordance with recognised Standards or Codes.

1.7.2 All equipment recognised as being of importance for the safety of personnel and the production and process plant facility is to be documented by a data book.

1.8 Fabrication records

1.8.1 Fabrication records are to be made available for Categories 1A and 1B equipment for inspection and acceptance by LR Surveyors. These records should include the following:
   - Manufacturer's statement of compliance.
   - Reference to design specification and plans.
   - Traceability of materials.
   - Welding procedure tests and welders' qualifications.
   - Heat treatment records.
   - Records/details of non-destructive examinations.
   - Load, pressure and functional test reports.

1.9 Installation of plant equipment

1.9.1 The installation of equipment on board the unit is to be controlled by LR in accordance with the following principles:
   - All Category 1A and 1B equipment delivered to the unit is to be accompanied by a certificate of design strength approval and an equipment certificate of conformity and all other necessary documentation.
   - All Category II equipment delivered to the unit is to be accompanied by equipment data and a works' certificate.

1.10 Maintenance and repair

1.10.1 It is the Owner's/Operator's responsibility to ensure that installed production and process plant is maintained in a safe and efficient working condition in accordance with the manufacturer's specification.

1.10.2 When it is necessary to repair or replace installed production and process plant, any repaired or spare part is to be subject to the equivalent certification as the original.

1.11 Plans and data submissions

1.11.1 Plans, calculations and data are to be submitted as required by the relevant Parts of the Rules together with the additional plans and information listed in this Chapter. Plans are to be submitted in triplicate, but only a single copy of supporting documents and calculations is required.

2.1 Plans and data submissions

2.1.1 The following additional plans and information are to be submitted:
   - General arrangement plans of the plant layout.
   - Plans and design calculations as required for derricks in Ch 7.2, when appropriate.
   - Structural plans of equipment skids and design calculations.
   - Structural plans of equipment support frames and trusses and design calculations.

2.2 Materials

2.2.1 Materials are to comply with Ch 1.4 and material grades are to comply with Pt 4, Ch 2 using the categories defined in this Section.

2.2.2 Support structures for the production and process plant are to be divided into the following categories:
   - Primary structure.
   - Secondary structure.
2.2.3 Some specific examples of structural elements which are considered as primary structure are as follows:
- Module main frame members and deck support stools.
- Main legs and chords including end connections.
- Foundation bolts.

2.3 Miscellaneous structures

2.3.1 The design loadings for all structures supporting plant, including equipment skids, support frames and trusses, are to be defined by the designers/Builders and calculations are to be submitted in accordance with an appropriate Code or Standard, see Appendix A. The design requirements of 1.4 are to be complied with.

2.3.2 The design of process plant support structures should integrate with the primary hull under-deck structure.

2.3.3 The permissible stresses in the hull structure below the production and process plant are to be in accordance with Ch 3,2 and Pt 4, Ch 5,2.

2.4 Flare structures

2.4.1 Flare structures are to be designed for an emergency condition and for normal operating conditions as defined in 1.4 and in accordance with an appropriate Code or Standard, see Appendix A.

2.4.2 The flare structures are also to be designed for the imposed loads due to handling the structure and when in the stowed position.

2.4.3 The designers/Builders are to specify the maximum weight of the burner and spreader and the design criteria defined in 1.4.

2.4.4 The structural design of flare structures is to include the effect of fatigue loading and the thermal loads during flaring, see Pt 4, Ch 5.

2.4.5 Where National Administrations give specific requirements with respect to fatigue design, it is the responsibility of the Owners to comply with such Regulations.

2.4.6 For slender structures and components, the effects of wind induced cross-flow vortex vibrations are to be assessed.

2.4.7 Wind loads are to be calculated in accordance with LR’s Code for Lifting Appliances in a Marine Environment (hereinafter referred to as LAME Code) or a recognised Code or Standard, see Appendix A.

2.4.8 Permissible stresses in the hull structure below the flare structure supports are to be in accordance with Pt 4, Ch 5.

2.5 Lifting appliances

2.5.1 Lifting appliances used for handling flare structures and blow out preventers are to be in accordance with LR’s LAME Code, see also Chapter 11.

2.6 Guard rails and ladders

2.6.1 It is the Owners’ responsibility to provide permanent access arrangements and protection by means of ladders and guard rails. It is recommended that such arrangements are designed in accordance with a recognised Code or Standard.

Section 3
Production, process and utility systems

3.1 Plans and particulars

3.1.1 Plans and particulars showing arrangement of production, process and utility systems and equipment listed in 1.3, and diagrammatic plans of the associated piping systems, are to be submitted for approval.

3.2 General requirements for piping systems

3.2.1 The design and construction of the piping systems, piping and fittings forming parts of such systems are to be in accordance with a recognised Code or Standard, see 1.5, and are also to comply with the remainder of this Section.

3.2.2 Piping systems for the production and process plant are, in general, to be separate and distinct from piping systems essential to the safety of the unit. Notwithstanding this requirement, this does not exclude the use of the unit’s main, auxiliary and/or essential services for process plant operations in suitable cases. Attention is drawn to the relevant Chapters of Part 5, Main and Auxiliary Machinery, when such services are to be utilised. Substances which are known to present a hazard due to a reaction when mixed are to be kept entirely separate.

3.2.3 All piping systems are to be suitable for the service intended and for the maximum pressures and temperatures to which they are likely to be subjected.

3.2.4 The number of detachable pipe connections in hydrocarbon production and process piping is to be limited to those which are necessary for installation and dismantling. The pipe connections are to be suitable for the intended use.

3.2.5 Soft-seated valves and fittings which incorporate elastomeric sealing materials installed in systems containing hydrocarbons or other flammable fluids are to be of a fire-tested type.
3.2.6 The production and process system piping is to be protected from the effects of fire, mechanical damage, erosion and corrosion. Corrosion coupons or test spool pieces are to be designed into the system. Spool pieces are to be fitted in such a manner as to be easily removed or replaced. Sand probes and filters should be provided where necessary for extraction of sand or reservoir fracture particles.

3.2.7 The corrosion allowance for hydrocarbon production and process piping of carbon steel is not to be less than 2 mm.

3.2.8 Piping for services essential to the production and process operations, and piping containing hydrocarbon or other hazardous fluids is to be of steel or other approved metallic construction. Piping material for H₂S-contaminated products (sour service) is to comply with the NACE MR0175/ISO15156 – Petroleum and Natural Gas Industries – Materials for use in H₂S-containing Environments in Oil and Gas Production, see Appendix A.

3.2.9 Arrangements are to be made to isolate the unit from the supply and discharge of produced oil and gas by the provision of suitable shut-down valves on the unit and at the receiving installation. The valves on board the unit are to be operable from the control stations as well as locally at the valve.

3.2.10 If a single failure in the supply from utility systems such as compressed air or cooling water which are essential to the operation of the production and process plant could cause an unacceptable operating condition to arise, an alternative source of supply is to be provided.

3.2.11 Process vessel washout connections are to be fitted with non-return valves in addition to the shut-off valves.

3.2.12 The locking open/closed of valves is to be means of a suitable keyed locking device operated under a permit-to-work system.

3.2.13 For process vessels which periodically require isolation prior to gas-freeing and personnel entry, pipelines which connect the vessel to a source of pressure and/or hazardous fluid are to be provided with isolating valves, bleed arrangements and means to blank off the open end of the pipe. For systems containing significant hazards, consideration is to be given to double block and bleed valves and blanking-off arrangements.

3.2.14 For surface type units, the design of piping systems should take into consideration the effect of hull girder bending.

3.3 Flexible piping

3.3.1 Flexible piping elements approved for their intended use may be installed in locations where rigid piping is unsuitable or impracticable. Such flexible elements are to be accessible for inspection and replacement, and are to be secured and protected so that personnel will not be injured in the event of failure.

3.3.2 Short lengths of flexible hose may be utilised to allow for limited misalignment or relative movement. All flexible hoses are to be manufactured to a recognised Code or Standard, and a prototype hose with end fittings attached is to have been burst-tested to the minimum pressure stipulated by the appropriate standard. Protection against mechanical damage is to be provided where necessary.

3.3.3 Means are to be provided to isolate flexible hoses if used in systems where uncontrolled outflow would be critical.

3.4 Christmas tree

3.4.1 The christmas tree is to have at least one remotely-operated, self-closing master valve and a corresponding wing valve for each penetration of the tree. In addition, there is to be a closing device for each penetration at a level higher than the wing outlets.

3.4.2 Additional wing outlets such as injection lines are to penetrate the christmas tree above the lowest remotely-operated master valve, and be fitted with a remotely-operated, self-closing control valve and a check valve installed as close as possible to the injection point. The injection point for hydrate inhibitor may be fitted below the lowest self-closing master valve if the christmas tree is fitted with valve(s) below this point.

3.4.3 All valves in the vertical penetrations of the christmas tree are to be capable of being opened and kept in the open position by means of an external operational facility independent of the primary actuator.

3.4.4 Valves that are important in connection with the emergency shut-down system such as the master and wing valves are to be fitted locally with visual position indicators.

3.4.5 Where exposure to H₂S-contaminated products is likely, materials and welds shall meet the requirements of the NACE MR0175/ISO15156 – Petroleum and Natural Gas Industries – Materials for use in H₂S-containing Environments in Oil and Gas Production.

3.5 Protective pressure relief

3.5.1 Process vessels, equipment and piping are to be provided with pressure-relieving devices to protect against system pressures exceeding the maximum allowable pressure such that the system will remain safe under all foreseeable conditions, unless the system is designed to withstand the maximum pressure which can be exerted on it under any circumstances. Where appropriate, sections of the production and process system are to be protected against underpressure resulting from a change of temperature or state of the contents, see also 4.9.

3.5.2 The pressure-relieving devices are to be sized to handle the expected maximum relieving rates due to any single failure or fire incident. The rated discharge capacity of any pressure-relieving device is to take into account the back pressure in the vent system.
3.5.3 For protected items or sections of the system not in continuous service, a single pressure-relieving device is acceptable. Block valves for maintenance purposes, where fitted, in the pressure relief lines are to be interlocked with the source of pressure or spare relief valves as applicable.

3.5.4 For any particular item or section of the system in continuous service at least two pressure relief possibilities are to be provided for operational and maintenance purposes. In this case, each pressure relief possibility is to be designed to handle 100 per cent of the maximum relieving rate expected unless alternative systems are available or short-term shut-down is acceptable.

3.5.5 If more than two pressure relief possibilities are provided on any particular item or section of the system in continuous service, and any pressure relief possibility is designed to handle less than 100 per cent of the maximum relieving rate expected, the arrangements are to be such as to allow any one device to be isolated for operational and maintenance purposes without reducing the capacity of the remaining devices below 100 per cent of the maximum relieving rate.

3.5.6 Block valves fitted in pressure relief lines for isolation purposes are to be of the full-flow type, capable of being locked in the fully open position by an approved keyed method.

3.5.7 The arrangement in 3.5.4 or 3.5.5 is to ensure that all relief possibilities cannot be isolated from the system at the same time, by interlocking the block valves using an approved keyed method of interlocking operated under a permit-to-work system.

3.5.8 The set pressure for all pressure-relieving devices should generally not exceed the design pressure of the protected system or item. Pressure relief valves are to be sized such that any accumulation of pressure from any source will not exceed 110 per cent of the design pressure.

3.5.9 Bursting discs fitted in place of, or in series with, a pressure relief valve are to be rated to rupture at a pressure not exceeding the design pressure of the protected system or item. However, in the case of a bursting disc fitted in parallel with a relief valve(s), such as in vessels containing substances which may render a pressure relief valve inoperative or where rapid rates of pressure rise may be encountered, the bursting disc is to be rated to burst at a maximum pressure not exceeding 1.3 times the design pressure of the vessel at the operating temperature.

3.5.10 Pressure-relieving devices are normally to be connected to the flare and relief header to minimise the escape of hydrocarbon fluids, and to ensure their safe collection and disposal. Where appropriate, vent and discharge piping arrangements are to be such as to avoid the possibility of a hazardous reaction between any of the fluids involved.

3.5.11 In circumstances where hazardous vapours are released directly to the atmosphere, the outlets are to be arranged to vent to a safe location where personnel would not be endangered.

3.5.12 The inlet piping to a pressure relief device should be sized so that the pressure drop from the protected item to the pressure relief device inlet flange does not exceed three per cent of the device set pressure.

3.5.13 Pressure-relieving devices and all associated inlet and discharge piping are to be self-draining. Open vents are to be protected against ingress of rain or foreign bodies.

3.5.14 Relief piping supports are to be designed to ensure that reaction forces during relief are not transmitted to the vessel or system, and to ensure that relief devices are not used as pipe supports or anchors where the resultant forces could interfere with the proper operation of the device.

3.5.15 The design and material selection of the pressure-relieving devices and associated piping is to take into consideration the resulting low temperature, vibration and noise when gas expands in the system.

3.5.16 Positive displacement pumps and compressors for hydrocarbon oil/gas service are to be provided with relief valves in closed circuit, set to operate at a pressure not exceeding the maximum allowable pressure of the pump or equipment connected to it, and adequately sized to ensure that the pump output can be relieved without exceeding the system's maximum allowable pressure. Proposed alternatives to relief valves may be considered and full details should be submitted.

3.5.17 Relief valves may also be required on the suction side of pumps and compressors when recycling from the discharge side is possible.

3.6 Flaring arrangements

3.6.1 Facilities for gas flaring and oil burning are to be adequate for the flaring requirements during well control, well testing and production operations. For well testing, at least two flare lines are to be arranged through which any flow from the well may be directed to different sides of the unit.

3.6.2 The flare system is to be designed to ensure a clean, continuous flame. Provision is to be made for the injection of make-up gas into the vent system to maintain steady flaring conditions. A means of cooling the flare burners when used for well testing is to be available.

3.6.3 The flare burners are to be located at a safe distance from the unit. This distance, or protection zone, is to be determined by consideration of the calculated thermal radiation levels. For limiting thermal radiation levels, see 3.9.

3.6.4 For well test systems, any flare line or other line downstream of the choke manifold is to have an inside diameter not less than the inside diameter of the largest line in the choke manifold.
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3.6.5 Production and process plant venting systems are to be led to a liquid separator or knock-out drum to remove any entrained liquids which cannot be safely handled by the flare. Where a liquid blow-down system is provided, adequate provision is to be made in the design for the effects of back pressure in the system, and for vapour flash-off when the pressures in the blow-down system are reduced.

3.6.6 The flare system is to be capable of controlling any excess gas pressures resulting from emergency depressurising conditions.

3.7 Depressurising system

3.7.1 All production and process plant in which significant volumes of hydrocarbon liquids and gases with potential for incident escalation can be blocked in during a fire is to be capable of being depressurised. The capacity of the system should be based on evaluation of:

- system response time;
- heat input from defined accident scenarios;
- material properties and material utilisation ratio;
- other protection measures, e.g., active and passive fire protection;
- system integrity requirements.

3.7.2 The emergency depressurising system is to be designed to reduce pressures to a level to prevent rupture of the pressure-containing components. As a minimum requirement, the depressurising system is to be designed to ensure that the pressure is reduced to half the equipment's maximum allowable working pressure or 6.9 bar, whichever is lower, within approximately 15 minutes.

3.7.3 The cooling effect due to throttling of large volumes of high pressure gas in the discharge piping and valves during the depressurising period is to be evaluated for appropriate material selection. Where temperatures below minus 29°C are expected, the piping and valve material is to have specified average Charpy V-notch impact values of 27J minimum at the calculated lowest operational temperature.

3.7.4 The vent system design should ensure that allowance has been given to the possibility of high dynamic forces at pipe bends and supports during emergency depressurisation.

3.8 Cold vents

3.8.1 A cold vent is acceptable only if it is determined that the gas release will not create any danger to the unit. Due consideration should be given to the prevailing wind to ensure that gases do not flow down around operating areas. Where cold venting is provided, the arrangement is to minimise:

- Accumulation of toxic and flammable gases.
- Ignition of vent gases from outside sources.
- Flashback upon accidental ignition of the vent gases.

3.8.2 In order to avoid continuous burning of the vent gases in the case of accidental ignition, an extinguishing system using a suitable inert gas is to be installed.

3.8.3 The dew point of the gases is to be such that they will not condense at the minimum ambient temperature. In the case of liquid condensation in the cold vent piping, a drain or liquid collection system is to be provided to prevent accumulation of liquid in the vent line.

3.9 Radiation levels

3.9.1 The location and designed throughput of the flare is to take into consideration the levels of thermal radiation to ensure that exposure of personnel, structure and equipment is acceptable even under unfavourable wind conditions.

3.9.2 Under normal operating circumstances, the intensity of thermal radiation, including solar radiation, in unprotected areas where personnel may be continuously exposed is not to exceed 1.9 kW/m² in calm conditions. Allowance for the cooling effect of wind in unsheltered areas may be taken into consideration in determining the radiation levels.

3.9.3 Under emergency flaring conditions, the intensity of thermal radiation at muster stations and in areas where emergency actions of short duration may be required by personnel is not to exceed 4.7 kW/m² in calm conditions.

3.9.4 Suitable radiation screens, water screening or equivalent provision should be utilised to protect personnel, structure and equipment as necessary.

3.10 Firing arrangements for steam boilers, fired pressure vessels, heaters, etc.

3.10.1 The requirements of this Section are applicable to all types of fired equipment associated with the process plant. The equipment is to be constructed, installed and tested to the Surveyor's satisfaction.

3.10.2 Details of the design and construction of the fuel gas burning equipment for steam boilers, oil and gas heater furnaces, etc., are to be in accordance with agreed Codes, Standards and specifications normally used for similar plants in land installations, suitably modified and/or adapted for the marine environment. Ignition of the burners is to be by means of permanently installed igniters, or properly located and interlocked pilot burners and main burners arranged for sequential ignition.

3.10.3 Proposals to burn gas or gas/air mixtures having relative densities compared with air at the same temperature greater than one will be specially considered in each case. See also Pt 5, Ch 16.

3.10.4 Proposals for the furnace purging arrangements prior to ignition of the burners are to be submitted. Such arrangements are to ensure that any accidental leakage of product liquid or gas into the furnace, from a liquid or gas heating element, or from the accidental ingestion of flammable gases and/or vapours, does not result in hazardous conditions.
3.10.5 Compartments containing fired pressure vessels, heaters, etc., for heating or processing hazardous substances are to be arranged so that the compartment in which the fired equipment is installed is maintained at a higher pressure than the combustion chamber of the equipment. For this purpose, induced draft fans or a closed system of forced draught may be employed. Alternatively, the fired equipment may be enclosed in a pressurised air casing.

3.10.6 The fired equipment is to be suitably lagged. The clearance spaces between the fired equipment and any tanks containing oil are to be not less than 760 mm. The compartments in which the fired equipment is installed are to be provided with an efficient ventilating system.

3.10.7 Smoke box and header box doors of fired equipment are to be well fitted and shielded, and the uptake joints made gastight. Where it is proposed to install dampers in the uptake gas passages of fired equipment, the details are to be submitted. Dampers are to be provided with a suitable device whereby they may be securely locked in the fully open position.

3.10.8 Each item of fired equipment is to have a separate uptake to the top of the stack casing. Where it is proposed to install process fired equipment with separately fixed furnaces converging into a convection section common to two or more furnaces and/or a secondary radiant section at the confluence of the fired furnace uptake to the convection section, the proposed arrangements, together with the details of the furnace purging and combustion controls, are to be submitted.

3.11 Drain systems

3.11.1 Drainage systems are to be provided to collect and direct drained or escaped liquids to a location where they can be safely handled or stored. In general, equipment is to be provided with a hard-piped, closed drainage system for small quantities of produced liquids, an open system handling drainage from hazardous areas, and an open system handling drainage from non-hazardous areas. These systems are to be entirely separate and distinct.

3.11.2 The hazardous drainage systems are to be kept separate and distinct from those of the main and auxiliary machinery systems. Consideration will be given to directing the process facilities hazardous drains to the facilities oil storage tanks. The hazardous drains fluids should not be allowed to free-fall into the tank. In units equipped with an inert gas system, a U-seal of adequate height, or equivalent method, should be arranged in the piping leading to the oil storage tanks.

3.11.3 Provision is to be made for protection against over-pressurisation of a lower pressure drainage system when connected to a higher pressure system.

3.12 Bilge and effluent arrangements

3.12.1 Where, during operation, the production plant spaces contain, or are likely to contain, hazardous and/or toxic substances, they are to be kept separate and distinct from the unit’s main bilge pumping system. This does not, however, preclude the use of the unit’s main bilge system when the production plant is shut down, gas freed or otherwise made safe.

3.12.2 The bilge and effluent pumping systems handling hazardous and/or toxic substances should, wherever possible, be installed in the space associated with the particular hazard. Spaces containing pumping systems that take their suction from a hazardous space will also be designated as hazardous spaces unless all associated pipelines are of all-welded construction without flanges, valve glands and bolted connections, and the pump is totally enclosed.

3.12.3 Bilge and effluent piping systems related to the production plant are to be constructed of materials suitable for the substances handled, including any accidental admixture of such substances.

3.12.4 Arrangements are to be provided for the control of the bilge and effluent pumping systems installed in production and process plant spaces from within the spaces and from a position outside the spaces.

Section 4

Pressure vessels and bulk storage

4.1 General

4.1.1 The Rules in this Section are applicable to fired and unfired pressure vessels associated with process plant, and drilling plant defined in Chapter 7.

4.1.2 Pressure vessels are to be designed in accordance with Pt 5, Ch 10 and Ch 11 or with internationally recognised and agreed Codes and Standards and in accordance with the requirements of Section 1.

4.1.3 The list in Appendix A, A 1.2.11 gives reference to some generally recognised Codes and Standards frequently specified for drilling and production equipment. These Codes and Standards may be used for certification but the additional requirements given in the Rules apply and the Rules will take precedence over the Codes and Standards wherever conflict occurs.

4.1.4 Portable gas cylinders and other pressure vessels used to transport liquids or gases under pressure are to comply with an acceptable National or International Standard.
4.1.5 Where pressure parts are of such an irregular shape that it is impracticable to design their scantlings by the application of recognised formulae, the acceptability of their construction is to be determined by hydraulic proof testing and strain gauging or by an agreed alternative method.

4.2 Plans and data submissions

4.2.1 Design documentation is to be submitted for all pressure vessels.

4.2.2 The submitted information is to include the following:
- Design specification, including data of working medium and pressures.
- Minimum/maximum temperatures, corrosion allowance, environmental and external loads.
- Plans, including sufficient detail and dimensions to evaluate the design.
- Strength calculations for normal operating and emergency conditions.
- Bill of Materials including material specifications as necessary.
- Fabrication specifications including welding, heat treatment, type and extent of NDE.

4.3 Equipment certification

4.3.1 Equipment certification is to be carried out in accordance with Section 1 and equipment categories are to comply with Table A 2.3 in Appendix A.

4.4 Materials

4.4.1 Materials for pressure vessels are to comply with Ch 1, 4 and the Rules for the Manufacture, Testing and Certification of Materials (hereinafter referred to as the Rules for Materials), except where modified by this Section.

4.4.2 Welded carbon/manganese (C–Mn) steels used for major pressure containing parts should have a chemical composition limited by the carbon content and the carbon equivalent:

\[ C \leq 0.25 \]

When the elements in the following formula are known, this formula is to be used:

\[ CE = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15} \leq 0.45 \]

Symbols are as defined in the Rules for Materials.

4.4.3 The use of material not meeting these limitations is subject to special consideration in each case. The welding of such materials normally requires more stringent fabrication procedures regarding the selection of consumables, preheating and post weld heat treatment.

4.4.4 Materials for pressure containing parts are to be tested at the temperature specified in Table 13.4.1 in Chapter 13 of the Rules for Materials and shall achieve a minimum energy of 27J for materials with specified minimum yield strength less than or equal to 360 MPa and 42J for higher strength materials.

4.4.5 Equipment and components required for hydrogen sulphide sour service shall meet the property requirements of NACE MR0175/ISO15156 – Petroleum and Natural Gas Industries – Materials for use in H₂S-containing Environments in Oil and Gas Production.

4.5 Design pressure and temperature

4.5.1 The design pressure is the maximum permissible working pressure and is not to be less than the highest set pressure of the safety valve. If the design of the system is such that it may be possible for it to see a vacuum, the design pressure shall also consider the minimum working pressure which the system may see.

4.5.2 The calculations made to determine the scantlings of the pressure parts are to be based on the design pressure, adjusted where necessary to take account of pressure variations corresponding to the most severe operating conditions.

4.5.3 It is desirable that there should be a margin between the normal pressure at which the pressure vessel operates and the lowest pressure at which any safety valve is set to lift, to prevent unnecessary lifting of the safety valve.

4.5.4 The design temperature, \( T \), used to evaluate the allowable stress, \( \sigma \), is to be taken as the actual mean wall metal temperature expected under operating conditions for the pressure part concerned, and is to be stated by the manufacturer when the plans of the pressure part are being considered. For fired steam boilers, \( T \) is to be taken as not less than 250°C.

4.6 Design safety factors

4.6.1 The term ‘allowable stress’, \( \sigma \), is the stress to be used in the formulae for calculating the scantlings of pressure vessels.

4.6.2 The allowable stress used for the design of a pressure vessel is to be in accordance with the Code or Standard being used to design that vessel.

4.6.3 Pressure vessels are to be designed for the emergency conditions referred to in 1.4.

4.6.4 It is not permissible to use the allowable stress levels of one Code or Standard to determine the scantlings using the formulae from a different Code or Standard.

4.6.5 The yield strength used in the determination of allowable stress or in calculations is not to exceed 0,85 of the specified minimum tensile strength of the material in question.
4.7 Construction and testing

4.7.1 Fabrication documentation is to be compiled by the manufacturer simultaneously with the fabrication in a systematic and traceable manner so that all the information regarding the design specification, materials, fabrication processes, inspection, heat treatment, etc., can be readily examined by the Surveyor.

4.7.2 Welding procedures and construction requirements for welding shall be in accordance with those specified in Chapters 12 and 13 of the Rules for Materials.

4.7.3 Procedures for performing non-destructive examination and the acceptance criteria to be applied shall be in accordance with the Chapter 13 of the Rules for Materials.

4.8 Hydrostatic test pressure

4.8.1 Pressure vessels are to be subject to a hydrostatic test in accordance with the applied Code, Standard, or specification before being taken into service.

4.8.2 The hydrostatic test pressure is to be a minimum of 1.5 x design pressure if not specified in the Code or Standard.

4.8.3 The pressure and holding time are to be recorded.

4.8.4 Primary general membrane stresses are in no case to exceed 90 per cent of the minimum yield strength of the material.

4.9 Protective and pressure relief devices

4.9.1 Pressure vessels are to be provided with protective devices so that they remain safe under all foreseeable conditions.

4.9.2 Where pumps and pressure surges are capable of developing pressures exceeding the design conditions of the system, effective means of protection such as pressure relief devices or equivalent are to be provided.

4.9.3 Pressure relief valves are to be sized such that any accumulation of pressure from any source will not exceed 121 per cent of the design pressure. For specific fire contingencies where accumulated pressure could exceed 121 per cent, design proposals will be specially considered.

4.9.4 Bursting discs fitted in place of or in series with safety valves are to be rated to burst at a maximum pressure not exceeding the design pressure of the vessel at the operating temperature. Bursting discs are only to be used for pressure vessels located in open areas or if fitted in conjunction with a relief line led to an open area.

4.9.5 Where a bursting disc is fitted downstream of a safety valve, the maximum bursting pressure is also to be compatible with the pressure rating of the discharge system.

4.9.6 In the case of bursting discs fitted in parallel with relief valves to protect a vessel against rapid increase of pressure, the bursting disc is to be rated to burst at a maximum pressure not exceeding 1.3 times the design pressure of the vessel at operating temperature.

4.9.7 Pressure relief devices are to be type tested to establish their discharge capacities at their maximum rated design pressures and temperatures in accordance with an approved Code or Standard.

4.9.8 Where pressure relief devices can be isolated from the pressure vessel whilst in service, there is to be an alternative independent pressure relief device. The system pressure relief valve set pressure and bursting disc rupture pressure should be displayed at the respective operating position.

4.9.9 Any isolating valves used in conjunction with pressure relief devices are to be the full flow type capable of being locked in the full open position. Where isolating valves are arranged downstream and upstream of a relief device they are to be interlocked with each other.

4.9.10 Where pressure relief devices are duplicated on the same vessel or system and fitted with isolating valves, these valves are to be so interlocked as to ensure that before one relief device is isolated the other relief device is fully open and the required discharge capacity is maintained. The interlocking system is to be submitted for approval.

4.9.11 The design of the pressure-relieving system is to take into account the characteristics of the fluid handled and any extreme environmental condition recorded for the geographical zone of operation. The vent and pressure relieving systems are to be self-draining.

4.9.12 The rated discharge capacity of any pressure relief device is to take into account the back pressure in the vent systems. Where hazardous vapours are discharged directly to the atmosphere, the outlets are to be arranged to vent to a safe location.

4.10 Bulk storage vessels

4.10.1 Bulk storage vessels are to be designed in accordance with the general requirements of this Section and with one of the internationally recognised Codes or Standards for fusion welded pressure vessels quoted in Appendix A, A1.2.11, and in accordance with the design requirements given in Section 1, see also Ch 7.3.10.

4.10.2 For bulk storage vessels in enclosed areas, testable safety valves are to be used, which can be vented out of the area. Such enclosed areas are to be ventilated so that a pressure build-up will not occur in the event of a break or a leak in the air supply system.

4.10.3 Bulk storage vessels are normally to be supported by suitable skirts in order to distribute the loads into the supporting structure.
4.10.4 Bulk storage vessels which penetrate watertight decks or flats are to be suitably reinforced, see Ch 3.2.10.

Section 5
Mechanical equipment

5.1 General

5.1.1 The Rules in this Section are applicable to all types of mechanical equipment associated with the production and process plant, with the exception of pressure vessels which are dealt with in Section 4.

5.1.2 Mechanical equipment is to be designed in accordance with internationally recognised and agreed Codes and Standards and in accordance with the requirements of Section 1.

5.1.3 The list in Appendix A, A1.2 gives reference to some generally recognised Codes and Standards frequently specified for drilling and production equipment. These Codes and Standards may be used for certification, but the additional requirements given in these Rules apply and will take precedence over the Codes and Standards wherever conflict occurs.

5.1.4 Production and process plant equipment is to be suitable for the service intended and for the maximum loads, pressures, temperatures and environmental conditions to which the system may be subjected.

5.2 Plans and data submissions

5.2.1 Design documentation for mechanical equipment is to be submitted in accordance with the equipment categories and certification requirements defined in Section 1.

5.2.2 The submitted information should include the following, as applicable to the equipment categories:
- Design specification, including data of working medium and pressures.
- Minimum/maximum temperatures, corrosion allowance, environmental and external loads.
- Plans, including sufficient detail and dimensions to evaluate the design.
- Strength calculations as applicable.
- Material specifications and welding details.

5.3 Equipment certification

5.3.1 Equipment categories and certification of production and process plant equipment are to be in accordance with the requirements of Section 1.

5.3.2 A general guide to specific equipment categories are given in Table A 2.3 in Appendix A.

5.3.3 Hoisting and pipe handling equipment are to comply with Ch 7.6.

5.4 Materials

5.4.1 Materials are to comply with Ch 1.4 and the Rules for Materials, except where modified by this Section.

5.4.2 The selected materials are to be suitable for the purpose intended and must have adequate properties of strength and ductility and materials to be welded shall be of weldable quality.

5.4.3 As a minimum, unless specified by the design specification, Charpy impact tests are required to be carried out at the minimum design temperature (MDT) and exhibit minimum impact energy of 34J for minimum specified yield strengths up to 360 MPa and 40J for higher yield strengths.

5.4.4 For selection of acceptable materials suitable for hydrogen sulphide contaminated products (sour service), reference is to be made to the ISO 15156/NACE Standard in Appendix A, A1.2.21.

5.4.5 Grey iron castings are not to be used for critical components.

5.4.6 Proposals to use spheroidal graphite iron castings for critical components operating below 0°C will be specially considered by LR in each case.

5.4.7 In general, bolts and nuts are to comply with the Standards listed in Appendix A, A1.2.

5.4.8 Bolts and nuts for major structural and mechanical components are to have a tensile strength of not less than 600 N/mm².

5.4.9 For general service the specified tensile strength of bolting material should not exceed 1000 N/mm².

5.4.10 Where required, materials of high heat resistance are to be used and the ratings are to be verified.

5.5 Design and construction

5.5.1 The design strength of production and process plant equipment is to comply generally with Part 5, as applicable, and with LR agreed Codes and Standards.

5.5.2 All equipment included in this Section is to be suitable for the design environmental conditions for the unit.
5.5.3 Combustion equipment and combustion engines are not normally to be located in a hazardous area, unless the air space is pressurised to make the area non-hazardous in accordance with the following criteria:
- Pressurisation air is to be taken from a safe area.
- An alarm is to be fitted to indicate loss of air pressure.
- An air lock system with self-closing doors is to be fitted.
- The exhaust outlet is to be located in a non-hazardous area, and be fitted with spark arresters, see 5.5.4.
- The combustion air inlet is to be located in a non-hazardous area.
- Automatic shut-down is to be arranged to prevent overspeeding in the event of accidental ingestion of flammable gases or vapours.

5.5.4 Efficient spark arresters, of LR approved type, are to be fitted to the exhaust from all combustion equipment, except from exhaust gas turbines. Water cooled spark arresting equipment is to be fitted with means to give a warning in the event of failing cooling water supply.

5.5.5 Exhaust gases are to be discharged so that they will not cause inconvenience to personnel or a dangerous situation during helicopter operations.

5.5.6 The equipment and systems are to be designed, installed, and protected so as to be safe with regard to the risk of fire, explosions, leakages and accidents.

7.1.3 All butt welds are to be subjected to 100 per cent NDE. Examination by radiography is to be to a Standard acceptable to LR, e.g., ISO 17636: Non-destructive testing of welds – Radiographic testing of fusion welded joints, with acceptance criteria as detailed in the Construction Code, or BS 4515: Specification for welding of steel pipelines on land and offshore, if not specified in the Code. Proposals for examination by ultrasonics are to be submitted for review and acceptance.

Section 8
Fire, hazardous areas and ventilation
8.1 General
8.1.1 Hazardous areas and ventilation are to comply with Ch 3,3 and Pt 7, Ch 2.
8.1.2 The general requirements for fire safety are to comply with Pt 7, Ch 3.

Section 9
Riser systems
9.1 General
9.1.1 Production riser systems which comply with the requirements of Chapter 12 will be eligible for the special features class notation PRS.
Dynamic Positioning Systems

Section 1

1. General

1.1 Application

1.1.1 The requirements of this Chapter apply to mobile offshore units with installed dynamic positioning systems and are additional to those applicable in other Parts of these Rules.

1.1.2 A mobile offshore unit provided with a dynamic positioning system in accordance with these Rules will be eligible for an appropriate class notation which will be recorded in the ClassDirect Live Website.

1.1.3 Requirements additional to these Rules may be imposed by the National Administration with whom the unit is registered and/or by the administration within whose territorial jurisdiction it is intended to operate. Where national legislative requirements exist, compliance with such regulations shall also be necessary.

1.1.4 For the purpose of these Rules, dynamic positioning means the provision of a system with automatic and/or manual control capable of maintaining the heading and position of the unit during operation within specified limits and environmental conditions.

1.1.5 For the purpose of these Rules, the area of operation is the specified allowable position deviation from the desired set point, see 1.3.2.

1.2 Classification notations

1.2.1 Units complying with the requirements of this Chapter will be eligible for one of the following class notations, as defined in Pt 1, Ch 2:

- **DP(CM)**: See Section 2.
- **DP(AM)**: See Section 3.
- **DP(AA)**: See Section 4.
- **DP(AAA)**: See Section 5.

1.2.2 The notations given in 1.2.1 may be supplemented with a Performance Capability Rating (PCR). This rating indicates the calculated percentage of time that a unit is capable of maintaining heading and position under a standard set of environmental conditions (North Sea), see Section 6.

1.2.3 Additional descriptive notes may be entered in the ClassDirect Live Website, indicating the type of position reference system, control system, etc.

1.2.4 Where a DP notation is not requested, dynamic positioning systems are to comply with the requirements of Section 2, as far as is practicable.

1.3 Information and plans required to be submitted

1.3.1 The information and plans specified in 1.3.2 to 1.3.7 are to be submitted in triplicate. The Operation Manuals specified in 1.3.8 are to be submitted in a single set.

1.3.2 Details of the limits of the area of operation and heading deviations, together with proposals for redundancy and segregation provided in the machinery, electrical installations and control systems, are to be submitted. These proposals are to take account of the possible loss of performance capability should a component fail, or in the event of fire or flooding, see also 1.3.6 and Sections 4 and 5.

1.3.3 Where a common power source is utilised for thrusters, details of the total maximum load required for dynamic positioning are to be submitted.

1.3.4 Plans of the following, together with particulars of ratings in accordance with the relevant Parts of the Rules, are to be submitted for:

- (a) Prime movers, gearing, shafting, propellers and thrust units.
- (b) Machinery piping systems.
- (c) Electrical installations.
- (d) Pressure vessels for use with dynamic positioning system.

1.3.5 Plans of control, alarm and safety systems, including the following, are to be submitted:

- (a) Functional block diagrams of the control system(s).
- (b) Functional block diagrams of the position reference systems and the environmental sensors.
- (c) Details of the electrical supply to the control system(s), the position reference system(s) and the environmental sensors.
- (d) Details of the monitoring functions of the controllers, sensors and reference system, together with a description of the monitoring functions.
- (e) List of equipment with identification of the manufacturer, type and model.
- (f) Details of the control stations, e.g., control panels and consoles, including the location of the control stations.
- (g) Test schedules (for both works testing and sea trials) that are to include the methods of testing and the test facilities provided.
1.3.6 For assignment of a DP(AA) or DP(AAA) notation, a Failure Mode and Effect Analysis (FMEA) is to be submitted, demonstrating that adequate segregation and redundancy of the machinery, the electrical installation and the control systems have been achieved in order to maintain position in the event of equipment failure, see Section 4, or fire or flooding, see Section 5. The FMEA is to take a formal and structured approach and is to be performed in accordance with an acceptable and relevant national or international standard, e.g., IEC 60812.

1.3.7 Where the DP notation is to be supplemented with a Performance Capability Rating (PCR), see 1.2.2, the following information is to be submitted for assignment of a PCR:
(a) Lines plan.
(b) General arrangement.
(c) Details of thruster arrangement.
(d) Thruster powers and thrusts.

1.3.8 Operation Manuals, including details of the dynamic positioning system operation, installation of equipment, maintenance and fault finding procedures, together with a section on the procedure to be adopted in an emergency, are to be submitted. A copy of the manual is to be placed and retained on board the unit.

### Section 4
#### Class notation DP(AA)

4.1 Requirements

4.1.1 The requirements for class notation DP(AA) are given in Pt 7, Ch 4.4 of the Rules for Ships, which are to be complied with where applicable.

### Section 5
#### Class notation DP(AAA)

5.1 Requirements

5.1.1 The requirements for class notation DP(AAA) are given in Pt 7, Ch 4.5 of the Rules for Ships, which are to be complied with where applicable.

### Section 6
#### Performance Capability Rating (PCR)

6.1 Requirements

6.1.1 The requirements for Performance Capability Rating (PCR) are given in Pt 7, Ch 4.6 of the Rules for Ships, which are to be complied with where applicable.

### Section 7
#### Testing

7.1 Requirements

7.1.1 The requirements for testing are given in Pt 7, Ch 4.7 of the Rules for Ships, which are to be complied with where applicable.
Positional Mooring Systems

Section 1

1.1 Application

1.1.1 Mobile offshore units with positional mooring systems complying with the requirements of this Chapter will be eligible for the assignment of a special features notation.

1.1.2 The mooring system will be considered for classification on the basis of operating constraints and procedures specified by the Owner and recorded in the Operations Manual.

1.1.3 Requirements additional to these Rules may be imposed by the National Authority with whom the unit is registered and/or by the Administration of the coastal state(s) with territorial jurisdiction over the waters in which it is intended to operate.

1.2 Class notations

1.2.1 The Regulations for classification and the assignment of class notations are given in Pt 1, Ch 2, to which reference should be made.

1.2.2 Units provided with a positional mooring system which complies with the requirements of this Chapter will be eligible for the assignment of a special features class notation as follows:

PM (Positional mooring system), or

PMC (Positional mooring system for mooring in close proximity to other vessels or installations. This notation will apply in particular to any unit operating adjacent to a fixed installation, e.g., crane unit, accommodation unit, support unit, etc.).

1.2.3 Units fitted with a thruster-assisted positional mooring system which complies with the requirements of this Chapter will be eligible for the assignment of one of the following supplementary special features class notations:

TA(1)
TA(2)
TA(3)

1.2.4 The numeral in parenthesis after the thruster-assist notation TA in 1.2.3 defines the thruster allowance which may be permitted in the design of the positional mooring system, and is determined by the capacity/redundancy of the thrust/machinery installation, see Sections 4, 14 and 15.

1.2.5 For units with positional mooring systems, a typical example of character of classification and class notations is:

+OU 100A1 Mobile Drilling Unit, DRILL, PM TA(3).

1.3 Definitions

1.3.1 The definitions given in this Section are for Rule application only and will not necessarily be valid in any other context, see also Pt 1, Ch 2.2.

1.3.2 Positional mooring. Station-keeping by means of multi-leg mooring system with or without thruster-assist. The positional mooring system will consist of the following components, as relevant:

(a) Anchor points:
   - Drag embedment anchors.
   - Anchor piles.
   - Suction anchor piles.
   - Gravity anchors.
   - Plate anchors.

(b) Anchor lines.

(c) Anchor line fittings:
   - Shackles.
   - Connecting links/plates.
   - Wire rope terminations.
   - Clump weights.
   - Quick release devices, etc.

(d) Fairleads/bending shoes.

(e) Chain or wire rope stoppers.

(f) Winches or windlasses.

Where applicable, the structural or mechanical connection of these items to the unit is also considered to be part of the positional mooring system.

1.3.3 Thruster-assist. The use of thrusters, inclusive of their associated equipment, to supplement the unit’s positional mooring system.
1.3.4 **Catenary mooring.** A mooring system which derives its compliance mainly from the catenary action of the anchor lines. Some additional resilience is provided by the characteristic axial elasticity of the anchor lines.

1.3.5 **Taut-leg mooring.** A mooring system based on light-weight anchor lines pre-tensioned to a taut configuration with no significant catenary shape at any unit offset, and applying vertical and horizontal loads at the anchor points. With this type of system, compliance is derived from the inherent axial elastic stretch properties of the anchor line.

1.3.6 **Spread mooring.** A multi-line mooring system designed to maintain an offshore unit on an approximately fixed heading.

### 1.4 Plans and data submission

1.4.1 The positional mooring system will be subject to review and approval. The following information and plans are to be submitted in triplicate, to cover the design review and class approval of the positional mooring system:

(a) Plans of the positional mooring system and associated equipment are to be submitted, including the following, as applicable:
   - General arrangement of floating unit.
   - Mooring layout.
   - Anchor lines and fittings.
   - Anchor points.
   - Fairleads/bending shoes.
   - Cable stoppers.
   - Winches, windlasses or tensioners.

(b) For thruster-assisted positional mooring systems, plans of the following, together with particulars of ratings, in accordance with the relevant Parts of these Rules, are to be submitted for the following:
   - Prime movers, gearing, shafting, propellers and thrust units, see also Part 5.
   - Machinery piping systems.
   - Electrical installations.

(c) In addition, details of proposals for the redundancy provided in machinery, electrical installations, and control systems are to be submitted. These proposals are to take account of the possible loss of performance capability should a component fail. Where a common power source is utilised for thrusters, details of the total maximum load required for thruster-assist are to be submitted.

(d) Plans of control, alarm and safety systems, including the following, are to be submitted:
   - Functional block diagrams of the control system(s).
   - Functional block diagrams of the position reference systems and environmental sensors.
   - Details of electrical supply to the control system(s), the position reference system(s) and the environmental sensors.
   - Details of the monitoring functions of the controllers, sensors and reference system together with a description of the monitoring functions.
   - List of equipment with identification of the manufacturer, type and model.

- Details of the overall alarm system linking the centralised control station, subsidiary control stations, relevant machinery spaces and operating areas.
- Details of control stations, e.g., control panels and consoles, including the location of the control stations.
- Factory and customer acceptance test schedules which are to include the methods of testing and the test facilities provided.

1.4.2 Single copies of the following supporting plans, data, calculations or documents are to be submitted:

(a) General:
   - Mooring design premise.
   - Moored unit details (dimensions and main particulars).

(b) Specifications:
   - Materials.
   - Equipment and fittings.
   - Model testing.

(c) Data reports:
   - Environmental criteria.

(d) Design reports and calculations:
   - Hydrodynamic/motion analysis.
   - Mooring analysis.
   - Model test results.
   - Design load report.
   - Anchor line components: strength and fatigue.
   - Anchor point: strength and fatigue.
   - Fatigue.
   - Equipment/ancillaries including the associated equipment, stoppers and fairleads: strength and fatigue.
   - Corrosion protection and/or corrosion allowance.

(e) Other information:
   - In-service inspection programme.
   - Anchor point holding capacity.

1.4.3 An Operations Manual, as required by Ch 1.3, is to be submitted and the Manual is to contain all necessary information and instructions regarding positional mooring and, where relevant, thruster-assisted positional mooring. It would normally also contain descriptions of the following:
   - Mooring systems.
   - Laying the mooring system.
   - Anchor pre-loading.
   - Pre-tensioning anchor lines.
   - Tension adjustment.
   - Winch/windlass performance.
   - Winch/windlass operation.
   - Procedure in event of failure or emergency.
   - Procedure for operating thrusters.
   - Fault-finding procedures for thruster-assist system.
   - Maintenance procedures.
Positional Mooring Systems

Section 2
Survey

2.1 General requirements

2.1.1 Positional moorings, with or without thruster-assist, are to be inspected and tested during manufacture/construction, and under working conditions on completion of the installation.

2.1.2 The scope of inspection and/or testing to be carried out at the manufacturer's works is to be agreed with LR before the work is commenced.

2.1.3 The general requirements for Periodical Surveys contained in Pt 1, Ch 2 of the Rules are to be complied with.

2.1.4 For guidance on the inspection of positional mooring systems, see Appendix B.

Section 3
Environmental conditions

3.1 General

3.1.1 The Owner/Operator or designer is to specify the environmental criteria for which the unit is to be considered. The extreme environmental conditions applicable to the operating areas are to be specified, together with all operating environmental limits. Detailed specialist environmental reports are to be submitted, with sufficient supporting information to demonstrate the validity of the limiting criteria, see 3.3.

3.1.2 A comprehensive set of operating and extreme environmental limiting conditions is to be submitted. This is to cover the following cases, as applicable, and any other conditions relevant to the system under consideration:
- Extreme environmental conditions.
- Limiting environmental conditions in which the unit may remain moored.
- Limiting environmental conditions in which the unit's main operating functions may be carried out (e.g., drilling, gangway connection, etc.).
- Limiting environmental conditions in which the unit may (re)connect.

3.2 Environmental factors

3.2.1 The following environmental factors are to be considered in the design of the positional mooring system:
- Marine growth.
- Air and sea temperatures.
- Marine growth.
- Air and sea temperatures.

3.2.2 In certain locations, the following factors may need to be considered in the design of the positional mooring system:
- Ice.
- Seismic events, such as earthquakes.

3.3 Metocean data

3.3.1 As part of the environmental data, the following metocean data will normally be required to be submitted:
- 50, 10 and 1-year return period values for wind-speed, significant wave height and current.
- Directional data for extreme values of wind, waves and current.
- Wave height/period joint frequency distribution (wave scatter diagram).
- Wave spectral parameters.
- Wind/wave/current angular separation data.
- Current speed and/or directional variation over the water depth.
- Long-term wave statistics by direction.

3.4 Environmental parameters

3.4.1 Water depth. Minimum and maximum still water levels are to be determined, taking account of the tidal range, sea bed subsidence, wind and pressure surge effects.

3.4.2 Wind. The 1-hour wind speed, plus wind gust spectrum, will normally require to be applied in design. The following wind gust spectra formulations can be adopted for the time varying component:
- API RP 2A, Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platform.
- Other published spectra formulations may be accepted (Harris, Slettringen), see Appendix A, A1.2.17.

Estimating wind forces and moments for design input into analysis or model basin wind fields should preferably be done on the basis of wind tunnel tests using an accurate project-specific model.

3.4.3 Waves:
(a) To ensure that the most critical combinations of low frequency and wave frequency response are determined, a broad range of significant wave heights and peak periods will require to be investigated, preferably based on the use of a 50-year wave contour.
(b) For this approach, a wave contour of significant wave height and peak period combinations will require to be developed, using appropriate extrapolation techniques, to extend shorter term wave height and period joint frequency distribution data. Each point on the wave contour will represent a combination of $H_s$ and $T_p$ having a 50-year recurrence interval. Appropriate methods of developing the wave contour are to be used, see Appendix A.A1.2.18.
Positional Mooring Systems

3.4.4 Current. Design current velocities are to be established, taking account of all relevant components including the following:
- Tidal currents.
- Circulation currents.
- Wind-driven current.
- Storm surge generated current.

3.4.5 Marine growth. Account is to be taken in the design of build-up of marine growth on the anchor lines, riser system and/or the hull, and the resulting increase in load and damping. The thickness of marine growth taken into account is to be stated in the Operations Manual and is not to be exceeded in service.

3.4.6 Air and sea temperature. The minimum and maximum air and sea temperatures are to be specified in accordance with Chapter 1.

3.4.7 Sea ice and icebergs. The design philosophy of units intended to be moored in regions subject to sea ice or icebergs will require to be defined, including any quick-release mooring system arrangements.

3.4.8 Seismic. The requirements for units intended to be moored in regions subject to seismic events, such as earthquakes or tsunamis, will be subject to special consideration.

4.2 Thruster-assist systems

4.2.1 Thrusters can be used to reduce the mean load on the mooring system, provide damping of low frequency surge motion, and/or control the heading of the unit, in order to limit the overall excursions. Thruster intervention allowances for supplementary thruster-assist notations is given in Table 10.4.1.

Table 10.4.1 Thruster allowance

<table>
<thead>
<tr>
<th>Case</th>
<th>Thruster allowance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TA(1)</td>
</tr>
<tr>
<td>Operating (Intact)</td>
<td>None</td>
</tr>
<tr>
<td>Survival (Intact)</td>
<td>70% of all thrusters</td>
</tr>
<tr>
<td>Operating (Single line failure)</td>
<td>None</td>
</tr>
<tr>
<td>Survival (Single line failure)</td>
<td>70% of all thrusters</td>
</tr>
</tbody>
</table>

NOTES
1. The conditions for assignment of supplementary notations TA(1), TA(2) and TA(3) are defined in Section 14.
2. Net thrust values can be applied in the calculations, to the extent indicated in the Table. The basis for deductions due to thruster-hull, thruster-current and thruster-thruster interference is to be documented and included in the design submission.
3. See 4.1.1 for the Rule basis of failure, including thruster system failure, for damaged case.

4.2.2 Units which utilise thruster assistance as an aid to position keeping or as a means of reducing anchor line tensions, and which have a system approved by LR, may be assigned a special features notation as defined in 1.2.

4.2.3 The requirements of Sections 14 and 15 are to be complied with and for the majority of offshore units with positional mooring systems which utilise thruster assistance the class notation TA(3) will be applicable. Thruster-assist notations TA(1) and TA(2) will only be considered for applications of low criticality.

4.3 Design environmental conditions

4.3.1 Unless agreed otherwise with LR, the following design environmental combinations are to be considered:
- 50-year waves + 50-year wind + 10-year current.
- 50-year waves + 10-year wind + 50-year current.
Joint probabilities of the various environmental actions may be taken into account if such information is available and can be adequately documented.

4.3.2 For 50-year waves, a range of different wave height/period combinations, each of which has a joint recurrence period of 50 years, will require to be considered, see 3.4.3.
4.3.3 Directional combinations are given in 4.4.

4.4 Directional combinations

4.4.1 For weathervaning units, sufficient combinations of directions of wind and current relative to wave direction are to be investigated to ensure the critical cases are found, swell is to be superimposed from the worst case direction, see 3.4.3(d). The following combinations are envisaged as a minimum for design (unless joint directional probabilities of the various environmental actions are available and can be adequately documented):

(a) Wave, wind and current collinear.
(b) Wind and current at 30° to waves.
(c) Wind at 30° to waves, and current at 90° to waves.

NOTE For case (c) above, only combination (a) given in 4.3.1 has to be considered (i.e., the 50-year current case is not applicable).

4.5 Environmental directions relative to unit and mooring system

4.5.1 For spread-moored units, at least head, quartering, beam relative to the unit and down-line directions are to be considered in mooring analysis. Dependent on response analysis and wind, wave and current force/moment calculations, other directions may require to be considered, see also 4.4.1.

4.5.2 For weathervaning units, the following cases must be considered as a minimum requirement:

- Wave direction along mooring line.
- Wave direction between mooring lines.

4.5.3 Where the mooring lines are grouped, additional wave directions will require to be considered at intermediate headings between the directions given above.

4.5.4 For a positional mooring system without thruster-assist, two conditions will normally need to be analysed:

- loss of highest loaded line, leading to highest excursions; and
- loss of second highest loaded line, leading to highest line tensions.

4.6 Other design aspects

4.6.1 Anchor lines are to have adequate clearance from sub-sea equipment such as templates, flowlines, etc.

4.6.2 The design of the mooring system is to take account of the offset limits required by the drill string or riser system, and the avoidance of contact between risers and anchor lines.

4.6.3 Where an operational activity is intended to be continued during periods where an anchor line is disconnected for inspection, etc., specific environmental limitations are to be established to ensure that safety factors are maintained even with one line out of action. A similar procedure applies when machinery and equipment cannot remain fully functional during maintenance and inspection.

4.6.4 In cases where the mooring system is intended to be actively controlled by adjustment of line lengths and tensions, satisfactory evidence must be submitted to show that the adjustment procedure is practical, taking account of winch control and prevailing environmental conditions.

4.6.5 Where units are moored in areas where high velocity currents occur, dynamic excitation due to vortex shedding is to be considered.

4.6.6 Positional mooring systems for units intended to remain on station for more than five years should comply with LR’s Rules and Regulations for the Classification of a Floating Offshore Installation at a Fixed Location.

Section 5

Design analysis

5.1 General

5.1.1 A comprehensive analysis will be required in all cases and model tests are normally to be performed for ship shape units or unique designs. Validation will be required for each part of the analysis process, by correlation with model tests or other proven method.

5.2 Model testing

5.2.1 The model test programme and test facilities are to be to LR’s satisfaction.

5.2.2 The model is to be of an adequate scale and is to represent fully the moored unit. Account is to be taken of the different draughts, deck structures and large equipment appendages such as anchor racks or thrusters. In case of (ultra) deep water moorings, the scale and representation of the moorings will be subject to special consideration.

5.2.3 The tests are to be of sufficient duration to establish the low frequency behaviour, and most probable maxima with sufficient reliability.

5.2.4 The tests are to include means of establishing the effects of green water and/or slamming, through video recordings of the model testing, and by measurement of the following:

- Relative motions.
- Forces on local panels mounted at various locations such as bow area and accommodation.
5.2.5 It is recommended that an initial analysis be performed prior to the start of the model test programme, in order to understand and clarify the conceptual design, and to help focus the model testing on the most important design parameters.

5.3 Analysis aspects

5.3.1 The analysis is to take account of the following:
- The effect of current on wave drift force.
- The effect of wave depth on current forces, first order responses and wave drift.

5.3.2 For response analysis, anchor line properties are to be based on the total line diameter including corrosion allowance, see Table 10.8.1.

5.3.3 Weight and elasticity properties of anchor lines are to be obtained from chain or rope manufacturers. This information is to be documented and included in the submission.

5.4 Analysis

5.4.1 The following analyses, which may be combined, are to be carried out and submitted to LR:
- Hydrodynamic analysis of the floating unit.
- Motions analysis of the moored unit.
- Mooring analysis.
- Thruster damping may also be applicable in relevant cases.

5.4.2 The following data has to be derived from the analyses:
- Steady force offsets, and tensions, from wind, current and wave drift.
- Wave frequency motions/accelerations.
- Low frequency offsets and tensions from second order wave drift forces, and wind gust effects.

5.4.3 Time domain or frequency domain analysis methods can be applied. The basis for linearisation of the frequency domain analysis is to be documented.

5.4.4 For low frequency response analysis, the non-linear stiffness characteristics are to be satisfactorily represented. The amplitude of low frequency motion will be highly dependent on system damping from the following:
- Current.
- Wave drift.
- Viscous effects on the hull.
- Anchor lines and risers.
- Wind effects.

Thrustor damping may also be applicable in relevant cases and the basis for the damping terms used in the analysis is to be documented and submitted.

5.4.5 Tensions due to low frequency and wave frequency excitation can be computed separately. The effect of line dynamics is to be accounted for in wave frequency analysis. Low frequency tension can be based on quasi-static catenary response. Wave frequency dynamic line tension is to be computed at alternative low frequency offset positions, see 5.5.3.

5.5 Combination of low and high frequency components

5.5.1 Maximum design values for offset and tension are preferably to be derived from combined wave frequency and low frequency response analyses. The time domain simulations are to be of sufficient length to establish reasonable confidence levels in the predictions of maximum response.

5.5.2 The most probable maximum values for tension and offset can be determined from the distribution of peak values. The statistical basis (Weibull, etc.) being applied to derive the probability distribution is to be documented and submitted.

5.5.3 Tensions and offset values can be combined as follows, when low frequency and wave frequency analyses are conducted separately:

(a) Offset:
\[ X_{\text{MAX}} = X_{\text{MEAN}} + X_{\text{LF max}} + X_{\text{WF max}} \]

(b) Tension:
\[ T_{\text{MAX}} = T_{\text{MEAN}} + T_{\text{LF max}} + T_{\text{WF max}} \]

5.5.4 Estimates of maximum design values can be based on the following:

(a) Low frequency:
\[ X_{\text{LF max}} = 2\sigma_{\text{xLF}} \]
\[ T_{\text{LF sig}} = 2\sigma_{\text{TLF}} \]
\[ T_{\text{LF max}} = \sigma_{\text{TLF}} \sqrt{2\ln(N_F)} \]

\[ \sigma_{\text{xLF}} = \text{significant low frequency offset} \]
\[ X_{\text{LF max}} = \text{maximum low frequency offset} \]
\[ T_{\text{LF sig}} = \text{significant low frequency tension} \]
\[ T_{\text{LF max}} = \text{maximum low frequency tension} \]
\[ \sigma_{\text{TLF}} = \text{standard deviation of low frequency offset} \]
\[ \sigma_{\text{TLF}} = \text{standard deviation of low frequency tension} \]
Positional Mooring Systems

\[ N_{LF} = \text{number of low frequency oscillations during short-term storm state (not less than 3 hour storm)} \]
\[ \ln = \log_e \]
\[ e = \text{base of natural logarithms, } 2,7183. \]

(b) Wave frequency:
\[ X_{WF \text{ sig}} = 2\sigma_{X_{WF}} \]
\[ X_{WF \text{ max}} = \sigma_{X_{WF}} \sqrt{2(\ln N_{WF})} \]
\[ T_{WF \text{ sig}} = 2\sigma_{T_{WF}} \]
\[ T_{WF \text{ max}} = \sigma_{T_{WF}} \sqrt{2(\ln N_{WF})} \]

where
\[ X_{WF \text{ sig}} = \text{significant wave frequency offset} \]
\[ X_{WF \text{ max}} = \text{maximum wave frequency offset} \]
\[ T_{WF \text{ sig}} = \text{significant wave frequency tension} \]
\[ T_{WF \text{ max}} = \text{maximum wave frequency tension} \]
\[ \sigma_{X_{WF}} = \text{standard deviation of wave frequency offset} \]
\[ \sigma_{T_{WF}} = \text{standard deviation of wave frequency tension} \]
\[ N_{WF} = \text{number of wave frequency oscillations during short-term storm state (not less than 3 hour storm)} \]
\[ \ln = \log_e \]
\[ e = \text{base of natural logarithms, } 2,7183. \]

Section 6
Anchor lines

6.1 General

6.1.1 Anchor line length is to be sufficient to avoid uplift forces occurring at the anchor point for damaged condition loads, unless the anchor point is specially designed to accept a vertical component of loading.

6.1.2 An anchor line tension measurement system or device will require to be provided.

6.1.3 Steel wire rope and chain requirements are defined in Sections 7 (Wire ropes) and 8 (Chains) respectively.

6.1.4 The break strength of the anchor line is not to be greater than the load bearing capacity of the connecting structure, see Pt 4, Ch 6.1.

6.2 Factors of safety – Strength

6.2.1 PM notation (including PM TA(1), PM TA(2) and PM TA(3)). Minimum factors of safety applicable to steel wire rope and chain anchor lines of moored floating units are given in Table 10.6.1.

Table 10.6.1 Factors of safety for PM notation

<table>
<thead>
<tr>
<th>Design case</th>
<th>Description</th>
<th>Quasi-static analysis</th>
<th>Dynamic analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Operating (Intact)</td>
<td>2,7</td>
<td>2,3</td>
</tr>
<tr>
<td>2</td>
<td>Survival (Intact)</td>
<td>1,8</td>
<td>1,5</td>
</tr>
<tr>
<td>3</td>
<td>Operating (Single line failure)</td>
<td>1,8</td>
<td>1,5</td>
</tr>
<tr>
<td>4</td>
<td>Survival (Single line failure)</td>
<td>1,25</td>
<td>1,1</td>
</tr>
</tbody>
</table>

NOTES
1. The factors of safety given in this Table apply to units positioned at least 300 m from another installation.
2. The unit is to be positioned to avoid contact with another installation in any of the design cases.

6.2.2 PMC notation (including PMC TA(1), PMC TA(2) and PMC TA(3)). Minimum factors of safety applicable to steel wire rope and chain anchor lines for mooring system analysed quasi-statically and dynamically are given in Tables 10.6.2 and 10.6.3 respectively.

Table 10.6.2 Factors of safety for PMC notation – Quasi-static analysis

<table>
<thead>
<tr>
<th>Design case</th>
<th>Description</th>
<th>Factors of safety for PMC notation Quasi-static analysis, see Note</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Unit moored 50 m or less from other structures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Critical line</td>
</tr>
<tr>
<td>1</td>
<td>Operating (Intact)</td>
<td>3,0</td>
</tr>
<tr>
<td>2</td>
<td>Survival (Intact)</td>
<td>—</td>
</tr>
<tr>
<td>3</td>
<td>Operating (Single line failure)</td>
<td>2,0</td>
</tr>
<tr>
<td>4</td>
<td>Survival (Single line failure)</td>
<td>—</td>
</tr>
</tbody>
</table>

NOTES
1. See also 5.4.
2. The unit is to be positioned to avoid contact with another installation in any of the design cases.
7.1.2 Wire ropes and associated fittings are to be of an approved design.

7.2 Rope construction

7.2.1 In selecting a rope construction the following considerations apply:
- Required service life.
- Position in catenary.
- Axial stiffness properties of rope.
- Bending over sheaves, etc.
- Characteristic torsional properties of rope construction.

7.2.2 Various rope constructions can be accepted for long-term mooring applications. These include:
- Spiral strand.
- Locked coil.
- Six-strand.
- Other constructions can be considered.

7.3 Design verification

7.3.1 The design of wire rope and associated fittings is to be verified. The following information will be required for appraisal and information:
- Plans of rope, socket and other fittings.
- Materials.
- Design specification.
- Purchaser’s specification.
- Codes and Standards applied.
- Calculations for the strength and fatigue of rope, socket, fittings, and their corrosion protection.
- Torsional stiffness data.

7.3.2 Data from prototype rope tests is to be made available as required.
7.3.3 Fatigue life calculations for steel wire ropes can be carried out in accordance with a recommended Code, e.g., API RP 2SK: Recommended Practice for Design and Analysis of Stationkeeping Systems for Floating Structures. Rope bending fatigue effects are to be included where relevant.

7.3.4 The minimum factors of safety on the calculated fatigue lives of wire rope and fittings are to comply with Table 5.5.2 in Pt 4, Ch 5.

7.3.5 The rope termination including the socket is to be designed to withstand a load of not less than the minimum breaking strength of the attached wire rope.

7.4 Materials

7.4.1 Steel wire used for rope manufacture is to be manufactured in accordance with a recognised National Standard:

(a) The steel is to be of homogeneous quality, consistent strength, and free from visual defects likely to impair the performance of the rope.

(b) The minimum tensile strength of the wire is to be the tensile strength ordered. The maximum tensile strength is not to exceed the specified minimum strength by more than 230 N/mm². The tensile strength should normally be within the range 1420 to 1770 N/mm².

7.4.2 The material used in the manufacture of sockets is to comply with the following requirements:

(a) Cast sockets:
   • Castings are to be manufactured and tested generally in accordance with Chapter 4 of the Rules for the Manufacture, Testing and Certification of Materials (hereinafter referred to as the Rules for Materials).
   • As a supplement to Chapter 4 of the Rules for Materials, impact tests are to be carried out at a test temperature of minus 20°C, to satisfy a minimum average energy requirement of 40 J, with no more than one individual result from each three test specimens being less than 70 per cent of the required minimum average. Increased material toughness may be required in specific cases.
   • Alternative casting standards to Chapter 4 of the Rules for Materials complying with recognised National or proprietary specifications may be accepted, see also Ch 5.1.1.3 of the Rules for Materials.

(b) Fabricated sockets:
   • Plate material to be Grade D or DH quality in accordance with Chapter 3 of the Rules for Materials. Increased material toughness may be required in some cases.
   • Plate with through-thickness properties will generally be required, in accordance with Ch 3.8 of the Rules for Materials.

(c) Socket pins:
   • Socket pins may be cast or forged. Where cast, material requirements are to comply with (a) above. Forged socket pins are to be manufactured in accordance with Chapter 5 of the Rules for Materials.
   • As a supplement to Chapter 5 of the Rules for Materials, impact tests are to be carried out at a test temperature of minus 20°C, to satisfy a minimum average energy requirement of 40 J, with no more than one individual result from each three test specimens being less than 70 per cent of the required minimum average. Increased material toughness may be required in specific cases.
   • Alternative standards to Chapter 5 of the Rules for Materials complying with recognised National or proprietary specifications may be accepted, see also Ch 5.1.1.3 of the Rules for Materials.

7.5 Corrosion protection

7.5.1 Wire ropes are to be protected against corrosion. The corrosion protection will normally consist of galvanising or other sacrificial coating of individual wires. Filler wires of zinc or other suitable sacrificial material can be incorporated in the outer layers of the rope, as an addition to, but not in place of, galvanising of individual wires.

7.5.2 Galvanising to meet the following minimum standards:

(a) Zinc:
   • BS EN 1179.

(b) Zinc weight:
   • ASTM A 603 Table 5, Class A (spiral strand and locked coil).
   • ISO 2232, Quality B (six-strand ropes).

(c) Alternative recognised Standards providing acceptable equivalence will be considered.

7.5.3 Sockets are to be protected against corrosion by sacrificial anodes or acceptable equivalent.

7.5.4 Suitable arrangements are to be made to insulate the corrosion protected rope/socket assembly from adjacent non-protected elements in the system.

7.5.5 Polyethylene sheathing can also be used on appropriate rope constructions, as an addition to, but not normally as an alternative to, galvanising:

(a) Where sheathing is intended to be fitted, the specification is to be submitted. ASTM D 1248 is an acceptable specification for medium or high density polyethylene sheathing.

(b) A continuous strip of contrasting colour is to be incorporated into the sheathing to aid monitoring for twist.

7.6 Manufacture and testing

7.6.1 Steel wire ropes are to be manufactured in accordance with the design standards and procedures and at a works approved by LR. Ropes and fittings will be subject to LR survey during manufacture and testing.

7.6.2 A certified ISO 9001/9002 Quality System is to be in place and a quality plan is to be produced and agreed with LR Surveyors.
7.6.3 Where sheathing is specified, it is to be carried out in accordance with the Quality Plan.

7.6.4 Cast sockets are to be manufactured and tested in accordance with the requirements of 7.4.2(a).

7.6.5 The following minimum requirements for the non-destructive testing of cast sockets are applicable:
(a) Ultrasonics: All areas of all sockets and pins.
(b) Radiography: Critical areas of first, last, and one intermediate socket selected by LR Surveyor to be examined. Critical areas to be identified on design drawings, and these to be included in the design submission for verification.
(c) Magnetic Particle Inspection (MPI): 100 per cent of all sockets and pins.
(d) Visual: 100 per cent of all sockets and pins.

7.6.6 The material of plate fabricated sockets is to comply with 7.4.2(b) and welding and NDE to be in accordance with Pt 4, Ch 8. Post-weld heat treatment to be carried out for thicknesses exceeding 65 mm.

7.6.7 Tests are to be carried out on individual wires for the following:
- Tensile strength and elongation.
- Torsion.
- Reverse bend.
- Zinc coating: mass, uniformity and adhesion.
Tests are to be carried out in accordance with recognised National Standards such as ISO 2232 and ASTM A603, as appropriate.

7.6.8 Rope production samples are to be tested for the following:
- Modulus.
- Minimum breaking strength.

7.6.9 The tests required by 7.6.8 are to be as follows:
(a) The modulus test is to be carried out on one finished rope sample taken from the first production length. Production sockets need not be fitted for this particular test. Load/extension characteristics and permanent stretch are to be determined and documented. Acceptance criteria for permanent stretch are to be as follows:
  - Maximum of 0,4 per cent for spiral strand and locked coil ropes.
  - Maximum of 0,8 per cent for six-strand ropes.
The modulus of elasticity is to be calculated and documented. The basis for the calculated value (cross-sectional metallic area, or area of circle enclosing the rope) is to be clearly stated.
(b) Breaking load test is to be carried out on one sample taken from each manufactured length.
  - Where the rope design, the machine, and the machine settings are identical, consideration can be given to a reduction in the number of tests. As a minimum, breaking load tests are to be carried out on a sample taken from each of the first manufactured length, and one other length, selected by LR Surveyors.
  - Tests are to be carried out in accordance with a recognised National Standard such as DIN 51201.

7.7 Identification

7.7.1 Each wire rope assembly is to be marked at each end with the letters LR and the Certificate Number.

7.8 Certification

7.8.1 A certificate is to be issued for each rope assembly by LR. The following is to be included in the Certificate:
- Purchaser’s name and order number.
- Description of order, including wire rope diameter and construction.
- Tested minimum breaking load.
- Design Appraisal Document Number.
- Socket inspection certificate references.
- Individual wire certificate references.
- Sheathing report references.

Section 8
Chains

8.1 Chain grades

8.1.1 Chains to be offshore Grades R3, R3S, or R4 and are to comply with Ch 10.3 and Ch 10.4 of the Rules for Materials, as applicable. Acceptance of other grades will be subject to special consideration.

8.2 Corrosion and wear

8.2.1 A size margin over and above the minimum chain size required to satisfy Rule factor of safety requirements is to be included to allow for the corrosion and wear which can occur over the intended service life of the anchor chain or associated component. The minimum margins shown in Table 10.8.1 are recommended.
Section 9
Provisional requirements for fibre ropes

9.1 General
9.1.1 This Section gives provisional requirements for fibre ropes used in positional mooring systems. The requirements apply to fibre ropes incorporated as follows:
(a) Catenary mooring system:
   • Fibre rope insert lines, these being confined to the suspended part of the catenary system. Chain or wire rope will be fitted in parts of the anchor leg subject to contact with sea bed or floating unit.
(b) Taut-leg moorings:
   • In this case, fibre rope will form the majority of the anchor leg’s length. System compliancy will come from the inherent extensibility of the fibre rope. Chain will be fitted at upper and lower parts of the taut leg, where hard contact can occur.
   • Special consideration will be given to other types of fibre rope mooring application.

9.2 Design aspects
9.2.1 Fibre ropes and associated fittings are to be of an approved design. The following information to be submitted:
(a) Specifications:
   • Rope purchaser’s specification.
   • Rope design specification.
   • Rope manufacturing and testing specification.
(b) Plans:
   • Rope, spool piece and other fittings.
(c) Calculations:
   • Strength and fatigue of rope and fittings.
(d) Rope particulars:
   • Fibre type.
   • Diameter of rope.
   • Length at specified tension.
   • Construction.
   • Weight in air and water.
   • Sheathing type.

9.2.2 Factors of safety for fibre rope anchor line elements to be a minimum of 20 per cent higher than the levels given in Section 6 for chain and wire rope materials.

\[
\text{Factor of safety} = \frac{\text{Minimum breaking strength}}{\text{Maximum tension}}
\]

A reduction factor will require to be applied to the standard designated minimum breaking strength, where the test database for the rope type is statistically small.

9.2.3 The fibre rope section of an anchor leg is not to touch the sea bed in any intact or damaged condition.

9.2.4 Fibre ropes are to be kept sufficiently far below the waterline, and below the connection point on the unit, to avoid any possibility of contact damage.

9.3 Manufacture
9.3.1 Fibre ropes are to be manufactured at a works approved by LR.

9.3.2 Ropes and fittings will be subject to LR survey during manufacture and testing.

9.3.3 A certified ISO 9001/9002 Quality System is to be in place and a quality plan is to be produced and agreed with LR Surveyors.

9.3.4 The ropes and fittings are to be manufactured in accordance with the approved design, standards and procedures.

9.3.5 See also the requirements of Ch 10.7 of the Rules for Materials.
Section 10
Anchor points

10.1 Drag embedment anchors – Structural aspects

10.1.1 This sub-Section and 10.2 apply to drag embedment anchors of high holding power type. Proposals for the use of other anchor types will be specially considered.

10.1.2 Anchors are to be of an approved type.

10.1.3 Material selection for drag embedment anchors are, generally, to be in accordance with Pt 4, Ch 2, 4, taking the structural category as ‘Primary’.

10.1.4 Supporting calculations to verify the structural strength of the anchor for design service loads and for proof test loads are to be submitted.

10.1.5 The anchors are to be manufactured in accordance with the requirements of Chapter 10 of the Rules for Materials.

10.1.6 Anchors are to be subject to proof test loading in the manner laid down in the Rules. The level of proof test loading for positional mooring anchors is 50 per cent of the minimum rated breaking strength of the attached anchor line.

10.1.7 Proof load testing of large fabricated anchors (in excess of 15 tonnes mass) may be waived for classification, subject to the following:
(a) Structural strength of anchor type being verified by finite element analysis procedure.
(b) All main structural welds being subject to non-destructive examination as follows at manufacture:
   • 100 per cent visual.
   • 100 per cent MPI.
   • 100 per cent UT/radiographic, for full penetration welds.

10.1.8 Notwithstanding the above, attention is drawn to the separate requirement of some National Authorities for proof load testing of anchors.

10.2 Drag embedment anchors – Holding capacity

10.2.1 The requirements of 10.1 are also to be considered, in addition to this sub-Section.

10.2.2 Anchors for positional mooring are to be sufficient in number and holding capacity for the intended service. It is the Owner’s/Operator’s responsibility to ensure adequate anchor holding capacity for each location or holding ground.

10.2.3 The following is to be submitted for information:
   • Data, calculations and analysis supporting the selection of anchor.
   • Anchor details.
   • Test loading at installation.

10.3 Other anchors

10.3.1 Proposals for the use of anchors other than drag embedment type will be specially considered. Reference can be made to Pt 3, Ch 10 and Ch 12 of LR’s Rules and Regulations for the Classification of a Floating Offshore Installation at a Fixed Location, for requirements applying to other anchor types (e.g., Pile Anchors, Suction Anchor Piles, Gravity Anchors).

Section 11
Fairleads and cable stoppers

11.1 General requirements

11.1.1 Fairleads and stoppers are to be designed to permit free movement of the anchor line in all mooring configurations and designed to prevent excessive bending and wear of the anchor lines. The hardness of fairleads and chain stoppers, where in contact with the anchor line, should be softer than the anchor line. In general, the anchor line should not be in contact with any welds but, where this is not possible, the welds are to be ground flush and are to be softer than the anchor line.

11.1.2 The minimum operating range of the fairlead to be considered in conjunction with the design load is shown in Fig. 10.11.1.

11.1.3 Fairleads and stoppers and their supporting structures are to be designed for a load equivalent to the rated minimum break strength of the anchor line. Where applicable, side loads due to friction in the bearings need to be accounted for in the design, see also 11.1.8.

11.1.4 The maximum permissible stresses are to be in accordance with Pt 4, Ch 5.2.1.1(c).

11.1.5 Materials and steel grades are generally to comply with the requirements given in Pt 4, Ch 2 for primary structures.

11.1.6 Chain cable fairleads are to have a minimum of five pockets.

11.1.7 It is recommended that wire rope fairleads have a minimum diameter of 16 times the wire rope diameter.

11.1.8 Special consideration will be given to permissible stresses where the chain is of downgraded quality.

Note
There have been cases of closing plates on the fairlead shaft coming loose due to corrosion of the threads of the securing bolts, resulting in serious damage to the fairlead arrangements and the complete jamming of the fairlead and chain. Consequently, the securing bolts should also be checked to ensure that the bolt material does not corrode preferentially should the sacrificial anode system fail to function in way of the fairlead.
12.1 General

12.1.1 This Section applies to winches and windlasses designed to actively control anchor line tensions in service, or to release anchor lines in an emergency.

12.1.2 Special consideration will be given to requirements for winches and windlasses for passive mooring systems or permanent mooring systems.

12.1.3 Machinery items are to be constructed to recognised design Codes and Standards. The relevant requirements of Part 5 may be used as guidance for small and simple equipment, but for larger and more complex designs, special analysis techniques such as finite element methods (or equivalent) are considered to be more appropriate.

12.1.4 Machinery items are to be installed and tested in accordance with the relevant requirements of Part 5. For electrical and control equipment, see Section 13.

12.2 Materials

12.2.1 Materials are to comply with the Rules for Materials. Alternatively, materials which comply with National or proprietary specifications may be accepted, provided that these specifications give reasonable equivalence to the requirements of the Rules for Materials, or are approved for a specific application. Generally, survey and certification are to be carried out in accordance with the requirements of the Rules for Materials.

12.2.2 For the selection of material grades, individual components of anchor winches and windlasses are to be categorised as primary or secondary.

12.2.3 Components where the failure would result in the loss of a primary function of the winch or windlass are considered to be ‘primary components’, see also 12.2.5.

12.2.4 All other components where the failure would not result in the loss of a primary function of the winch or windlass are to be categorised as ‘secondary components’.

12.2.5 Primary components which are designed with an adequate degree of redundancy in their operation will be specially considered and may be categorised as secondary components.

12.2.6 Material grades for all components are in general related to the thickness of the material, the structural category and the minimum design air temperature and are to be selected to provide adequate notch toughness.

12.2.7 Material grades for welded plate components are in general to comply with Pt 4, Ch 2,4. For plates with a thickness greater than 50 mm but not exceeding 100 mm, Grade E or EH may be accepted for a design air temperature down to minus 15°C. For thicker plates and/or lower design temperature the steel grades will be specially considered.

12.2.8 Material grades for components which are not subject to welding will be specially considered.

12.2.9 Castings and forgings are to comply with Chapters 4 and 5 of the Rules for Materials respectively and the requirements for notch toughness in relation to the design air temperature will be specially considered.

12.2.10 Non-ductile materials are not to be used for torque transmitting items or for those elements subject to tensile/bending stresses.
12.2.11 Spheroid graphite iron castings are to comply with Ch 7.3 of the Rules for Materials, Grades 370/17 or 400/12, or to an equivalent National Standard.

12.2.12 The use of grey iron castings will be subject to special consideration. Where approved, they are to comply with the requirements of Ch 7.2 of the Rules for Materials. This material is not to be used for gear components.

12.2.13 Brake lining materials are to be compatible with operating environmental conditions.

12.3 Brakes

12.3.1 Each anchor winch or windlass is required to have one primary braking system and one secondary braking system. The two systems are to operate independently. The requirements of 12.5 are to be complied with.

12.3.2 The braking action of the motor unit may be used for secondary braking purposes where the design is suitable.

12.3.3 A residual braking force of at least 50 per cent of the maximum braking force required by 12.5.1 is to be immediately available and automatically applied in the event of a power failure.

12.4 Stoppers

12.4.1 If the winch motor is to be used as a secondary brake then a stopper is to be provided to take the anchor line load during maintenance of the primary brake.

12.4.2 The stopper may be one of two different types – a pawl stopper fitted at the cable lifter/drum shaft, or a stopper acting directly on the anchor line.

12.4.3 Where the stopper acts directly on the cable, its design is to be such that the cable will not be damaged by the stopper at a load equivalent to the rated breaking strength of the cable.

12.4.4 See also 13.3.1 and 13.3.2, for stopper control station requirements, and 13.5.6, for emergency release of stoppers.

12.5 Winch/windlass performance

12.5.1 The primary brake is required to hold a static load equal to the minimum break strength of the anchor line (at the intended outer working layer of wire rope on storage drum winches). The static load capacity of the primary brake can be reduced to 80 per cent of that value when a stopper capable of holding 100 per cent of the breaking strength of the line is fitted.

12.5.2 The secondary brake is required to hold a static load equal to 50 per cent of the minimum breaking strength of the anchor line.

12.5.3 The anchor winch or windlass is to have adequate dynamic braking capability. The two brake systems in joint operation are to be capable of fully controlling, without overheating, the anchor lines during:
   • all anchor handling operations;
   • adjustment of anchor line tensions. (This is particularly relevant where the mooring system has been designed and sized on the basis of active adjustment of anchor lines in extreme conditions, to minimise line tensions).

12.5.4 See also 13.3 for control of winches, windlasses, stoppers and pawls, and 13.5 for brake fail-safe requirements and standby power for operation of brakes and release of stoppers in the event of a failure of normal power supply.

12.5.5 Means are to be provided to enable the anchor lines to be released from the unit after loss of main power.

12.5.6 The pulling force of the winches or windlasses is to be sufficient to carry out anchor pre-loading on location, to the necessary level. A minimum low-speed pull equal to 40 per cent of the anchor line breaking strength is recommended.

12.6 Strength

12.6.1 Design load cases for the winch or windlass assembly and the stopper, when fitted, are given in Table 10.12.1. The associated maximum allowable stresses are to be based on the factors of safety given in Table 10.12.2.

12.7 Testing

12.7.1 Works’ tests are to be carried out at the manufacturer’s works in the presence of the Surveyor, on at least one of the winches or windlass units out of the total outfit for the unit. The tests to be carried out are given in Table 10.12.3. Alternatively, where a prototype winch has been suitably tested, consideration will be given to the acceptance of these results.

12.7.2 The residual braking capability is to be verified in accordance with 12.5.4.
12.7.3 Each winch or windlass is to be tested on board the vessel in the presence of the Surveyor, to demonstrate that all main aspects including dynamic brakes function satisfactorily. The proposed test programme is to be submitted.

12.8 Type approval

12.8.1 Winches or windlasses may be type approved in accordance with LR’s Type Approval Scheme. Where this Type Approval is obtained, the requirements of 12.7.1 may not be applicable.

### Section 13

#### Electrical and control equipment

13.1 General

13.1.1 The electrical installation is to be designed, constructed and installed in accordance with the relevant requirements of Pt 6, Ch 2.

13.1.2 Control, alarm and safety systems are to be designed, constructed and installed in accordance with the relevant requirements of Pt 6, Ch 1, together with the requirements of 13.2 to 13.4.

13.2 Controls, indications and alarms

13.2.1 Adequate control, indication and alarm systems are to be provided to ensure satisfactory operation of the positional mooring system.

13.2.2 A suitable central control station is to be provided.

13.2.3 Where additional local control stations are provided, means of direct communication between the local and central control stations are to be arranged.

13.2.4 Indication of the following, as applicable, is to be provided at the central control station and, where local control is provided, at the local control station:

(a) Position of unit.
(b) Heading of unit.
(c) Anchor line tensions.
(d) Wind speed and directions.

13.2.5 Alarms are to be provided for the following fault conditions, as applicable:

(a) Deviation from positional limits.
(b) Deviation from heading limits.
(c) Deviation from anchor line tension limits (high and low).
(d) Gyro compass fault.
(e) Position reference system fault.
(f) Wind speed and direction indicator fault.
(g) Control computer system fault.

13.3 Control stations

13.3.1 The operation of winches, windlasses and associated brakes, chainstoppers and pawls is to be controlled locally from weather protected control stations which provide good visibility of the equipment and associated anchor handling operations.

13.3.2 A central control station, which may be located on the bridge or a separate manned control room, is to be provided from which brakes, chainstoppers and pawls can be remotely released.

13.3.3 For each anchor winch, the respective local control station is to be provided with a means of indicating the following:

(a) Line tension.
(b) Length of line paid out.
(c) Line speed.

### Table 10.12.2 Load case factors of safety

<table>
<thead>
<tr>
<th>Stress</th>
<th>Load case</th>
<th>Factor of safety</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 and 2</td>
<td>3</td>
</tr>
<tr>
<td>Shear</td>
<td>1,89</td>
<td>2,5</td>
</tr>
<tr>
<td>Tension, compression, bending</td>
<td>1,25</td>
<td>1,67</td>
</tr>
<tr>
<td>Combined</td>
<td>1,11</td>
<td>1,43</td>
</tr>
</tbody>
</table>

NOTES
1. Factors of safety relate to tensile yield stress.
2. Combined stress = \( \sqrt{\sigma_X^2 + \sigma_Y^2 - \sigma_X \sigma_Y + 3\tau^2} \)
   Where \( \sigma_X \) and \( \sigma_Y \) are the combined axial and bending stresses in the X and Y directions respectively and \( \tau \) is the combined shear stress due to torsion and/or bending in the X–Y plane.

### Table 10.12.3 Winch/windlass tests

<table>
<thead>
<tr>
<th>Test</th>
<th>Test load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static brake – Primary</td>
<td>100% anchor line break strength (or 80% where stopper fitted. See 12.5.1)</td>
</tr>
<tr>
<td>Static brake – Secondary</td>
<td>50% anchor line break strength</td>
</tr>
<tr>
<td>Stopper (where fitted)</td>
<td>100% anchor line break strength</td>
</tr>
<tr>
<td>Motor stall test</td>
<td>Specified stall load</td>
</tr>
</tbody>
</table>
13.3.4 The indication required by 13.3.3(a) and (b) is to be repeated to the central control station and in addition a means of indicating the following is to be provided at this position:
(a) Mooring patterns and anchor line catenaries.
(b) Status of winch operation.
(c) Position and heading, see also 13.5.7.
(d) Gangway angle and extension, when applicable.
(e) Riser angle, when applicable.
(f) Wind speed and direction, see also 13.5.10.

13.3.5 Means of voice communication are to be provided between the central control station, each local control station and anchor handling vessels, when applicable.

13.4 Alarms

13.4.1 Alarms are to be provided at the local and central control stations for the following fault conditions:
(a) Excessive line tension.
(b) Loss of line tension.
(c) Excessive gangway angle and extension, when applicable.
(d) Excessive riser angle, when applicable.

13.4.2 Alarms are to be provided adjacent to the winches and windlasses to warn personnel prior to and during any remote operation.

13.4.3 Alarms are to be provided at the central control station for the following fault conditions:
(a) When the unit deviates from its predetermined area of operation.
(b) When the unit deviates from its predetermined heading limits.
These alarms are to be adjustable but should not exceed specified limits. Arrangements are to be provided to fix and identify their set points.

13.5 Controls of winch and windlass systems

13.5.1 This sub-Section is applicable to mooring systems incorporating winches, windlasses, etc., which are used to actively control and adjust anchor line tensions in service, or to release anchor lines in an emergency.

13.5.2 Adequate controls are to be provided at the local control station for satisfactory operation of the winch(es).

13.5.3 The braking system is to be arranged so that the brakes, when applied, are not released in the event of a failure of the normal power supply.

13.5.4 Standby power is to be provided to enable winch brakes to be released within 15 seconds in an emergency. The release arrangements are to be operable locally at each winch and from the central control position, and are to be such that the entire anchor line can be lowered in a controlled manner.

13.5.5 The standby power is to be such that during lowering of the anchor line it is possible to apply the brakes once and then release them again in a controlled manner.

13.5.6 Standby power is to be provided so that any anchor line stoppers or pawl mechanisms may be released from either the local or central control stations up to a line tension equal to the minimum rated break strength of the anchor line. These mechanisms are to be capable of release at the maximum angles of heel and trim under the damage stability and flooding conditions for which the unit is designed.

13.5.7 At least one position reference system and one gyrocompass or equivalent is to be provided, when applicable, to ensure the specified area of operation and heading deviation can be effectively monitored.

13.5.8 Position reference systems are to incorporate suitable position measurement techniques which may be by means of acoustic devices, radio, radar, taut wire, riser angle, gangway extension and angle or other acceptable means, depending on the service conditions for which the unit is intended.

13.5.9 A vertical reference sensor is to be provided, if applicable, to measure the pitch and roll of the unit.

13.5.10 Means are to be provided to ascertain the wind speed and direction acting on the unit.

Section 14
Thruster-assisted positional mooring

14.1 General

14.1.1 Where the positional mooring system is assisted by thrusters, as defined in Section 4, units complying with the requirements of this Section together with the requirements in Section 15 will be eligible for one of the following supplementary class notations as specified in 1.2:
TA(1) See 15.1
TA(2) See 15.2
TA(3) See 15.3

14.1.2 Machinery items are to be constructed, installed and tested in accordance with the relevant requirements of Part 5 together with the requirements of 14.2 and Section 15.

14.2 Thrust units

14.2.1 Thruster installations are to be designed to minimise potential interference with other thrusters, sensors, hull or other surfaces which could be encountered in the service for which the unit is intended.

14.2.2 Thruster intakes are to be located at sufficient depth to reduce the possibility of ingesting floating debris and vortex formation.
14.2.3 Steerable thrusters and thrusters having variable pitch propellers are to be provided with two independent supplies of motive power to the pitch and direction actuating mechanisms.

14.2.4 Each thruster unit is to be provided with a high power alarm. The setting of this alarm is to be adjustable and below the maximum thruster output.

14.2.5 The response and repeatability of thrusters to changes in propeller pitch or propeller speed/direction of rotation are to be suitable for maintaining the area of operation and the heading deviation specified.

14.2.6 The thrust unit housing is to be tested at a hydraulic pressure of not less than 1.5 times the service immersion head of water or 1.5 bar (1.5 kgf/cm²), whichever is the greater.

14.3 Electrical equipment

14.3.1 The electrical installation is to be designed, constructed and installed in accordance with the relevant requirements of Pt 6, Ch 2, together with the requirements of 14.3.3 to 14.3.8, and the relevant requirements of Section 15.

14.3.2 Where the thruster units are electrically driven, the relevant requirements, including surveys, defined in Pt 6, Ch 2,15 are to be complied with.

14.3.3 The total generating capacity is to be in accordance with 15.1.3, 15.2.8 and 15.3.8, as applicable.

14.3.4 Where the electrical power requirements are supplied by one generator set, on loss of power there is to be provision for automatic starting and connection to the switchboard of a standby set and automatic restarting of essential auxiliary services. For other requirements relevant to particular thruster-assisted class notations, see Section 15.

14.3.5 An alarm is to be initiated at the thruster-assisted positioning control station(s) when the total electrical load of all operating thruster units exceeds a pre-set percentage of the running generator(s) capacity. This alarm is to be adjustable between 50 and 100 per cent of the full load capacity, having regard to the number of electrical generators in service.

14.3.6 The number and ratings of power transformers are to be sufficient to ensure full load operation of the thruster-assisted positioning system even when one transformer is out of service. This does not require duplication of a transformer provided as part of a transformer/silicon controlled rectifier (SCR) drive unit.

14.3.7 Thruster auxiliaries, control computers, reference systems and environmental sensors are to be served by individual circuits. Services that are duplicated are to be separated throughout their length as widely as is practical and without the use of common feeders, transformers, converters, protective devices or control circuits.

14.3.8 Where the auxiliary services and positioning mooring thrusters are supplied from a common source, the following requirements are to be complied with:
(a) The voltage regulation and current sharing requirements defined in Pt 6, Ch 2,8 are to be maintained over the full range of power factors that may occur in service.
(b) Where SCR converters are used to feed the thruster motors, and the instantaneous value of the line-to-line voltage wave-form on the a.c. auxiliary system busbars deviates by more than 10 per cent of \( \sqrt{2} \) times the r.m.s. voltage from the instantaneous value of the fundamental harmonic, the essential auxiliary services are to be capable of withstanding the additional temperature rise due to the harmonic distortion. Control, alarm and safety equipment is to operate satisfactorily with the maximum supply system wave-form distortion, or be provided with suitably filtered/converted supplies.
(c) When the control system incorporates volatile memory it is to be supplied via uninterruptible power supplies provision for automatic starting and connection to the (UPS), see also Pt 6, Ch 2,9.3.

14.4 Control engineering systems – Additional requirements

14.4.1 The control engineering systems are to be designed in accordance with the relevant requirements of Section 13 together with the additional requirements of 14.4.2 to 14.4.3 and the relevant requirements of Section 15.

14.4.2 Indication of the following is to be provided at each station from which it is possible to control the thruster-assisted positioning system, as applicable:
- The heading and location of the vessel relative to the desired reference point or course.
- Vectorial thrust output, individual and total.
- Operational status of position reference systems and environmental sensors.
- Environmental conditions, e.g., wind speed and direction.
- Availability status of standby thruster units.

14.4.3 Alarms are to be provided for the following fault conditions where applicable:
- When the unit deviates from its predetermined area of operation.
- When the unit deviates from its predetermined heading limits.
- Position reference system fault (for each reference system).
- Gyrocompass fault.
- Vertical reference sensor fault.
- Wind sensor fault.
- Taut wire excursion limit.
- Automatic changeover to a standby position reference system or environmental sensor.
- Control computer system fault.
- Automatic changeover to a standby control computer system, see 15.3.3.
Positional Mooring Systems

14.4.4 Suitable processing and comparative techniques are to be provided at the central control station to validate the control system inputs from position and other sensors, to ensure optimum performance of the thruster-assisted mooring system.

14.4.5 Abnormal signal errors revealed by the validity checks required by 14.4.4 are to operate alarms.

14.4.6 The control system for thruster-assisted positioning operation is to be stable throughout its operational range and is to meet the specified performance and accuracy criteria.

14.4.7 Automatic controls are to be provided to maintain the desired heading of the unit.

14.4.8 The deviation from the desired heading is to be adjustable, but is not to exceed the specified limits. Arrangements are to be provided to fix and identify the set point for the desired heading.

14.4.9 Sufficient instrumentation is to be fitted at the central control station to ensure effective control and indicate that the system is functioning correctly, see 14.4.2.

Section 15
Thruster-assist class notation requirements

15.1 Notation TA(1)

15.1.1 For assignment of the notation TA(1), in accordance with Section 4, the applicable requirements of Sections 13 and 14, together with 15.1.2 to 15.1.3, are to be complied with.

15.1.2 Centralised automated manual control of the thrusters is to be provided to supplement the positional mooring system. The manual control system is to provide output signals to the thrusters via the manual controller to change the speed, pitch and azimuth angle, as applicable, as indicated at the central control station, see 13.2.

15.1.3 For electrically driven thruster systems, the total generating capacity of the electrical system is to be not less than the maximum dynamic positioning load together with the maximum auxiliary load. This may be achieved by parallel operation of two or more generating sets, provided the requirements of Pt 6, Ch 2.2.2 are complied with.

15.2 Notation TA(2)

15.2.1 For assignment of the notation TA(2), in accordance with Section 4, the applicable requirements of Sections 13 and 14, together with 15.2.2 to 15.2.8, are to be complied with.

15.2.2 Automatic and manual control systems are to be provided to supplement the positional mooring systems and arranged to operate independently so that failure in one system will not render the other system inoperative, see also 15.1.2 for manual control.

15.2.3 The automatic control system is to utilise automatic inputs from the position reference system, the environmental sensors and line tensions, and automatically provide output signals to the thrusters to change the speed, pitch and azimuth angle, as applicable, such that the line tensions are optimised.

15.2.4 In the event of a failure of a reference or environmental sensor, the control systems are to continue to operate on signals from the remaining sensors without manual intervention.

15.2.5 In the event of line failure or failure of the most effective thruster, the unit is to be capable of maintaining its predetermined area of operation and desired heading in the environmental conditions for which the unit is designed and/or classed.

15.2.6 Control, alarm and safety systems are to incorporate a computer-based consequence analysis which may be continuous or at predetermined intervals and is to analyse the consequence of predetermined failures to verify that the anchor line tensions and position/heading deviations remain within acceptable limits. In the event of a possible hazardous condition arising as a result of the consequence analysis, an alarm is to be initiated at the central control station.

15.2.7 The area of operation is to be adjustable, but is not to exceed the specified limits, which are to be based on a percentage of water depth, or if applicable a defined absolute surface movement. Arrangements are to be provided to fix and identify the set point for the area of operation.

15.2.8 For electrically driven thruster systems, the following requirements are to be complied with:
(a) Generating capacity, as defined in 15.1.3.
(b) With one generating set out of action, the capacity of maximum positioning load with the most effective thruster inoperative, together with the essential services defined by Pt 6, Ch 2.1.5.
(c) Where generating sets are arranged to operate in parallel, the supplies to essential services are to be protected by the tripping of non-essential loads as required by Pt 6, Ch 2.6.9 and additionally, on loss of a running generator, a reduction in thrust demand may be accepted, provided the arrangements are such that a sufficient level of dynamic position capability is retained to permit the three degrees of manoeuvrability of the unit.
(d) Indication of absorbed electrical power and available on-line generating capacity is to be provided at the main thruster-assisted positioning control station, see 14.4.1.
(e) Means are to be provided to prevent starting of thruster motors until sufficient generating capacity is available.
15.3 **Notation TA(3)**

15.3.1 For assignment of the notation **TA(3)**, in accordance with Section 4, the applicable requirements of Sections 13 and 14, together with 15.2.3 to 15.2.8 and 15.3.2 to 15.3.9, are to be complied with.

15.3.2 Two automatic control systems are to be provided and arranged to operate independently so that failure in one system will not render the other system inoperative.

15.3.3 In the event of failure of the working system, the standby automatic control system is to be arranged to change over automatically without manual intervention and without any adverse effect on the vessel’s station-keeping capability. The automatic changeover is to initiate an alarm.

15.3.4 At least two position reference systems as defined by 13.5.8, and two gyrocompasses or equivalent, are to be provided.

15.3.5 At least two of each of the sensors as required by 13.5.9 and 13.5.10 are to be provided.

15.3.6 When two voyage recording systems are deployed, their outputs are to be compared and an alarm raised when a significant difference occurs.

15.3.7 The arrangement is to be verified by means of a Failure Modes and Effects Analysis (FMEA). Such components may include, but not be restricted to, the following:

- Mooring systems.
- Prime movers, e.g., auxiliary engines.
- Generators and the excitation equipment.
- Switchgear.
- Pumps.
- Thrusters.
- Fans.
- Valves, where power actuated.

15.3.8 Control, alarm and safety systems are to incorporate a computer-based consequence analysis which may be continuous or at predetermined intervals and is to analyse the consequence of predetermined failures to verify that position and heading deviation remain within acceptable limits. In the event of a possible hazardous condition being indicated from the consequence analysis, an alarm is to be initiated.

16.1 **Trials**

16.1.1 Before a new installation (or any alteration or addition to an existing installation) is put into service, trials are to be carried out. These trials are in addition to any acceptance tests which may have been carried out at the manufacturer’s works and are to be based on the approved test schedules list as required by 1.4.1(d).
Section 1

Rule application

1.1 General

1.1.1 Masts, derrick posts, crane pedestals and similar supporting structures to equipment are classification items, and the scantlings and arrangements are to comply with the additional requirements of this Chapter.

1.1.2 Certain lifting appliances on special purpose units which are considered an essential feature of the unit are to be included in the classification of the unit. Elsewhere, classification of lifting appliances is optional and may be assigned at the request of the Owner on compliance with the appropriate requirements.

1.1.3 Where the lifting appliance is considered to be an essential feature of a classed unit, the special feature class notation LA will, in general, be mandatory.

1.2 Masts, derrick posts and crane pedestals

1.2.1 The scantlings of masts and derrick posts, intended to support derrick booms, and of crane pedestals are to comply with the requirements of LR’s Code for Lifting Appliances in a Marine Environment (hereinafter referred to as LAME Code).

1.2.2 In addition to the information and plans requested in LR’s LAME Code, the following details are to be submitted:
(a) Details of deckhouses or other supports for the masts, derrick posts or crane pedestals, together with details of the attachments to the hull structure.
(b) Details of any reinforcement or additional supporting material fitted to the hull structure in way of the mast, derrick post or crane pedestal.

1.2.3 Masts, derrick posts or crane pedestals are to be efficiently supported and, in general, are to be carried through the deck and satisfactorily scarfed into transverse or longitudinal bulkheads, or equivalent structure. Alternatively, the mast, derrick posts or crane pedestals may be carried into a deckhouse or equivalent structure, in which case the house is to be of substantial construction. Proposals for other support arrangements will be specially considered.

1.2.4 Deck plating and underdeck structure are to be reinforced under masts, derrick posts and crane pedestals. Where the deck is penetrated the deck plating is to be suitably increased locally.

1.2.5 The permissible stresses in the support structure are to be in accordance with Pt 4, Ch 5.2.

1.3 Lifting appliances

1.3.1 Offshore units fitted with lifting appliances built in accordance with LR’s LAME Code in respect of structural and machinery requirements will be eligible to be assigned special features class notations as listed in Table 11.1.1. The notation will be retained so long as the appliances are found upon examination at the prescribed surveys to be maintained in accordance with LR’s requirements.

Table 11.1.1 Special features class notations associated with lifting appliances

<table>
<thead>
<tr>
<th>Lifting appliances formning an essential feature of the unit e.g. Cranes on crane barges or units, lifting arrangements for diving on diving support units, etc.</th>
<th>LA</th>
<th>Mandatory notation. Indicates that the lifting appliance is included in class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cranes on offshore units</td>
<td>PC</td>
<td>Optional notation. Indicates that the unit’s main deck cranes are included in class</td>
</tr>
<tr>
<td>Lifts</td>
<td>PL</td>
<td>Optional notation. Indicates that the unit’s personnel lifts are included in class</td>
</tr>
</tbody>
</table>

1.4 Crane boom rests

1.4.1 With the crane boom in the stowed position, the structure of the crane boom support structure is to be designed for the maximum reaction forces in any operating condition, taking into account the maximum design environmental loadings and inertia forces due to unit motions.

1.4.2 The crane boom support structure is also to be verified in the emergency condition defined in Ch 8.1.4.

1.4.3 The permissible stresses in the crane boom support structure and the deck structure below are to be in accordance with Pt 4, Ch 5.2.

1.5 Runway beams

1.5.1 Runway beams are to be designed and tested in situ in accordance with a recognised Standard and marked with the safe working load, see also Appendix A.

1.6 Lifting padeyes

1.6.1 Padeyes attached to the main structure which are to be used with a rated lifting appliance are to be proof tested after installation and marked with the safe working load (SWL). The proof load is not to be less than 1.5 x SWL.
1.6.2 Lifting lugs are to be permanently marked with the SWL, tested after installation and NDE to the Surveyor’s satisfaction. In agreement with LR, testing and NDE of lifting lugs with SWL < 1 tonne may be by sampling, provided design calculations can demonstrate a factor of safety greater than 2.

1.7 Access gangways

1.7.1 Pedestals and similar structures supporting installed gangways used for access to adjacent fixed installations are classification items and the scantlings and arrangements are to comply with the general requirements for crane pedestals and support structure in 1.2.

1.7.2 The gangway is to comply with the relevant statutory Regulations of the National Administration of the country in which the unit is registered and/or in which it is to operate and design calculations for the supporting structure are to be submitted.
Section 1

General

1.1 Application

1.1.1 The requirements of this Chapter apply to rigid and flexible risers, together with associated components, between the pipeline end manifold connection and the connection to the unit, see 1.4.2. The requirements of this Chapter are considered to be supplementary to the requirements in the relevant Parts of the Rules.

1.1.2 The requirements also apply to surface floating and suspended flexible loading hoses (as appropriate).

1.1.3 Submarine steel pipelines are to comply with the requirements contained in internationally recognised Codes and Standards.

1.1.4 The riser system will be considered for Classification on the basis of operating constraints and procedures specified by the Owner and recorded in the Operations Manual.

1.1.5 Risers may be arranged separately or in connected bundles comprising production risers together with other elements.

1.2 Class notations

1.2.1 The Regulations for classification and the assignment of class notations are given in Pt 1, Ch 2, to which reference should be made.

1.2.2 Offshore units connected to product riser systems which comply with the requirements of this Chapter will be eligible for the assignment of the special features class notation PRS.

1.2.3 The service limits on which approval of the riser system has been based are to be included in the Operations Manual, see 2.5.

1.3 Definitions

1.3.1 The definitions in this Chapter are stated for Rule application only, and may not necessarily be valid in any other context.

1.3.2 Riser system. The riser together with its supports, component parts and ancillary systems such as corrosion protection, mid water arch, bend stiffeners, buoyancy modules, bend restrictors, bend stiffener latching mechanisms, etc.

1.3.3 Riser. A subsea flexible hose or rigid pipe leading down from the connection on the unit to a sea bed termination structure. Risers may have a variety of functions including liquid and gas export, water injection, chemical injection and controls, etc.

1.3.4 Floating pipe. A surface pipe between the single-point mooring or buoy and the ship manifold. The floating pipe is normally permanently attached to the single-point mooring.

1.3.5 Riser support. Any structural item used for connecting a part of the riser system to the unit.

1.3.6 Riser components. Valves, connections, etc., and similar apparatus incorporated in the riser system.

1.4 Scope

1.4.1 The following additional topics applicable to the special features class notation are covered by this Chapter:

- Welded steel risers.
- Flexible risers.
- Floating hoses.
- Pig traps.
- Valves, controls and fittings.
- Safety devices.
- Coverings and protection.
- Cathodic protection system.

1.4.2 Unless agreed otherwise with LR, the Rules consider the following as the main boundaries of the riser system:

- Any part of the riser system as defined in 1.3.2 from the sea bed termination to the first riser connector valves on the unit.
- The riser connector valves will normally be considered part of the offshore unit, unless agreed otherwise with LR.

1.5 Damage protection

1.5.1 Wherever possible, risers should be protected from collision damage either by suitable positioning within the unit or by protective structure provided for this purpose.
1.5.2 The risk of damage arising from impact loads should form an integral part of the riser assessment. The assessment should evaluate the risk and consequences to the installation of a release of hydrocarbon from the riser.

1.5.3 Design of the riser system should consider the avoidance of collisions between individual risers and anchor lines, etc., with the positioning system intact and in a single fault damaged state under the appropriate environmental conditions. Contact may be allowed in a single fault damaged state provided special external armoury is fitted to the risers in the interference regions, or where appropriate calculations and/or tests indicate that no damage to the risers will occur.

1.5.4 Risers designed to be capable of rapid release should not be damaged in the course of such release, nor should they inflict critical damage on other components.

1.6 Buoyancy elements

1.6.1 Where subsea buoyant vessels are provided as an inherent part of the riser system design, the requirements of Pt 3, Ch 2.3 of the Rules and Regulations for the Classification of a Floating Offshore Installation at a Fixed Location are to be complied with.

1.6.2 The loss of buoyancy of any one element is not to affect adversely the integrity of the riser system.

1.7 Emergency shut-down (ESD) system

1.7.1 An ESD system is to be provided to riser systems in accordance with Pt 7, Ch 1. This requirement is generally not applicable to conventional surface floating and suspended flexible loading hoses.

1.7.2 An ESD system philosophy should be developed for the installation based on appropriate hazard and safety assessments. Due consideration is to be given to the sequence of events in relation to overall installation safety.

1.7.3 To limit the quantity of flammable or toxic substances escaping in the event of damage to a riser, emergency shut-down valves are to be fitted. The valves and their control mechanisms should be positioned to offer the maximum protection to the unit in the event of damage.

1.7.4 Facilities are to be provided to make it possible at all times to isolate risers by means of valves.

1.7.5 Where appropriate, rapid disconnection of risers must be possible from at least one location. The assessment of how many locations to be provided, and where they should be situated, is to be based on the evaluation of various accident scenarios. Suitable fail-safe measures are to be provided to prevent inappropriate or inadvertent disconnection.

1.8 Recognised Codes and Standards

1.8.1 In general, the requirements in this Chapter are based on internationally recognised Codes and Standards for riser systems, as defined in Appendix A. Other Codes and National Standards may be used after special consideration and prior agreement with LR. When considered necessary, additional Rule requirements are also stated in this Chapter.

1.8.2 The agreed Codes and Standards may be used for design, construction and installation, but the additional requirements stated in the Rules are to be complied with. Where there is any conflict, the Rules will take precedence over the Codes or Standards.

1.8.3 The mixing of Codes or Standards for each equipment item or system is to be avoided. Deviation from the Code or Standard must be specially noted in the documentation and approved by LR.

1.8.4 Where National Administrations have specific requirements regarding riser systems, it is the responsibility of the Owner and Operators to comply with such Regulations.

1.9 Equipment categories

1.9.1 The approval and certification of riser systems are to be based on equipment categories agreed with LR.

1.9.2 Riser systems, including their associated components and valves, are to be divided into equipment Categories 1A, 1B and II, depending on their complexity of manufacture and their importance with regard to the safety of personnel and the installation and their possible effect on the environment.

1.9.3 The following equipment categories are used in the Rules:

1A Equipment of primary importance to safety, for which design verification and survey during fabrication are considered essential. Equipment in this category is of complicated design/manufacturer and is not normally mass produced.

1B Equipment of primary importance to safety, for which design verification and witnessing the product quality are considered essential. Equipment in this category is normally mass produced and not included in Category 1A.

II Equipment related to safety, which is normally manufactured to recognised Codes and Standards and has proven reliability in service, but excluding equipment in Category 1A and 1B.

1.9.4 A guide to equipment and categories is given in Appendix A. A full list of equipment categories for the riser system is to be agreed with LR before manufacture. Minor equipment components need not be categorised.
1.10 Equipment certification

1.10.1 Equipment is to be certified in accordance with the following requirements:

(a) Category 1A:
- Design verification and issue of certificate of design strength approval.
- Pre-inspection meeting at the suppliers with agreement and marking of quality plan and inspection schedule.
- Survey during fabrication and review of fabrication documentation.
- Final inspection with monitoring of function/pressure/load tests and issue of a certificate of conformity.

(b) Category 1B:
- Design verification and issue of certificate of design strength approval, where applicable, and review of fabrication documentation.
- Final inspection with monitoring of function/pressure/load tests and issue of certificate of conformity.

(c) Category II:
- Supplier's/manufacturer's works certificate giving equipment data, limitations with regard to the use of the equipment and the supplier's/manufacturer's declaration that the equipment is designed and fabricated in accordance with recognised Standards or Codes.

1.10.2 All equipment recognised as being of importance for the safety of personnel and the riser system is to be documented by a data book.

1.11 Fabrication records

1.11.1 Fabrication records are to be made available for Categories 1A and 1B equipment for inspection and acceptance by LR Surveyors. These records should include the following:
- Manufacturer's statement of compliance.
- Reference to design specification and plans.
- Traceability of materials.
- Welding procedure tests and welders' qualifications.
- Heat treatment records.
- Records/details of non-destructive examinations.
- Load, pressure and functional test reports.

1.12 Site installation of riser systems

1.12.1 The installation of riser systems is to be controlled by LR in accordance with the following principles:
- All Category 1A and 1B equipment, when delivered to site, is to be accompanied by a certificate of design strength approval and an equipment certificate of conformity and all other documentation.
- All Category II equipment, delivered to site, is to be accompanied by equipment data and a works' certificate.
- Control and follow-up of non-conformities/deviations specified in design certificates and certificate of conformity.
- Ongoing survey and final inspection of the installed riser system.
- Monitoring of functional tests after installation and connection to the unit in accordance with an approved test programme.
- Issue of site installation report.

1.13 Maintenance and repair

1.13.1 It is the Owner's/Operator's responsibility to ensure that an installed riser system is maintained in a safe and efficient working condition in accordance with the manufacturer's and design specification.

1.13.2 When it is necessary to repair or replace components of a riser system, any repaired or spare part is to be subject to the equivalent certification as the original, see 10.2.

1.14 Plans and data submissions

1.14.1 Plans, calculations and data are to be submitted as required by the relevant Parts of the Rules together with the additional plans and information listed in this Chapter.

Section 2

Plans and data

2.1 General

2.1.1 Sufficient plans and data are to be submitted to enable the design to be assessed and approved. The plans are also to be suitable for use during construction, installation, hydrotesting, survey and maintenance of the riser system.

2.1.2 In general, engineering drawings and documents should be submitted electronically.

2.2 Specifications

2.2.1 Adequate design specifications, appropriate in detail to the approval required, are to be submitted for information.

2.2.2 Specifications for the design, construction and fabrication of the riser system, structure and associated equipment are to be submitted. The specifications are to include details of materials, grades/standards, consumables, construction and installation procedures and modes of operation with applicable design criteria. The specifications are also to include the proposed design codes.

2.2.3 Specifications and documentation are to be submitted, covering all instrumentation and monitoring systems proposed to cover the fabrication, installation and operating phases of risers, fittings and equipment.
2.3 Plans and data to be submitted

2.3.1 Plans and data covering the following items are to be submitted for approval, as relevant:
- Bend stiffeners.
- Bend stiffeners latching mechanisms.
- Bend restrictors.
- Buoyancy arches and fittings.
- Buoyancy modules.
- Construction and laying procedures.
- Corrosion protection system.
- Curvature bending stiffeners.
- Details of all attachments.
- Details of riser system control and communications.
- Details of sea bed.
- Emergency shut-down system and other safety devices, including pressure transient (surge) relief.
- End fittings.
- Instrumentation and communication line diagrams.
- Layout of risers and associated platform arrangements, including protection of risers.
- Leak detection system and hardware.
- Location survey showing name, latitude and longitude of terminal locations, location of isolating valves, position of platforms or other fabrications, shipping channels, presence of cables, pipelines and wellheads, etc.
- Mid water arches
- Quality Control and NDE procedures.
- Riser dimensions.
- Riser material specifications, including appropriate test results.
- Riser support details.
- Riser wall thickness tolerances.
- Sizes and details of expansion loops, reducers, etc.
- Test schedules for communication systems, controls, emergency shut-down systems and other safety devices, which are to include the methods of testing and test facilities provided.
- Tether arrangements
- Type and thickness of corrosion coating.
- Type and details of all pig traps, valves and control equipment, etc.
- Welding specification, details and procedures.

2.3.2 The following supporting plans and documents are to be submitted:
- Reference plans and listing of standard components, e.g., tees, reducers, connectors, valves, elbows, etc.
- Reference plans of anodes, sleeves, etc.
- Corrosive nature of sea-water and sea bed soils.
- Current, tidal current and storm surge velocities and directions.
- Design cathodic protection potential.
- Damaging tension of flexible risers.
- Design life.
- Design pressure and temperature.
- Design throughput.
- Fluid to be conveyed. (The maximum partial pressure and dew point of H₂S, CO₂ and H₂O for gas risers).
- Ice conditions, which may affect riser system.
- Leak detection accuracy and response.
- Maximum and minimum operating temperatures including distributions along the riser.
- Maximum and minimum temperatures of water and air.
- Maximum operating pressure.
- Maximum Excursion Envelopes (MEEs) for riser system (in the x, y and z axes) to prevent damage. MEEs to be provided in the operational and survival conditions, with the mooring system in connected and disconnected (where appropriate) conditions.
- Marine growth density and thickness profiles (varying with water depth) plotted against time, over the field life.
- Product density.
- Sea bed geology and soil characteristics including stability and sand waves, etc.
- Sea bed topography and bathymetry in way of riser system and any possible deviation or future development.
- Seismic activity survey.
- Test pressure to be applied.
- Type, activity and magnitude of marine growth predicted.
- Wave heights, periods and directions.
- Wind velocities and directions.

2.5 Operations Manual

2.5.1 The allowable modes of operation including the maximum and minimum internal pressure, product temperature and flow rate together with the operating and maximum environmental criteria on which classification is based are to be stated in the unit’s Operations Manual, as required by Ch 1.3.

2.5.2 The Manual is to contain instructions and guidance on any actions which need to be taken to satisfy environmental considerations and the safe operation of the riser system.
4.2 Environmental factors

4.2.1 The following environmental factors are to be considered in the design of the riser system:
- Air and sea temperatures.
- Current.
- Fouling.
- Ice.
- Water depth.
- Wave.
- Wind.

4.2.2 Environmental factors to be accounted for in the design loadings are contained in Pt 4, Ch 3,4 together with the additional considerations below.

4.3 Waves

4.3.1 When using acceptable wave theories to determine local wave velocities for smooth cylindrical members, appropriate hydrodynamic coefficients should be used. These values should be modified to account for marine growth, for proximity to the sea bed, or structural members on the unit.

4.4 Current

4.4.1 Where a current acts simultaneously with waves, the effect of the current is to be included. The current velocity is to be added vectorially to the wave particle velocity. The resultant velocity is to be used to compute the total force.

4.4.2 In the absence of more detailed information, the distribution of current velocity with depth may be assumed to vary according to the 1/7th power law.

4.5 Vortex shedding

4.5.1 Consideration is to be given to the possibility of vibration of structural members due to von Karman vortex shedding. (This is to apply to wind on exposed risers, and to wave and current on immersed risers).

4.6 Ice

4.6.1 Riser systems intended for operation in ice are to be designed to minimise the effect of ice loading. Proposals are to be submitted for consideration.
Section 5
Design loadings

5.1 General

5.1.1 All modes of operation are to be investigated using realistic loading conditions, including buoyancy, unit motions and gravity loadings and operational loads (temperature, pressure, etc.) together with relevant environmental loadings due to the effects of wind, waves, currents, vibrations, ice, and where necessary, the effects of earthquake, sea bed supporting capabilities and friction, temperature, fouling, etc.

5.1.2 The design of the riser system is to take account of all loads which can be imposed during its service life.

5.1.3 The design is also to take account of loads related to the construction, transportation and site installation stages.

5.2 Dead loads

5.2.1 All gravity loadings are to be taken into account and should include self-weight of the riser system and attachments. The deadweight of contents is to be included.

5.2.2 Buoyancy of risers including attached equipment is to be taken into account.

5.2.3 Constraints and loads arising from supports and attachments should be taken into account. Also any scour or subsidence of sea bed should be assessed.

5.3 Live loads

5.3.1 Static pressure, pressure surge transients and any peak ‘hammer-blow’ effects are all to be considered, together with corresponding temperatures.

5.3.2 Dynamic inertial vibrations and flutter induced by any activation, including vortex shedding, are to be considered.

5.4 Environmental loads and motions

5.4.1 The environmental loading on a riser system and its motion responses are to be determined for at least the design environmental conditions given in Section 6. Dynamic effects are to be considered.

5.4.2 The loads and motions can be established by model testing or by suitable calculations or both. The possibility of resonant motion is to be fully investigated.

5.4.3 Account is to be taken of the effect of marine growth. Both increase in the dimensions and the change in surface characteristics are to be considered.

5.4.4 Where model testing is to be adopted:
(a) the test programme and the model test facilities are to be to LR’s satisfaction;
(b) the relative directions of wind, wave and current are to be varied as required to ensure that the most critical loadings and motions are determined;
(c) the tests are to be of sufficient duration to establish low frequency motion behaviour; and
(d) the model testing is required to give suitable data pertaining to both strength and fatigue design aspects of the riser system.

5.5 Other loadings

5.5.1 Loads imposed during site installation, including those due to motion of the laying ship/unit, are to be assessed and taken into account. The curvature taken up during laying and loads imposed thereby are to be assessed and arrangements made for laying procedures to avoid any damage or overstress.

5.5.2 Hydrostatic effects are to be included in the design. Hydrostatic loading can be taken as the difference between internal and external pressures, as appropriate.

5.5.3 The riser system design should also take account of accidental loading, where relevant, and required test loads, see Section 9.

5.5.4 The riser system is to be designed to withstand the most unfavourable combinations of pressure, temperature and environmental loadings under normal operating conditions combined with the effects of the most severe single fault that might arise in the positioning system.

5.5.5 Scouring effects are to be considered for the support conditions of steel flexible risers at the touchdown locations.

Section 6
Strength

6.1 General

6.1.1 This Section defines the strength requirements, including static and dynamic aspects, for welded steel riser systems, flexible riser systems and hoses.

6.1.2 The design is to be analysed in accordance with acceptable methods and procedures and the resultant stresses or factors of safety determined.

6.1.3 In general, the strength of the riser system is to be determined from a three-dimensional analysis. Only if it can be demonstrated that other methods are adequate will they be considered.
6.1.4 The riser system is to be designed such that under transient operating conditions the maximum allowable operating pressure may not be exceeded by more than 10 per cent.

6.2 Structural analysis

6.2.1 The loading combinations considered are to represent all modes of operation so that the critical design cases are established.

6.2.2 All loads applicable to the design, as defined in Section 5, are to be fully covered in the loading combinations.

6.2.3 A fully representative number of design cases are to be defined, each of which should be associated with appropriate environmental conditions and allowable yield ratios or factors of safety. The design cases are to cover all critical aspects of riser system installation, testing and operation.

6.2.4 A detailed analysis of the riser system, including interaction with pipeline and expansion loop is to be carried out. This is to take account of thermal, hydrodynamic, gravity, buoyancy and pressure effects and vessel motions. Modelling is to describe riser geometry and stiffness, and soil interaction, including loss of contact.

6.2.5 Riser supports and stiffener bend restrictor forces are to be determined, and strength checks carried out.

6.3 Flexible risers and hoses

6.3.1 The design of flexible risers and associated appurtenances and fittings is to be based on sound engineering principles and practice, and is to be in accordance with recognised National or International Standards or Codes of Practice. Design calculations are to be submitted and, where considered necessary, LR will carry out independent analysis of the strength and stability of the flexible risers, see Appendix A, A1.2.10.

6.3.2 For all critical loading combinations relevant to the design axial loading, internal/external pressure and radius of curvature are to be considered in a rational manner.

6.3.3 Other factors which adversely affect the integrity of the riser such as abrasion, ageing, corrosion, fatigue and fire are also to be considered.

6.3.4 For fatigue see 6.4.6; however, endurance curves should also account for fluid permeation through polymers and potential accidental ingress of sea-water resulting from damage to the external sheath.

6.3.5 Special attention is to be given to riser end fittings to ensure effective bonding, pressure containment and load transfer.

6.3.6 In general, riser displacements are to achieve acceptable clearances with adjacent risers, mooring lines, unit structures and the sea bed. However, in extreme cases interference may be allowed, see 1.5.3.

6.3.7 Critical design parameters are to be demonstrated by means of appropriate tests and calculations.

6.4 Welded steel risers

6.4.1 The design of steel risers and associated appurtenances and fittings is to be based on sound engineering principles and practice, and is to be in accordance with recognised National or International Standards or Codes of Practice. Design calculations are to be submitted and, where considered necessary, LR will carry out independent analysis of the strength and stability of the steel risers, see Appendix A, A1.2.10.

6.4.2 Yielding: For any particular location, two stress intensity calculations will be required, as follows:

(a) Hoop stress calculations are to be made utilising the minimum specification wall thickness less corrosion allowance, as appropriate.

(b) All axial stresses arising from end load, bending moment, shear and torsion are to be combined with hoop stress to give an equivalent stress based on the Mises-Hencky criterion to conform with specified yield ratio limits. For this purpose, nominal section dimensions may be used.

6.4.3 Vortex shedding response:

(a) The effects of vortex-induced oscillations are to be accounted for. The effect of axial forces on natural frequency is to be included.

(b) The restraining effect of external spans, and relief due to wave and current directionality may be included provided that sufficient environmental data is available.

(c) In all cases, the effect of vortex shedding on fatigue life is to be checked.

6.4.4 Buckling. Local and overall buckling of the riser is to be checked for all locations and loading conditions for which free spans may arise. The worst combinations of axial and lateral loading are to be considered.

6.4.5 Stress concentrations. The effect of notches, stress raisers and local stress concentrations is to be taken into account in the design of the load-carrying elements.
6.4.6  **Fatigue:**

(a) Fatigue damage due to cyclic loading is to be considered in the design of the riser. The cyclic loading due to internal (contents) pressure fluctuations and external environmental loadings is to be taken into account. The extent of the fatigue analysis will be dependent on the mode and area of operations.

(b) Fatigue design calculations are to be carried out in accordance with the analysis procedures and general principles given in Pt 4, Ch 5.5, or other acceptable method, and the fatigue life calculations are to be based on the relevant stress range/endurance curves applicable to the service environment incorporating appropriate stress concentration factors.

(c) The minimum factors of safety on fatigue life are not to be less than as required by Pt 4, Ch 5.5.6.

6.4.7  **Plastic analysis.** Where plastic design methods are to be employed, the load factors will be specially considered.

6.5  **Pig trap**

6.5.1 Pig traps are to be designed to the requirements of a recognised pressure vessel code and since they are considered as part of the riser and associated equipment the hoop stress is not to exceed 60 per cent of the minimum yield stress of the material.

6.6  **Riser supports and attachments**

6.6.1 The riser supports and other attachments are to be designed to meet suitable structural design codes. Where the supports are attached to the structure of the unit the permissible stresses in the structure are to comply with Pt 4, Ch 5.2.

6.7  **Mechanical items**

6.7.1 The design of components such as valves and similar apparatus is to be in accordance with an acceptable design method or recognised Code or Standard.

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7.1  **General**

7.1.1 Welding, weld procedures and approval of welders are to be in accordance with the general requirements of Pt 4, Ch 8. When agreed with LR, the fabrication of riser systems may be in accordance with a recognised Code or Standard, see Appendix A.

7.1.2 The proposals for NDE procedures are to be agreed with LR prior to the commencement of construction.

7.1.3 All butt welds are to be subjected to 100 per cent NDE. Examination by radiography is to be to a Standard acceptable to LR, e.g., BS 2910: *Methods for Radiographic Examination of Fusion Welded Circumferential Butt Joints in Steel Pipes,* with acceptance criteria as detailed in the Construction Code, or BS 4515: *Specification for Process of Welding of Steel Pipelines on Land and Offshore,* if not specified in the Code. Proposals for examination by ultrasonics are to be submitted for review and acceptance.

7.1.4 All defective sections of welds are to be cut out, carefully re-welded and re-examined.

7.1.5 Weld procedures for repairs and alterations are to be qualified and approved by LR.

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8.1  **General**

8.1.1 Specifications covering the site installation procedures are to be submitted for approval.

8.2  **Location Survey**

8.2.1 Specifications, plans and data are to comply with 2.3.1. Additional data is to be submitted specifying sea bed preparation, extent and means of execution and survey prior to installation.

8.2.2 The construction specification is to specify the tolerance within which the riser system is to be positioned.

8.3  **Installation procedures**

8.3.1 The equipment used for operations is to be agreed by LR for the processes specified.

8.3.2 Individual risers, equipment, fittings and sub-assemblies are to be handled and stored with care, especially components with anodes or heavy anode bracelets. No components are to be stored in a manner which will cause damage or deformation.

8.3.3 All components and sub-assemblies are to be inspected before installation and be approved to the satisfaction of the Surveyor.

8.3.4 The installation of the riser is not to introduce any unscheduled loading and the transfer of loading to riser supports is to be shown to be in accordance with design specifications.

8.3.5 All monitoring systems are to be operated and calibrated to the Surveyor’s satisfaction during all laying and installation operations.
Riser Systems

8.4 Completion Survey

8.4.1 As soon as is practicable following installation and prior to start-up, a survey of the entire riser system is to be carried out.

Section 9
Testing

9.1 Hydrostatic testing

9.1.1 The requirements of 1.10, 1.11 and 1.12 regarding certification and testing are to be complied with.

9.1.2 Steel risers:
(a) The riser system is to be hydrostatically tested after installation. Hydrostatic Testing Procedures are to comply with recognised international Codes and Standards.
(b) A written procedure is to be developed before hydrostatic testing commences. The acceptance criteria are to be agreed by LR.

9.1.3 Flexible risers. For flexible risers, pressure testing includes acceptance tests in the factory and hydrostatic test after installation. The acceptance test pressure should be in accordance with international Codes and Standards for flexible risers.

9.1.4 It is permissible to have pressure variations during a hydrostatic test provided they can be explained in terms of temperature changes and/or motions of the riser system.

9.1.5 In order to calculate the effect of temperature on pressure, it is essential that the temperature of the fluid in the pipe is measured and recorded at the same time as each pressure measurement is made and recorded. Ambient air or sea-water temperature are not relevant.

9.1.6 As a minimum, the temperature is to be measured near each end of the riser. Preferably at least one transducer on the sea bed part of the riser should also be provided.

9.1.7 Temperature sensors attached to the outside of the steel wall of a riser and insulated from the thermal effects of the sea are acceptable provided the test medium has been in the riser for at least 24 hours before the test is started, in order to allow the temperature of the fluid and steel to stabilise.

9.1.8 When conducting a hydrostatic test of a riser, the following requirements are to be complied with:
(a) The pressure (and temperature, if applicable) is to be continuously recorded for the duration of the test on a chart recorder.
(b) The chart is to be signed by the Surveyor at the beginning and end of the test.
(c) Pressure (and temperature, if applicable) readings are to be made at intervals not greater than 30 minutes and tabulated.

(d) Where temperature readings are to be taken the line is to be filled at least 24 hours before the test to enable the temperature to stabilise.

(e) The results of a hydrostatic test are to be recorded by a dossier containing the following:
- Copies of all charts made during the test.
- Copies of all tables of pressure readings (and temperature readings where applicable) made during the test.
- Copies of calibration certificates for the pressure recorders used.
- Calculations demonstrating temperature correction to pressure change where applicable.

9.1.9 The sections of riser are to be hydrostatically tested at the place of manufacture in accordance with Chapter 6 of the Rules for Materials or the relevant National Standard.

9.1.10 Before a consent to start-up a riser can be given, evidence of a satisfactory hydrostatic test is to be provided. The evidence is to relate to a test completed during the 12 months prior to the date of application for the consent to start up.

9.2 Buckle detection

9.2.1 An adequate examination is to be carried out to determine that the completed riser is free from buckles, dents or similar damage.

9.3 Testing of communications, controls and safety systems

9.3.1 Communication systems, remote and automatic controls, emergency shut-down systems and other safety devices are to be tested in accordance with the approved test schedules required by 2.3.1.

Section 10
Operation and repairs

10.1 Operation procedures

10.1.1 A written operation procedure is to be prepared and issued prior to the riser system being put into operation. One operation procedure may, where applicable, cover several riser systems of the same type.

10.1.2 Where a riser system forms part of a system covering other lines, platforms, terminals, etc., the operating procedure is to embrace those parts of the entire system which are relevant to the operation of the riser system.

10.1.3 In order to minimise the risk of damage to the riser system, it is the Owner’s/Operator’s responsibility to ensure that supply boat approach routes to the installation are strictly controlled. A mooring procedure is to be produced which clearly indicates safe and hazardous anchoring areas.
10.1.4 Operation procedures are to be written in English with translations into other languages, as necessary, for the operating personnel involved.

10.2 Repairs

10.2.1 It is the Owner’s responsibility to inform LR of any defects found. The exact location, nature and extent of the defects are to be stated. The requirements of 1.13 are to be complied with.

10.2.2 Plans and particulars of any proposed repairs are to be submitted for approval. All repair work is to be carried out to the satisfaction of LR’s Surveyors.
Section 1
General

1.1 Application

1.1.1 The requirements of this Chapter apply to units or vessels engaged in installation and/or maintenance activities relating to offshore wind turbines and cover the unit types indicated in 1.2.

1.1.2 The requirements of this Chapter also apply to liftboats whose primary function is to provide support services to offshore wind turbine installations or other types of offshore installation, see 1.2.

1.1.3 The requirements in this Chapter are supplementary to those given in the relevant Parts of the Rules.

1.1.4 Surface type units and surface type self-elevating units are to comply with LR's Rules and Regulations for the Classification of Ships (hereinafter referred to as the Rules for Ships), but aspects which relate to the specialised offshore function of the unit will also be considered on the basis of these Rules.

1.1.5 Requirements additional to these Rules may be imposed by the National Authority with whom the unit is registered and/or by the Administration within whose territorial jurisdiction the unit is operating.

1.2 General definitions

1.2.1 A column-stabilised unit is a unit with a working platform supported on widely spaced buoyant columns. The columns are normally attached to buoyant lower hulls or pontoons. These units are normally floating types but can be designed to rest on the sea bed.

1.2.2 A liftboat is a unit with a buoyant hull (generally either triangular or pontoon shaped) with moveable legs capable of raising the hull above the surface of the sea and designed to operate as a sea bed-stabilised unit in an elevated mode. The legs may be designed to penetrate the sea bed, or be attached to a mat or individual footings which rest on the sea bed. In general, installation and maintenance activities would be undertaken in the jacked-up condition. These unit types are generally self-propelled.

1.2.3 A self-elevating (or jack-up) unit is a floating unit which is designed to operate as a sea bed-stabilised unit in an elevated mode. These units have a buoyant hull (generally either triangular or pontoon shaped) with moveable legs capable of raising its hull above the surface of the sea. The legs may be designed to penetrate the sea bed, or be attached to a mat or individual footings which rest on the sea bed. These unit types are generally not fitted with a propulsion system.

1.2.4 A surface type floating unit is a unit with a ship or barge type displacement hull of single or multiple hull construction intended for operation in the floating condition.

1.2.5 A surface type self-elevating (or jack-up) unit is a floating unit, which is designed to operate as a sea bed-stabilised unit in an elevated mode. These units have a ship type displacement hull of single or multiple hull construction fitted with moveable legs capable of raising the hull above the surface of the sea. The legs may be designed to penetrate the sea bed, or be attached to a mat or individual footings which rest on the sea bed. In general, installation and maintenance activities would be undertaken in the jacked-up condition. These unit types are generally self-propelled.

1.2.6 Further general definitions for all unit types can be found in Pt 1, Ch 2.2.

1.3 Guidance note

1.3.1 Summary information for unit types engaged in installation and/or maintenance activities relating to offshore wind turbines can be found in LR’s Guidance Note Mobile Offshore Units – Wind Turbine Installation Vessels.

1.3.2 Summary information for Liftboats engaged in support services to offshore wind turbine installation or other types of offshore installation can be found in LR’s Guidance Note Mobile Offshore Units – Liftboats.

1.3.3 The Guidance Notes referred to in 1.3.1 and 1.3.2 provide summary information on the following topics:
- Classification Rules, Regulations and procedures.
- National Administration requirements.
- Documentation.
- Applicable LR Rule requirements for unit types identified in 1.2.

1.3.4 For the unit types identified in 1.2.1, 1.2.3, 1.2.4 and 1.2.5, Appendices A2, A3, A4 and A5 of the Guidance Note referred to in 1.3.1 include summary Tables indicating the relevant Parts and Chapters of these Rules and the Rules for Ships, which are to be applied to the individual unit types.
1.3.5 For the unit type identified in 1.2.2, the Guidance Note referred to in 1.3.2 includes summary Tables indicating the relevant Parts and Chapters of these Rules and the Rules for Ships, which are to be applied to the individual unit types.

1.4 Class notations

1.4.1 The Regulations for classification and the assignment of class notations are given in Pt 1, Ch 2, to which reference should be made.

1.4.2 In general, units or vessels engaged in installation and/or maintenance activities relating to offshore wind turbines, which comply with the requirements of this Chapter and the relevant Parts of the Rules will be eligible for the assignment of the following class type notations:

- **MainWIND**

1.4.3 In general, liftboats whose primary function is to provide support services to offshore wind turbine installations or other types of offshore installation which comply with the requirements of this Chapter and the relevant Parts of the Rules will be eligible for the assignment of the following class type notations:

- **Liftboat**

1.4.4 Units engaged in more than one function may be assigned a combination of class type notations at the discretion of the Classification Committee.

1.4.5 Lifting appliances are to comply with LR’s Code for Lifting Appliances in a Marine Environment (LAME), see also Chapter 11.

1.4.6 Where the lifting appliances form an essential feature of a classed unit, the special feature class notation ‘LA’ will be assigned, see Chapter 11.

1.4.7 Other special features class notations associated with lifting appliances may be assigned, see Chapter 11.

1.4.8 Where the lifting appliance is not assigned a special feature class notation, the crane is to be certified by a recognised competent body, see Ch 1, 1.2 of LR’s LAME.

1.5 Scope

1.5.1 The following additional topics applicable to the class type notation are covered by this Chapter:

- Hull scantlings
- Strength of structure for accommodation
- Supports for containerised modules
- Structure in way of cranes
- Structure below any other major mission equipment, laydown areas, etc.
- Positional mooring
- Main and auxiliary machinery
- Control and electrical engineering
- Safety systems, hazardous areas and fire
- Corrosion control

1.6 Installation layout and safety

1.6.1 Living quarters, lifeboats and other evacuation equipment are to be located in non-hazardous areas.

1.6.2 The requirements for fire safety are to be in accordance with the requirements of a National Administration, see Pt 1, Ch 2, and Pt 7, Ch 3.

1.6.3 Additional requirements for hazardous areas, safety and communication systems are given in Part 7 and are to be applied to the relevant unit type. For surface type self-elevating units, the requirements for surface type units are to be complied with as applicable.

1.7 Survey

1.7.1 For all unit types, the requirements for periodical surveys are defined in Pt 1, Ch 2, and Ch 3.

1.7.2 In general, where a classed or certified lifting appliance is fitted to a classed unit, the survey requirements of the lifting appliance are to be in accordance with Chapter 9 of LR’s LAME and Part E, Ch 8 of LR’s Marine Survey Procedures Manual.

1.8 Plans and data submission

1.8.1 Plans, calculations and data are to be submitted as required by the relevant Parts of the Rules, together with the additional plans and information listed in this Chapter.

1.8.2 For units or vessels engaged in installation and/or maintenance activities relating to offshore wind turbines, see also Ch 2, of LR’s Guidance Note Mobile Offshore Units – Wind Turbine Installation Vessels, for additional information on the plans and data to be submitted.

1.8.3 For liftboats engaged in support services to offshore wind turbine installation, see also LR’s Guidance Note Mobile Offshore Units – Liftboats, for additional information on the plans and data to be submitted.
Wind Turbine Installation and Maintenance Vessels and Liftboats

Section 2
Structure

2.1 Plans and data submission

2.1.1 In addition to the structural plans and information as required by Ch 2.8 of LR’s Guidance Note Mobile Offshore Units – Wind Turbine Installation Vessels and also LR’s Guidance Note Mobile Offshore Units – Liftboats, the following additional plans and information are to be submitted as applicable:

- General arrangement plans.
- Structural plans of the accommodation including deck houses and modules.
- Design calculations for containerised modules (if applicable).
- Structural arrangements in way of crane supports and boom rests (if applicable).
- Structural arrangements in way of permanently attached, purpose built cargo stacking and securing arrangements.
- Structural arrangements under the weather deck which support heavy items of deck cargo such as nacelles, towers, blades, foundations and temporary transportation frames.
- Structural arrangements and supports under any other major mission or topsides equipment.
- Positional mooring equipment and supporting structures (if applicable).

2.2 General

2.2.1 The hull strength is to take into account the applied weights and forces due to the accommodation, deck cargo, cranes and, if applicable, mooring forces and the local structure is to be suitably reinforced. Appendices A2, A3, A4 and A5 of the Guidance Note referred to in 1.3.1 include summary Tables indicating the relevant Parts and Chapters of these Rules and the Rules for Ships, which are to be applied to the individual unit types for hull strength requirements.

2.2.2 For the unit types identified in 1.2.1, 1.2.3, 1.2.4 and 1.2.5, the hull scantlings for each unit type are to be calculated in accordance with the relevant parts of the Rules identified in Appendices A2, A3, A4 and A5 of the Guidance Note Mobile Offshore Units – Wind Turbine Installation Vessels.

2.2.3 For the unit type identified in 1.2.2, the hull scantlings for each unit type are to be calculated in accordance with the relevant parts of the Rules identified in the Guidance Note Mobile Offshore Units – Liftboats.

2.2.4 The design loadings for all purpose built cargo stacking arrangements, support frames and trusses are to be defined by the designers/Builders and calculations are to be submitted in accordance with an internationally recognised Code or Standard as defined in Appendix A. The supporting structure and attachments below the purpose built cargo stacking arrangements, support frames and trusses are to be designed for all operating conditions and for the emergency condition as defined in Ch 8.1.4. For a surface type self-elevating unit in the afloat condition, the angle of inclination in the emergency static condition is to be considered in accordance with the requirements for a self-elevating unit.

2.2.5 The supporting structure and attachments below any other mission equipment items are to be designed for all operating conditions and for the emergency condition as defined in Ch 8.1.4. For a surface type self-elevating unit in the afloat condition, the angle of inclination in the emergency static condition is to be considered in accordance with the requirements for a self-elevating unit.

2.2.6 When the unit is intended to operate in an area which could result in the build-up of ice on the crane, leg and any other structure, the effects of ice loading are to be included in the calculations. See Pt 4, Ch 3,4.

2.2.7 For column-stabilised and self-elevating units, the decks and other under-deck structure supporting the mission equipment and deck cargo are to be suitable for the local loads at the mission equipment and deck cargo support points and an agreed uniformly distributed load acting on the deck. See Pt 4, Ch 6.2.

2.2.8 For surface type and surface type self-elevating units, the decks and other under-deck structure supporting the mission equipment and deck cargo are to be suitable for the local loads at the mission equipment and deck cargo support points and an agreed uniformly distributed load acting on the deck. See Pt 3, Ch 3,5 of the Rules for Ships.

2.2.9 In general, all seatings, platform decks, girders and pillars supporting mission equipment and deck cargo are to be arranged to align with the main hull structure, which is to be suitably reinforced, where necessary, to carry the appropriate loads.

2.2.10 Attention should be paid to the capability of support structures to withstand buckling. For column-stabilised and self-elevating units, see Pt 4, Ch 5.4. Surface type and surface type self-elevating units are to comply with Pt 3, Ch 4.7 of the Rules for Ships, but aspects which relate to the specialised offshore function of the unit will be considered on the basis of Pt 4, Ch 5.4.

2.2.11 Crane pedestals are classification items and are to comply with the requirements of Chapter 11.

2.2.12 For liftboats, a fatigue life assessment of all relevant structural elements in accordance with Pt 4, Ch 5.5 is required. Structural elements to be assessed include lattice legs and connections to mats and footings and leg support structure. The fatigue loading spectrum may be based on the transit environmental criteria.
2.2.13 The minimum fatigue life of a liftboat is to be specified by the Owners, but is generally not to be less than 20 years, unless agreed otherwise with LR.

2.2.14 For liftboats, when considering the overturning moment, in no case is the variable load to be taken greater than 10 per cent of the maximum variable load. The percentage of variable load used when considering the overturning moment is to be stated in the Operations Manual.

2.2.15 For liftboats, when calculating the overturning moment, the unit should be considered supported through the centre line of the legs about which the unit is considered rotating. However, for hard foundation bases, the maximum stressed edge of the mat may be taken as an appropriate support position. In this instance, a safety factor of at least 1.2 against overturning is considered acceptable.

2.2.16 For liftboats, the Owner is to specify the minimum design environmental criteria and return periods for which the unit is to be approved. In general, a return period of not less than 1 year should be used for operational conditions and 100 years for survival conditions.

2.2.17 For liftboats, restricted to seasonal operations in order to avoid extremes of wind and wave, such seasonal limitations must be specified. The unit’s actual minimum design environmental criteria and return periods used in the design of the liftboat are to be stated in the Operations Manual.

2.2.18 The thickness of marine growth to be taken into account during the design of submerged members on liftboats is not to be less than 50 mm. The actual thickness of marine growth used in the design of the liftboat is to be stated in the Operations Manual and the design limit is not to be exceeded in service.

2.2.19 For liftboats, the minimum design deck loads are to be specified by the Owner and are not to be less than the minimum design deck loads required by Pt 4, Ch 6.2.

2.2.20 For liftboats, the foundation fixity need not be considered for the in-place strength analysis.

2.3 Deckhouses and modules

2.3.1 For column-stabilised and self-elevating units, the scantlings of structural deckhouses are to comply with Pt 4, Ch 6.9. Where deck-houses support equipment loads, they are to be suitably reinforced.

2.3.2 For surface type and surface type self-elevating units, the scantlings of structural deckhouses are to comply with Pt 3, Ch 8.2 of the Rules for Ships. Where deck-houses support equipment loads, they are to be suitably reinforced.

2.3.3 The strength of containerised modules which do not form part of the main hull structure will be specially considered in association with the design loadings.

2.3.4 When containerised modules can be subjected to wave loading or protect openings leading into buoyant spaces, the scantlings are not to be less than required by 2.3.1 or 2.3.2, as applicable.

2.3.5 For column-stabilised and self-elevating units, the structural strength of the connections between containerised modules and the supporting frame or structure are to comply with the general strength requirements of Pt 4, Ch 6.9, taking into account the unit’s motions and marine environmental aspects. For surface type and surface type self-elevating units, the scantlings of structural deckhouses are to comply with Pt 3, Ch 8.2 of the Rules for Ships.

2.3.6 The connections of containerised modules are also to satisfy an emergency static condition with an applied horizontal force \( F_H \) in any direction as follows:

\[
F_H = W \sin \theta \text{ N (tonne-f)}
\]

where

\[
\theta = 25^\circ \text{ for semi-submersible and surface type units}
\]

\[
\theta = 17^\circ \text{ for self-elevating and surface type self-elevating units}
\]

\[
W = \text{weight of the modules supported in N (tonne-f)}
\]

2.3.7 In the emergency static condition, defined in 2.3.6, the permissible stress levels are to be in accordance with Pt 4, Ch 5, 2.1.1(c).

2.4 Permissible stresses

2.4.1 In general, for column-stabilised and self-elevating units the permissible stresses in the structure in operating, transit and survival conditions are to comply with Pt 4, Ch 5.2, but the minimum scantlings of the local structure are to comply with Pt 4, Ch 6.

2.4.2 In general, for surface type and surface type self-elevating units the primary hull strength and the minimum scantling requirements for the local structure can be considered under Pt 3, Ch 4 and Pt 4, Ch 1 of the Rules for Ships. However, aspects which relate to the specialised offshore function of the unit will be considered under the basis of Pt 4, Ch 5.2.

2.4.3 Permissible stresses for lattice type structures may be determined from an acceptable code, see Appendix A.

2.5 Watertight and weathertight integrity

2.5.1 For column-stabilised and self-elevating units, the general requirements for watertight and weathertight integrity are to be in accordance with Pt 4, Ch 7.

2.5.2 For surface type and surface type self-elevating units, the general requirements for watertight and weathertight integrity are to be in accordance with Pt 3, Ch 11 and Ch 12 of the Rules for Ships.
2.5.3 The integrity of the weather deck is to be maintained. Where mission equipment penetrates the weather deck and is intended to constitute the structural barrier to prevent the ingress of water to spaces below the deck, its structural strength is to be equivalent to the Rule requirements for this purpose. Otherwise, such items are to be enclosed in superstructures or deck-houses fully complying with the Rules. Full details are to be submitted for approval.

2.5.4 Where items of mission equipment penetrate watertight boundaries, the watertight integrity is to be maintained and full details are to be submitted for approval.

2.6 Materials

2.6.1 For column-stabilised and self-elevating units, the general requirements for materials are to be in accordance with Pt 3, Ch 1,4 and Pt 4, Ch 2.

2.6.2 For surface type and surface type self-elevating units, the general requirements for materials are to be in accordance with Pt 3, Ch 2 and Pt 4, Ch 1,2 of the Rules for Ships. Aspects which relate to the specialised offshore function of the unit will be considered under the basis of Pt 3, Ch 1,4 and Pt 4, Ch 2.

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Section 3

Positional mooring systems

3.1 Application

3.1.1 The requirements of this Section apply to units which are intended to perform their primary designed service function only while they are moored with a catenary type positional mooring system including thruster-assisted systems.

3.1.2 The mooring system will be considered for classification on the basis of operating constraints and procedures specified by the Owner and recorded in the Operations Manual.

3.1.3 The mooring system is to comply with the requirements of Chapter 10.

3.1.4 For column-stabilised and self-elevating units, dynamic positioning systems are to comply with the requirements of Chapter 9. For surface type and surface type self-elevating units, dynamic positioning systems are to comply with the requirements of Pt 7, Ch 4 of the Rules for Ships.

3.1.5 The support structure in way of fairleads and winches, etc., are to be in accordance with Pt 4, Ch 6,1.

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Section 4

Main and auxiliary machinery

4.1 Application

4.1.1 For surface type units, the general requirements for main and auxiliary machinery are to be in accordance with Pt 5, Ch 1 of the Rules for Ships. Aspects which relate to the specialised offshore function of the unit will be considered on the basis of Pt 5, Ch 1 and are to be complied with as applicable. All other main and auxiliary machinery requirements are to be in accordance with Pt 5, Ch 2 to Ch 22 of the Rules for Ships and are to be complied with as applicable.

4.1.2 For surface type self-elevating units, the general requirements for main and auxiliary machinery are to be in accordance with Pt 5, Ch 1 of the Rules for Ships. Aspects which relate to the specialised offshore function of the unit will be considered on the basis of Pt 5, Ch 1 and Ch 4,2, and are to be complied with as applicable. All other main and auxiliary machinery requirements are to be in accordance with Pt 5, Ch 2 to Ch 22 of the Rules for Ships and are to be complied with as applicable.

4.1.3 For both column-stabilised and self-elevating units, the main and auxiliary machinery requirements are to be in accordance with Part 5 and are to be complied with as applicable.

4.1.4 For all unit types, due account should be taken of the unit type and operational role when applying these requirements.

4.2 Angle of inclination

4.2.1 For surface type units, the angles of inclination are to be in accordance with Table 1.3.2 in Pt 5, Ch 1,3.7 of the Rules for Ships.

4.2.2 For surface type self-elevating units in the afloat conditions, the angles of inclination are to be in accordance with Table 1.3.2 in Pt 5, Ch 1,3.7 of the Rules for Ships.

4.2.3 For both column-stabilised and self-elevating units, the angles of inclination are to be in accordance with Tables 1.3.3 and 1.3.4, respectively, in Pt 5, Ch 1,3.7.

4.3 Bilge systems and cross flooding arrangements

4.3.1 For all unit types with accommodation for more than 12 persons who are not crew members, the requirements of Pt 3, Ch 4,3 are to be complied with as applicable.
4.4 Jacking gear machinery

4.4.1 For all types of self-elevating units, the number of jacking cycles expected to be seen during the unit’s intended design life will need to be specially considered in the design of the jacking gear machinery. Relevant calculations will be required to be submitted, taking into account the expected number of jacking cycles during the unit’s intended design life.

Section 5
Control and electrical engineering

5.1 Application

5.1.1 For surface type units, the control and electrical engineering requirements are to be in accordance with Part 6 of the Rules for Ships, and are to be complied with as applicable.

5.1.2 For surface type self-elevating units, the control and electrical engineering requirements are to be in accordance with Part 6 of the Rules for Ships. Aspects which relate to the specialised offshore function of the unit will be considered on the basis of Pt 6, Ch 1 and Ch 2 and are to be complied with as applicable.

5.1.3 For both column-stabilised and self-elevating units, the main and auxiliary machinery requirements are to be in accordance with Part 6 and are to be complied with as applicable.

5.1.4 For all unit types, due account should be taken of the unit type and operational role when applying these requirements.

5.2 Angle of inclination

5.2.1 For surface type units, the angles of inclination are to be in accordance with Table 2.1.1 in Pt 6, Ch 2.1.9, of the Rules for Ships.

5.2.2 For surface type self-elevating units in the afloat conditions, the angles of inclination are to be in accordance with Table 2.1.1 in Pt 6, Ch 2.1.9 of the Rules for Ships.

5.2.3 For both column-stabilised and self-elevating units, the angles of inclination are to be in accordance with Table 2.1.1 in Pt 6, Ch 2.1.9.

5.3 Emergency source of electrical power

5.3.1 For all unit types with accommodation for more than 50 persons who are not crew members, the requirements of Pt 3, Ch 4.4.2 are to be complied with as applicable.

Section 6
Safety systems, hazardous areas and fire

6.1 Application

6.1.1 For all unit types, the safety systems, hazardous areas and fire safety requirements are to be in accordance with the requirements of Part 7, and are to be complied with as applicable.

6.1.2 The requirements of Pt 7, Ch 1.9.1, are not applicable to surface type units and surface type self-elevating units. For these unit types, the requirements of Pt 3, Ch 11.9 of the Rules for Ships are to be complied with as applicable.

6.1.3 For surface type self-elevating units, the remaining requirements in Part 7 for surface type units are to be complied with as applicable.

6.1.4 For all unit types, due account should be taken of the unit type and operational role when applying these requirements.

Section 7
Corrosion control

7.1 Application

7.1.1 For all unit types, the corrosion control requirements are to be in accordance with Part 8 and are to be complied with as applicable.

7.1.2 The minimum corrosion protection requirements for external structural steel work for surface type self-elevating units are to comply with Table 1.1.1 in Pt 8, Ch 1. The unit’s main hull and all structure above the splash zone are to comply with the requirements for a surface type unit. The legs, footings and mats for these units are to comply with the requirements for a self-elevating unit.
Integrated Software Intensive Systems – ‘ISIS’ notation

Section 1

1. Integrated Software Intensive System – ‘ISIS’ notation

1.1 General

1.1.1 Integrated Software Intensive System class notation ‘ISIS’ may be assigned where an integrated computer system in compliance with Pt 6, Ch 1.6 of the Rules and Regulations for the Classification of Ships (hereinafter referred to as the Rules for Ships) provides fault tolerant control and monitoring functions for one or more of the following services:

• Propulsion and auxiliary machinery.
• Dynamic positioning systems.
• Positional mooring systems.
• Ballast systems.
• Process and utilities.
• Drilling equipment.
• Product storage and transfer systems.
• Well control system.
• Pollution control system.
• Jacking system for self-elevating unit.
• Cantilever skidding system for drilling unit.
• Power Management System (PMS).
• Zone Management Systems (ZMS) (for all equipment where applicable).
• Mud and cement management system.

1.2 General requirements

1.2.1 The Integrated Software Intensive System is to comply with the programmable electronic system requirements of Pt 6, Ch 1.2.10 to 2.13 of the Rules for Ships and the control and monitoring requirements of the Rules applicable to a particular equipment, machinery or systems.

1.2.2 Alarm and indication functions required by 2.4 are to be provided by the integrated computer control system in response to the activation of any safety function for associated machinery. Systems providing the safety functions are in general to be independent of the integrated computer system, see also Pt 6, Ch 1.2.14.7 of the Rules for Ships.

1.3 Programmable electronic systems – Additional requirements for integrated systems

1.3.1 The requirements of Pt 6, Ch 1.2.14.2 to 2.14.7 of the Rules for Ships apply to integrated systems providing control, alarm or safety functions in accordance with the Rules, including systems capable of independent operation interconnected to provide co-ordinated functions or common user interfaces. Examples include integrated machinery control, alarm and monitoring systems, power management systems and safety management systems providing a grouping of fire, passenger, crew or ship safety functions, see Pt 6, Ch 2.17 to 19 of the Rules for Ships.

1.3.2 System integration is to be managed by a single designated party, and is to be carried out in accordance with a defined procedure identifying the roles, responsibilities and requirements of all parties involved. This procedure is to be submitted for consideration where the integration involves control functions for essential services or safety functions including fire, passenger, crew, and ship safety.

1.3.3 The system requirements specification, see Pt 6, Ch 1.2.5 of the Rules for Ships, is to identify the allocation of functions between modules of the integrated system, and any common data communication protocols or interface standards required to support these functions.

1.3.4 Reversionary modes of operation are to be provided to ensure safe and graceful degradation in the event of one or more failures. In general, the integrated system is to be arranged such that the failure of one part will not affect the functionality of other parts, except those that require data from the failed part.

1.3.5 Where the integration involves control functions for essential services or safety functions, including fire, passenger, crew, and ship safety, a Failure Mode and Effects Analysis (FMEA) is to be carried out in accordance with IEC 60812, or an equivalent and acceptable National or International Standard and the report and worksheets submitted for consideration. The FMEA is to demonstrate that the integrated system will ‘fail-safe’, see Pt 6, Ch 1.2.4.6 and 2.5.4 of the Rules for Ships, and that essential services in operation will not be lost or degraded beyond acceptable performance criteria where specified by these Rules.

1.3.6 The quantity and quality of information presented to the operator are to be managed to assist situational awareness in all operating conditions. Excessive or ambiguous information that may adversely affect the operator’s ability to reason or act correctly is to be avoided, but information needed for corrective or emergency actions is not to be suppressed or obscured in satisfying this requirement.

1.3.7 Where information is required by the Rules or by National Administration requirements to be continuously displayed, the system configuration is to be such that the information may be viewed without manual intervention, e.g., the selection of a particular screen page or mode of operation. See also Pt 6, Ch 1.2.10.16 of the Rules for Ships.
2.2.2 General description detailing the extent of the integrated software intensive system, the offshore unit services it is to provide, its operating principles, and its functionality and capability when operating in the environment to which it is likely to be exposed under both normal and foreseeable abnormal conditions. The general description is to be supported by the following information as applicable:

(a) System block diagram.
(b) Piping and instrumentation diagrams, communication networks.
(c) Description of operating modes, including:
   - start-up;
   - shut-down;
   - automatic reversionary;
   - manual, and emergency.
(d) Description of safety related arrangements, including:
   - safeguards;
   - automatic safety systems; and interfaces with offshore units safety systems.
(e) Description of connections to other offshore unit machinery, equipment and systems, including:
   - electrical;
   - mechanical;
   - fluids;
   - automation;
   - communication network; and protocols of the network.
(f) Plans of physical arrangements, including:
   - location;
   - operational access; and maintenance access.
(g) Operating manuals, including:
   - instructions for start-up;
   - operation;
   - shut-down and emergency;
   - instructions and frequency for maintenance;
   - instructions for adjustments to the performance; parameters and functionality; and details of risk mitigation arrangements.
(h) Maintenance manuals, including:
   - Instructions for routine maintenance or repair following failure.
   - Instructions for software configuration management such as upgrading and modification.
   - Disposal of components and recommended spares inventory.

2.2.3 Project process documentation including:

(a) Project management plan, see 2.3.
(b) Quality assurance plan, see 2.4.
(c) Risk management plan, see 2.5.
(d) Configuration management plan, see 2.6.
(e) Requirements definition document, see 2.9.
(f) Design definition document, see 2.8.
(g) Implementation plan, see 2.9.
(h) Integration plan, see 2.10.
(i) Verification plan, see 2.11.
(j) Validation plan, certification and survey, see 2.12.
2.3 Project management

2.3.1 A project management procedure is to be established in order to define and manage the key project processes. The project processes are to include the those described in Pt 6, Ch 1,2,4 to 2.12 of the Rules for Ships.

2.3.2 For the entire project, and each of the processes within the project, the project management procedure is to define the following:
(a) Activities to be carried out.
(b) Required inputs and outputs.
(c) Roles of key personnel.
(d) Responsibilities of key personnel.
(e) Competence of key personnel.
(f) Schedules for the activities.
(g) Roles and responsibilities of stakeholders including Owner, Operator, Shipyard, System Integrator, Supplier or Subcontractor for each required activity of project processes from 2.3 to 2.12.

2.4 Quality assurance

2.4.1 A quality assurance procedure is to be established in order to ensure that the quality of the integrated software intensive system is in accordance with a defined quality management system that is acceptable to LR.

2.4.2 The procedure is to define the specific quality controls to be applied during the project in order to satisfy the requirements of the quality management system.

2.4.3 The quality management system is to satisfy the requirements of ISO 9001 Quality management systems. Requirements and software development is to satisfy the requirements of ISO 90003 Software engineering – Guidelines for the application of ISO 9001 to computer software, or other equivalent acceptable National Standard.

2.5 Risk management

2.5.1 A risk management procedure is to be established in order to ensure that any risks stemming from the introduction of the integrated software intensive system are addressed, in particular risks affecting:
(a) The structural strength and integrity of the offshore unit’s hull.
(b) The safety of integrated software intensive system onboard of the offshore unit.
(c) The safety of crew.
(d) The reliability of essential and emergency systems.
(e) The environment.
(f) Offshore drilling operations with introduction of integrated software intensive systems.

2.5.2 The procedure is to consider the hazards associated with development, integration, installation, operation, maintenance and disposal, both with the integrated software intensive system functioning correctly and following any reasonably foreseeable failure.

2.5.3 The procedure is to take account of stakeholder requirements, see 2.7.

2.5.4 The procedure is to take account of design requirements, see 2.8.

2.5.5 The procedure is to ensure that hazards are identified using acceptable and recognised hazard identification techniques, see 2.5.9 to 2.5.14, and that the effects of the following influences are considered:

(a) Offshore unit operations, including:
- Underway, manoeuvring, piloting, docking, alongside and maintenance, jacking or dynamic positioning, well drilling, well completion, well control, training exercises, emergency abandon, commissioning and trials.

(b) Offshore unit conditions under normal and reasonably foreseeable abnormal operating conditions arising from failures or misuse of equipment or systems onboard offshore unit, including:
- Normal operation, blackout, loss of position, fire in a single compartment, explosion in a single compartment and flooding of a single compartment.

(c) Configuration and modes of operation provided for the intended control of integrated software intensive system, including:
- Start-up, running, shut-down, automatic, reversionary, manual and emergency.

(d) Environmental conditions, including:
- Temperature, pressure, humidity, water spray, salt mist, vibration, shock, inclination, volcanic activities, seabed conditions, hurricane or storm, subsea acoustic noise, electrical fields and magnetic fields.

(e) Dependencies, including:
- Power, fuel, air, cooling, heating, mud, cement, data, and human input.

(f) Environmental impact of the offshore unit throughout its lifecycle, including:
- Emissions to air, discharges to water, noise and waste products.

(g) Failures, including:
- Human error, supply failure, system, software, communication network, machinery, equipment and component failure, random, systematic and common cause failures.

2.5.6 The procedure is to ensure that risks are analysed using acceptable and recognised Risk Based Analysis techniques, see 2.5.9 to 2.5.14, and that the following effects are considered:

(a) Local effects: Loss of function, component damage, fire, explosion, electric shock, harmful releases and hazardous releases.

(b) End effects on: Loss of services essential to the safety of the offshore unit, services essential to the safety of personnel onboard of offshore unit and services essential to the protection of the environment.

2.5.7 The procedure is to ensure that risks are eliminated wherever possible. Risks which cannot be eliminated are to be mitigated as necessary.
2.5.8 Details of risks, and the means by which they are mitigated, are to be included in the operating manual, see 2.2.2.

2.5.9 Risk Based Analysis (RBA) technique is to be selected from IEC/ISO 31010 Risk Management – Risk Assessment Techniques. The technique selected is to be carried out in accordance with the relevant International Standard or applicable National Standard and with 2.5.10 to 2.5.14. A justification is to be provided which demonstrates the suitability of the Standard and analysis technique chosen.

2.5.10 The RBA is to demonstrate that suitable risk mitigation has been achieved for all normal and foreseeable abnormal conditions. The scope of analysis required for each system is defined in 2.5.11 to 2.5.14 and in the respective parts of the Rules.

2.5.11 The RBA is to be organised in terms of items of equipment and function. The effects of item failures or damage at stated level and at higher levels are to be analysed to determine the effects on the system as a whole. Actions for mitigation are to be determined.

2.5.12 RBA is to:
(a) Identify the equipment or sub-system and their mode of operation;
(b) Identify potential failure modes and damage situations and their causes;
(c) Evaluate the effects on the system of each failure mode and damage situation;
(d) Identify measures for reducing the risks associated with each failure mode;
(e) Identify measures for failure mitigation; and
(f) Identify trials and testing necessary to prove conclusions.

2.5.13 At sub-system level it is acceptable, for the purpose of these Rules, to consider failure of equipment items and their functions, e.g., failure of a pump to produce flow or pressure head. It is not required that the failure of components within that pump be analysed. In addition, failure need only be dealt with as a cause of failure of the pump.

2.5.14 Where RBA is used for consideration of systems that depend on software based functions for control or co-ordination, the analysis is to investigate failure of the function rather than a specific analysis of the software code.

2.6 Configuration management

2.6.1 A configuration management procedure is to be established in order to ensure traceability of the configuration of the integrated software intensive system, its subsystems and its components.

2.6.2 The procedure is to identify items essential for the safety or operation of the integrated software intensive system (configuration control items) which could foreseeably be changed during the lifetime of the integrated software intensive system, including:
(a) Documentation.
(b) Software.
(c) Sensors.
(d) Actuators.
(e) Instrumentation.
(f) Valves.
(g) Pumps.
(h) BOP stacks.

2.6.3 The procedure is to take account of the design requirements, see 2.8.

2.6.4 The procedure is to include items used to mitigate risks, see 2.5.

2.6.5 The procedure is to ensure that any changes to configuration control items are:
(a) Identified.
(b) Recorded.
(c) Evaluated.
(d) Approved.
(e) Incorporated.
(f) Verified.

2.6.6 The procedure is to specify the required software testing for any changes to configuration control items for the whole lifecycle of the integrated software intensive system.

2.7 Requirements definition

2.7.1 A requirements definition procedure is to be established in order to define the functional behaviour and performance throughout the whole lifecycle of the integrated software intensive system required by individual stakeholders, in the environments to which the integrated software intensive system is likely to be exposed under both normal and foreseeable emergency conditions.

2.7.2 The procedure is to take account of requirements resulting from key stakeholders, including:
(a) Owner.
(b) Operator.
(c) Crew.
(d) Shipyard.
(e) Systems integrator.
(f) Maintenance personnel.
(g) Surveyors.
(h) Manufacturers and suppliers.
(i) National Administration.
(k) LR.
2.7.3 The procedure is to take account of requirements resulting from the following influences:
(a) Offshore unit operations, see 2.5.5(a).
(b) Ship conditions, see 2.5.5(b).
(c) Environmental conditions, see 2.5.5(d).
(d) Applicable provisions, including:
   Statutory legislation;
   classification requirements;
   international standards;
   national standards; and
   codes of practice.
(e) Expected users, including:
   Multi-national users with a range of national languages and cultures
   fatigued users;
   users without dedicated training; and
   maintenance and survey personnel.
(f) Design, construction and operational constraints, including:
   Effect of particular design decisions or component choices on other aspects of design, risk and production engineering compromises, verification, integration and validation considerations, maintenance and disposal, and changes in use.

2.7.4 The procedure is to specify the functional behaviour and performance requirements and is to identify the source of the requirements.

2.7.5 The requirements specification is to fully specify, either directly or by reference to other submitted documents, all external interfaces between the software product and other software or hardware.

2.7.6 The procedure is to detail required functions the integrated software intensive system is to perform under both normal and foreseeable abnormal conditions.

2.7.7 The procedure is to define specific boundary conditions of each required function of the integrated software intensive system.

2.7.8 The procedure is to ensure overall integrity of the system requirements through verification and analysis of integrity of sets of requirements.

2.8 Design definition

2.8.1 A design definition procedure is to be established in order to define the requirements for the design of the integrated software intensive system which satisfies stakeholder requirements, quality assurance requirements, risk mitigate requirements and complies with basic internationally recognised design requirements for safety and functionality.

2.8.2 The procedure is to ensure that the design of the integrated software intensive system satisfies:
(a) Statutory legislation.
(b) LR's requirements.
(c) International Standards and Codes of Practice where relevant.

2.8.3 The procedure is to take account of stakeholder requirements, see 2.7.

2.8.4 The procedure is to take account of quality assurance requirements, see 2.4.

2.8.5 The procedure is to take account of risk management requirements, see 2.5.

2.8.6 The procedure is to ensure that the requirements for the design of major components and subsystems of the integrated software intensive system can be verified before and after integration.

2.8.7 The procedure is to specify the design requirements and is to identify the source of the requirements.

2.8.8 Any deviations from stakeholder requirements are to be identified, justified and accepted by the originating stakeholder, communicated to involved stakeholders and documented.

2.9 Implementation

2.9.1 An implementation procedure and technology is to be selected in order to realise specific integrated software intensive system that satisfies the design requirements of the machinery or an engineering system or integrated software intensive system through verification, see 2.11 and satisfies stakeholder requirements through validation, see 2.12.

2.9.2 The procedure and technology is to take account of quality assurance requirements, see 2.4.

2.9.3 The procedure and technology is to take account of design requirements, see 2.8.

2.9.4 Software lifecycle activities are to be carried out in accordance with an acceptable quality management system, see Pt 6, Ch 1.2.13.2 and 2.13.7 of the Rules for Ships. Appropriate safety related processes, methods, techniques and tools are to be applied to software development and maintenance by the manufacturer.

2.9.5 To demonstrate compliance with 2.9.4:
(a) software quality plans and safety evidence are to be submitted for consideration;
(b) an assessment inspection of the manufacturer’s completed development is to be carried out by LR. The inspection is to be tailored to verify application of the standards and codes used in software safety assurance accepted by LR; and
(c) for software development lifecycle, an evidence of satisfying internationally recognised standards and practices that are acceptable to LR is to submit for consideration of satisfying 2.9.4(b).
2.10 Integration

2.10.1 An integration procedure is to be established in order to ensure that the integrated software intensive system is assembled in a sequence which allows verification of individual system, individual subsystems and major components following integration in advance of validating the entire integrated software intensive system.

2.10.2 The procedure is to take account of the verification requirements, see 2.11.

2.10.3 The procedure is to identify the subsystems and major components, the sequence in which they are to be integrated, the points in the project at which integration is to be carried out, and the points in the project at which verification is to be carried out.

2.11 Verification

2.11.1 A verification procedure is to be established in order to ensure that systems, subsystems and major components of the integrated software intensive system satisfy their design requirements.

2.11.2 The procedure is to verify design requirements, see 2.8.

2.11.3 The procedure is to identify the requirements to be verified, the means by which they are to be verified, the verification methods and techniques, and the points in the project at which verification is to be carried out.

2.11.4 The procedure is to be based on one or a combination of the following activities as appropriate:
  (a) Design review.
  (b) Product inspection.
  (c) Process audit.
  (d) Product testing.

2.12 Validation

2.12.1 A validation procedure is to be established in order to ensure the functional behaviour and performance of the integrated software intensive system meets with its functional and performance requirements in its intended operational environment.

2.12.2 The procedure is to validate stakeholder requirements, see 2.7.

2.12.3 The procedure is to validate arrangements required to mitigate risks, see 2.5.

2.12.4 The procedure is to validate the traceability of the configuration control items, see 2.6.

2.12.5 The procedure is to identify the requirements to be validated, the means by which they are to be validated and the points in the project at which validation is to be carried out, including:
  (a) Factory acceptance testing.
  (b) Integration testing.
  (c) Commissioning.
  (d) Sea trials.
  (e) Survey.

3.1 General, scope and objectives

3.1.1 Where software is used as the implementation technology for the ISIS then the additional requirements in 3.1.2 to 3.1.9 are to be applied. Where a proposed activity is not undertaken, justification is to be documented and submitted.

3.1.2 A plan for the production of software is to be produced and is to include, but not limit to, the elements listed below.
  (a) A full list of software components being developed and, for each, what is required to be produced including code artefacts, tools, specifications, design models, and documentation.
  (b) The identification of the deliverables, including those for the purposes of late project phase activities such as boat/platform integration, boat trials, operations and maintenance.
  (c) Details of any work that is being subcontracted and how the subcontract will be managed, including specifically ensuring that the Software Development Plan for the software lifecycle will be adhered to.
  (d) An identification of the principal project risks arising from the development work.
  (e) A definition of the software lifecycle is to be deployed.
  (f) The processes, methods, techniques and tools to be used for each phase of the software lifecycle, including:
     • pedigree of chosen language, tools and design methods;
     • the identification of specific software architecture and software design features appropriate to the reliance being placed on the software; and
     • verification performed at each stage of the lifecycle including measures to show that all the requirements, have been correctly translated or implemented by the lifecycle phase activities.
  (g) Identify the key personnel in the software development team and in any subcontractors, and their responsibilities. The competency of software development team, especially experience of using the processes, methods, techniques and tools to be used.
  (h) Analysis of the software architecture and the software design to confirm that the specific design features which are implemented by functions to satisfy the requirements will work as intended in all modes of operation and failure conditions.
Details of the code implementation and coding standards to be applied to ensure that the software code will be reliable and maintainable.

Validation activities to demonstrate that the functions of the software specifically implemented to satisfy the requirements will operate as intended in all feasible operating scenarios, including:

- testing to show that hazard mitigations work as intended;
- testing and demonstration of safe and acceptable behaviour even in unexpected states, modes and failure conditions; and
- testing that functions implemented to satisfy the requirements work in all credible operating scenarios.

3.1.3 Additional requirements for verification and validation of software components in software-based control systems that handles safety and critical operational functions are listed in 3.1.4 to 3.1.9.

3.1.4 Evidence of satisfying the requirements of ISO/IEC 21119: Software and Systems Engineering – Software Testing, or ISO/IEC 61508-3 Functional safety of electrical/electronic/programmable, is to meet requirements 3.1.5 to 3.1.9 in this sub-Section.

3.1.5 Evidence is to be submitted that software test scenarios and software test results cover all of the independent paths. Evidence is to be submitted that test results and software static tests on control flow, data flow and design review are to be used to analyse the quality of software code.

3.1.6 For the purpose of black-box testing, evidence is to be submitted that test results, methods, techniques and tools that are acceptable to LR are applied before and after integrations.

3.1.7 Evidence is to be submitted that test results and software tests listed below are to be applied for software verification:

- Dynamic analysis and testing for:
  Boundary values, structural test coverage (entry points) 100 per cent and structural test coverage (statements) 100 per cent.

- Static analysis and testing for:
  Control flow, data flow and design review.

- Functional and black box testing on:
  Equivalence classes and input partition testing including boundary value analysis.

- Performance testing for:
  Response timings and memory constraints, performance requirements.

- Data recording and analysis.

3.1.8 Evidence is to be submitted that test results and software tests listed below are to be applied for software validation:

- Functional and black box testing.

3.1.9 Evidence that coding reviews have been undertaken is to be submitted.
Section A1

A1 Codes and Standards

A1.1 Abbreviations

The following abbreviations are used in this Appendix:

- AISC: American Institute of Steel Construction.
- ASME: American Society of Mechanical Engineers.
- BS: British Standard.
- CSA: Canadian Standards Association.
- DIN: Deutsches Institut für Normung.
- FEM: Fédération Européenne de la Manutention.
- NACE: National Association of Corrosion Engineers.
- NS: Norwegian Standard.
- TBK: Norwegian Pressure Vessel Committee.

A1.2 Recognised Codes and Standards

A1.2.1 The following Codes and Standards are recognised by LR in connection with the design, construction and installation of machinery, equipment and systems which form part of the drilling plant facility, production and process plant facility and riser systems installed on offshore units as appropriate. Codes are also given for structural components, concrete structures, bearings and formulations used in positional mooring systems.

A1.2.2 The following National and International Codes and Standards listed are subject to change/deletion without notice. The latest edition of a Code or Standard, with all applicable addenda, current at the date of contract award should be used.

A1.2.3 When requested, other National and International Codes and Standards may be used after special consideration and agreement by LR.

A1.2.4 Blow out prevention:

- API Spec. 16A: Specification for Drill through Equipment.
- API RP 16E: Design of Control Systems for Drilling Well Control Equipment.

A1.2.5 Lifting appliances for blow out preventer and burner boom, and other equipment:

- API Spec 2C: Specification for Offshore Pedestal Mounted Cranes.
- ASME B30.20: Below the Hook Lifting Devices.
- API Spec 8C: Drilling and Production Hoisting Equipment.
- FEM 1.001: Section-1: Heavy lifting appliances – Rules for the design of Hoisting Appliance Methods of Strength Calculation.
- ISO 10245: (all parts) Cranes – Limiting and indicating devices.
- LR’s Code for Lifting Appliances in a Marine Environment.

A1.2.6 Derrick:

- API Spec. 7: Specification for Rotary Drilling Equipment.
- API RP 7G: Drill Stem Design and Operating Limits.
- API Spec. 8A and 8C: Drilling and Production Hoisting Equipment.
- API RP 8B: Hoisting Tool Inspection and Maintenance Procedures.
- API Spec. 9A: Wire Rope.
- API RP 9B: Application, Care and Use of Wire Rope for Oil Field Service.
- ISO 10405: Petroleum and natural gas industries – Care and use of casing and tubing.
- ISO 10426: Petroleum and natural gas industries – Cements and materials for well cementing.
- ISO 11960: Petroleum and natural gas industries – Steel pipes for use as casing or tubing for wells.
Codes, Standards and Equipment Categories

Part 3, Appendix A

Section A1

ISO 13678  Petroleum and natural gas industries – Evaluation and testing of thread compounds for use with casing, tubing and line pipe.

ISO 13680  Petroleum and natural gas industries – Corrosion-resistant alloy seamless tubes for use as casing, tubing and coupling stock – Technical delivery conditions.

FEM 1001  Rules for the Design of Hoisting Appliances, Section 1, Booklets 3 to 8.

A1.2.8  **Wellhead equipment:**

API Spec. 6A & ISO 10423  Wellhead and Christmas Tree: Equipment.


API RP 17D  Specification for Subsea Wellhead and Christmas Tree Equipment.

A1.2.9  **Piping:**

ASME B16.47  Large Diameter Steel Flanges: NPS 26 Through NPS 60.

ASME B16.5  Pipe Flanges and Flanged Fittings.

ANSI/ASME B31.3 BS 3351  Specification for Piping Systems for Petroleum Refineries and Petrochemical Plants.

ISO 13703  Petroleum and natural gas industries – Design and installation of piping systems on offshore production platforms.

API RP 14E  Design and Installation of Offshore Production Platform Piping Systems.

API RP 17B  Flexible Pipe.

API RP 520  Design and Installation of Pressure Relieving Systems in Refineries.

API RP 521  Guide for Pressure Relieving and Depressurising Systems.


ISO 10434  Bolted bonnet steel gate valves for the petroleum, petrochemical and allied industries.

ISO 13623  Petroleum and natural gas industries – Pipeline transportation systems.


ISO 14313  Petroleum and natural gas industries – Pipeline transportation systems – Pipeline valves.

ISO 15649  Petroleum and natural gas industries – Piping.

ISO 15761  Steel gate, globe and check valves for sizes DN 100 and smaller, for the petroleum and natural gas industries.

UKOOA  Specification and Recommended Practice for the Use of GRP Piping Offshore.

A1.2.10  **Riser and flow lines:**

API RP 2RD  Riser Design.


API RP 16Q  Design and Operation of Marine Drilling Riser Systems.

API Bul 2J  Comparison of Marine Drilling Riser Analysis.

API RP 17B  Recommended Practice for Flexible Pipe.


BS PD 9010  Code of Practice for Pipelines, Part 3, Pipelines Subsea: Design, Construction and Installation.

ISO 3183  Petroleum and natural gas industries – Steel pipe for pipeline transportation systems.

ISO 10414  Petroleum and natural gas industries – Field testing of drilling fluids.

ISO 10426  Petroleum and natural gas industries – Cements and materials for well cementing.

ISO 10427  Petroleum and natural gas industries – Equipment for well cementing.

ISO 11960  Petroleum and natural gas industries – Steel pipes for use as casing or tubing for wells.


ISO 15463  Petroleum and natural gas industries – Field inspection of new casing, tubing and plain-end drill pipe.

ISO 16070  Petroleum and natural gas industries – Downhole equipment – Lock mandrels and landing nipples.

ISO 18165  Petroleum and natural gas industries – Performance testing of cementing float equipment.

ISO 15590  Petroleum and natural gas industries – Induction bends, fittings and flanges for pipeline transportation systems.

A1.2.11  **Pressure vessels/fired units/heat exchangers:**

TBK-1-2  General Rules for Pressure Vessels.

ASME Section VIII, Div. 1 and 2  Rules for Construction of Pressure Vessels.

PD 5500  Unified Fusion Welded Pressure Vessel.

ASME Section 1  Power Boilers.

ASME Section IV  Heating Boilers.

ASME BPVC Sec I  Boiler And Pressure Vessel Code, Section I, Rules For The Construction Of Power Boilers.

ASME BPVC Sec IX  Boiler And Pressure Vessel Code, Section IX, Welding And Brazing Qualifications.

ASME BPVC Sec V  Boiler And Pressure Vessel Code, Section V, Nondestructive Examination.

ASME BPVC Sec VIII-1  Boiler And Pressure Vessel Code, Section VIII, Rules For The Construction Of Pressure Vessels, Division 1.
<table>
<thead>
<tr>
<th><strong>ASME BPVC Sec VIII-2</strong></th>
<th><strong>ASME BPVC Sec VIII-3</strong></th>
<th><strong>BS 2790</strong></th>
<th><strong>TEMA</strong></th>
<th><strong>EEMUA</strong></th>
<th><strong>API RP 530</strong></th>
<th><strong>API 660</strong></th>
<th><strong>API 661</strong></th>
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<th><strong>BS EN 12952</strong></th>
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<th><strong>ISO 15547</strong></th>
<th><strong>ISO 13705</strong></th>
<th><strong>ISO 16812</strong></th>
<th><strong>A1.2.12 Process plant equipment</strong></th>
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</thead>
<tbody>
<tr>
<td>API Std 620</td>
<td>API Std 670</td>
<td>API Std 671</td>
<td>API Std 672</td>
<td>API Std 673</td>
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<td>API Std 676</td>
<td>API Std 678</td>
<td>BS 2790</td>
<td>ISO 15547</td>
<td>ISO 13705</td>
<td>ISO 16812</td>
<td>BS EN 12952</td>
<td><strong>A1.2.12 Process plant equipment:</strong></td>
</tr>
<tr>
<td><strong>API 610</strong></td>
<td><strong>API 615</strong></td>
<td><strong>API 617</strong></td>
<td><strong>API RP 14C</strong></td>
<td><strong>API RP 550</strong></td>
<td><strong>API Std 613</strong></td>
<td><strong>API Std 614</strong></td>
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<td><strong>API Std 619</strong></td>
<td><strong>ISO 2314</strong></td>
<td><strong>ISO 2858</strong></td>
<td><strong>ISO 2954</strong></td>
<td><strong>ISO 3046</strong></td>
<td><strong>ISO 3977</strong></td>
<td><strong>ISO 3046</strong></td>
</tr>
</tbody>
</table>
ISO 10437 Petroleum, petrochemical and natural gas industries – Steam turbines – Special-purpose applications.
ISO 10438 Petroleum, petrochemical and natural gas industries – Lubrication, shaft-sealing and control-oil systems and auxiliaries.
ISO 10439 Petroleum, chemical and gas service industries – Centrifugal compressors.
ISO 13631 Petroleum and natural gas industries – Packaged reciprocating gas compressors.
ISO 13691 Petroleum and natural gas industries – High-speed special-purpose gear units.
ISO 14310 Petroleum and natural gas industries – Downhole equipment – Packers and bridge plugs.
ISO 15136 Downhole equipment for petroleum and natural gas industries – Progressing cavity pump systems for artificial lift.
NFPA No. 37 1975 Stationary Combustion Engines and Gas Turbines.

A1.2.13 General structural items (skids, support frames and trusses, helidecks, etc):

CAP 437 Offshore Helicopter Landing Areas – Guidance on Standards.
BS 2853 The Design and Testing of Steel Overhead Runway Beams.
BS EN 1993 Eurocode 3: Design of Steel Structures.
BS 8118 Structural Use of Aluminium.
API BUL 2U Design of Flat Plate Structures.
BS 8100 Lattice Towers and Masts.
API RP 2SK Recommended Practice for Design and Analysis of Stationkeeping Systems for Floating Structures.

A1.2.14 Hazard area classification:

API RP 500 Classification of Locations for Electrical Installations at Petroleum Facilities.
API RP 505 Classification of Locations for Electrical Installations at Petroleum Facilities, Classed as Class I, Zones 0, 1 & 2. Refining Safety Code.
IP Code, Part 8 Area Classification Code for Petroleum Installations.


A1.2.15 Fire and safety standards:

ISO 13702 Petroleum and natural gas industries – Control and mitigation of fires and explosions on offshore production installations – Requirements and guidelines.


A1.2.16 Bearings:

Section A2

Equipment categories

A2.1 Drilling equipment

A2.1.1 A list of usual drilling equipment with its categories is given in Table A2.1.
<table>
<thead>
<tr>
<th>Systems and types of equipment</th>
<th>Category</th>
<th>Description of equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Well protection valves with control systems</strong></td>
<td>1A</td>
<td>Hydraulic connector for wellhead</td>
</tr>
<tr>
<td>1.1 Blow out prevention</td>
<td>1A</td>
<td>Ram preventers</td>
</tr>
<tr>
<td>1.1.1 Equipment</td>
<td>1A</td>
<td>Annular preventers</td>
</tr>
<tr>
<td>1.1.2 Control equipment</td>
<td>1B</td>
<td>Accumulators for sub-sea stack</td>
</tr>
<tr>
<td>1.2 Choke and kill equipment</td>
<td>1B</td>
<td>Sub-sea fail-safe valves in choke and kill lines</td>
</tr>
<tr>
<td>1.3 Diverter unit</td>
<td>1A</td>
<td>Clamp</td>
</tr>
<tr>
<td>1.3</td>
<td>1B</td>
<td>Test stump</td>
</tr>
<tr>
<td>1.2</td>
<td>1A</td>
<td>Electrical/electronic control systems</td>
</tr>
<tr>
<td>1A</td>
<td>Deadman systems</td>
<td></td>
</tr>
<tr>
<td>1A</td>
<td>Autoshear system</td>
<td></td>
</tr>
<tr>
<td>1A</td>
<td>Emergency disconnect system</td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td>Accumulators in control system</td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td>Welded pipes and manifolds</td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td>Unwelded hydraulic piping</td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td>Flexible control hoses</td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td>Hydraulic hose reel</td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td>Hydraulic power unit including pumps and manifold</td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td>Control panels</td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td>Acoustic transportable emergency power package</td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>1A</td>
<td>Choke manifold</td>
</tr>
<tr>
<td>1B</td>
<td>All piping to and from choke manifold</td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td>Piping for choke, kill and booster lines</td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td>Flexible hoses for choke, kill and booster lines</td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td>Valves in choke, kill and booster lines</td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td>Unions and swivel joints</td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td>Emergency circulation pump – pressure side</td>
<td></td>
</tr>
<tr>
<td>1.3</td>
<td>1A</td>
<td>Diverter house with annular valve</td>
</tr>
<tr>
<td>1B</td>
<td>Diverter piping</td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td>Valves in diverter piping</td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td>Control panel</td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td>Hydraulic power unit including pumps and manifold</td>
<td></td>
</tr>
<tr>
<td>2. Marine riser with control systems</td>
<td>1A</td>
<td>Hydraulic connector</td>
</tr>
<tr>
<td>1A</td>
<td>Ball joint and flexible joint</td>
<td></td>
</tr>
<tr>
<td>1A</td>
<td>Riser sections including joints</td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td>Support ring for riser tensioning</td>
<td></td>
</tr>
<tr>
<td>1A</td>
<td>Telescopic joint</td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td>Accumulators</td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td>Hydraulic power unit including pumps and manifold</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>1B</td>
<td>Control panel</td>
</tr>
<tr>
<td>3. Heave compensation</td>
<td>1B</td>
<td>Riser tensioner</td>
</tr>
<tr>
<td>3.1 Tensioning system for riser and guidelines</td>
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<td>Guideline and podline tensioners</td>
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<td>1B</td>
<td>Hydro-pneumatic accumulators</td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td>Pressure vessels</td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td>Piping system</td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td>Air compressors</td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td>Air dryers</td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td>Wire ropes for tensioning equipment</td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td>Sheaves for riser tension line</td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td>Sheaves for guideline and podline</td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td>Telescopic arms for tension lines</td>
<td></td>
</tr>
<tr>
<td>3.2 Drill string compensator</td>
<td>1B</td>
<td>Control panels</td>
</tr>
<tr>
<td>1B</td>
<td>Telescopic arms for tension lines</td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td>Control panels</td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td>Control panels</td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td>Control panels</td>
<td></td>
</tr>
<tr>
<td>Systems and types of equipment</td>
<td>Category</td>
<td>Description of equipment</td>
</tr>
<tr>
<td>--------------------------------------------------------</td>
<td>----------</td>
<td>--------------------------------------------------------------</td>
</tr>
<tr>
<td>4. Hoisting rotation and pipe handling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1 Drilling derrick</td>
<td>1A</td>
<td>Derrick and substructure</td>
</tr>
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<td>4.2 Hoisting equipment for derrick</td>
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<td>Sheaves for crown block and travelling block</td>
</tr>
<tr>
<td></td>
<td>1A</td>
<td>Crown block including support beams</td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td>Guide track and dolly for travelling block</td>
</tr>
<tr>
<td></td>
<td>1A</td>
<td>Travelling block</td>
</tr>
<tr>
<td></td>
<td>1A</td>
<td>Drilling hook</td>
</tr>
<tr>
<td></td>
<td>1A</td>
<td>Swivel</td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td>Links</td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td>Elevators</td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td>Drilling line and sand line</td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td>Deadline anchor</td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td>Drawworks including foundation</td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td>Air winches for the transport of personnel</td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td>Cranes in derrick</td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td>Cherry picker</td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td>Personal hoisting equipment</td>
</tr>
<tr>
<td>4.3 Rotary equipment</td>
<td>1B</td>
<td>Rotary table including skid adopter and driving unit</td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td>Kelly</td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td>Master bushing</td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td>Kelly bushing</td>
</tr>
<tr>
<td></td>
<td>1A</td>
<td>Top drive</td>
</tr>
<tr>
<td>4.4 Pipe handling</td>
<td>1B</td>
<td>Racking arms with or without lifting head</td>
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<tr>
<td></td>
<td>1B</td>
<td>Finger board</td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td>Tubular chute</td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td>Hydraulic cathead</td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td>Mousehole powered</td>
</tr>
<tr>
<td>5. Miscellaneous equipment for drilling</td>
<td>1B</td>
<td>Manual tongs for pipe handling</td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td>Power tongs for pipe handling</td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td>Kelly spinner</td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td>Power slips</td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td>Elevators for lifting pipe</td>
</tr>
<tr>
<td>6. Bulk storage, drilling fluid circulation and cementing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.1 Bulk storage</td>
<td>1A</td>
<td>Drilling systems controls</td>
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<tr>
<td></td>
<td>1B</td>
<td>Hydraulic control systems</td>
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<tr>
<td></td>
<td>1B</td>
<td>Hydraulic power units including ring lines</td>
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<td>6.2 Drilling fluid, circulation and transportation</td>
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<td></td>
</tr>
<tr>
<td>6.2.1 Suction and transport</td>
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<td>Piping systems for mixing of drilling fluid and suction line to the drilling fluid pump</td>
</tr>
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<td>System II</td>
<td>II</td>
<td>Centrifugal pumps for mixing drilling fluid</td>
</tr>
<tr>
<td>(low pressure)</td>
<td>1B</td>
<td>Drilling fluid pump – pressure side</td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td>Pulsation dampers</td>
</tr>
<tr>
<td>6.2.2 Well circulation system</td>
<td>1B</td>
<td>Piping circulation of drilling fluid in the well</td>
</tr>
<tr>
<td>(high pressure)</td>
<td>1B</td>
<td>Standpipe manifold</td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td>Rotary hose with end connections</td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td>Kelly cocks</td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td>Non-return valve in drill string (inside BCP)</td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td>Mixing pumps</td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td>Safety valves</td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td>Circulation head</td>
</tr>
<tr>
<td>6.2.3 Mud return system on deck</td>
<td>II</td>
<td>Mud return pipe</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>Dump tank</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>Shale shaker</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>Drilling fluid tanks</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>Trip tank</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>Desander, desilter</td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td>Degasser</td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td>Piping from degasser to burners or to ventilation</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>Chemical mixers</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>Agitators for drilling fluid</td>
</tr>
</tbody>
</table>
A2.2 Miscellaneous equipment

A2.2.1 A list of miscellaneous equipment forming part of the drilling installation is given in Table A2.2.

Table A2.2  Miscellaneous equipment forming part of the drilling installation

<table>
<thead>
<tr>
<th>Component</th>
<th>Conditions</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Piping</td>
<td>Thickness of wall &gt; 25.4 mm. Design temperature &gt; 400°C</td>
<td>1B</td>
</tr>
<tr>
<td></td>
<td>All welded pipes and piping systems used in Category 1A and 1B piping systems</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pipes other than those mentioned above and pipes in Category II systems</td>
<td>II</td>
</tr>
<tr>
<td>2. Flanges and couplings</td>
<td>Standard flanges and pipe couplings</td>
<td>1B</td>
</tr>
<tr>
<td></td>
<td>Non-standard flanges and pipe couplings used in Category 1A and 1B piping</td>
<td></td>
</tr>
<tr>
<td></td>
<td>systems</td>
<td>II</td>
</tr>
<tr>
<td>3. Valves</td>
<td>Valve body welded construction with ANSI rating &gt; 600 lbs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Valves designed and manufactured in accordance with recognised standards</td>
<td></td>
</tr>
<tr>
<td>4. Components of high strength</td>
<td>Specified yield strength &gt; 345 N/mm² or tensile strength &gt; 515 N/mm²</td>
<td></td>
</tr>
<tr>
<td>material</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTES
1. The equipment list is intended as a guide only and does not necessarily cover all the equipment items found in a drilling plant facility.
2. Equipment considered to be important for safety which is not listed in the Table will be specially considered by LR and categorised.

A2.3 Production equipment

A2.3.1 A list of usual production equipment with its categories is given in Table A2.3.
### Table A2.3  Production equipment with its categories

<table>
<thead>
<tr>
<th>Systems and types of equipment</th>
<th>Category</th>
<th>Description of equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Christmas tree and sub-sea production system</td>
<td>1A</td>
<td>Christmas tree, wellhead couplings, valves and control lines</td>
</tr>
<tr>
<td></td>
<td>1A</td>
<td>Production manifolds and piping</td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td>Template and other floor structures</td>
</tr>
<tr>
<td></td>
<td>1A</td>
<td>Well safety valve</td>
</tr>
<tr>
<td></td>
<td>II</td>
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<td>Crude oil and gas metering equipment</td>
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<td>Oil protection and process shut-down equipment</td>
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<td>Valves and pipes</td>
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<td>1B</td>
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<td>Instrumentation and control equipment</td>
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<td>1A</td>
<td>Swivel for production</td>
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<td>6. Pressure vessels (general)</td>
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<td>Pressure vessels</td>
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<td>7. Miscellaneous equipment</td>
<td>1A</td>
<td>Flare booms</td>
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<td></td>
<td>1B</td>
<td>Burners</td>
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<td>II</td>
<td>Instrumentation components in general</td>
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<tr>
<td>8. For well overhaul and maintenance equipment, see Table A2.1.</td>
<td>1B</td>
<td>Main instrumentation components and equipment in critical systems (e.g., control panels)</td>
</tr>
</tbody>
</table>

**NOTES**
1. The equipment list is intended as a guide only and does not necessarily cover all the equipment items found in a production plant facility.
2. Equipment considered to be important for safety which is not listed in the table will be specially considered by LR and categorised.
Guidelines on the Inspection of Positional Mooring Systems

Section B1
Survey requirements

B1.1 Application

B1.1.1 The information in this Appendix is intended to provide guidance to Owners and Surveyors for the inspection of classed positional mooring systems as defined in Chapter 10.

B1.2 Annual Surveys

B1.2.1 Annual Surveys are to be carried out in accordance with Pt 1, Ch 3 with the vessel at its normal operational draft with the positional mooring system in use.

B1.2.2 The purpose of the Annual Survey is to confirm that the mooring system will continue to carry out its intended purpose until the next Annual Survey. No disruption of the unit’s operation is intended. Where practicable the Annual Survey is to be carried out during a relocation move.

B1.2.3 The scope of the Annual Survey is limited to the mooring components adjacent to winches, windlasses and fairleads. Depending on the mooring component visible from the unit, particular attention should be given to:
(a) Chain:
   • Wear in the chain shoulders in way of the chain stopper, windlass pockets and fairleads.
   • Support of chain links in the windlass pockets.
(b) Wire rope:
   • Flattened ropes.
   • Broken wire.
   • Worn or corroded ropes.

B1.2.4 The Surveyor should examine the maintenance records and determine if any problems have been experienced with the mooring system in the previous twelve months, e.g., breaks, mechanical damage, loose joining shackles, and chain or wire jumping.

B1.2.5 Should the Annual Survey reveal severe damage or neglect to the visible chain or cable, a more extensive survey will be required by Lloyd’s Register (hereinafter referred to as ‘LR’).

B1.2.6 Typical damage warranting a more comprehensive survey would include:
   (a) Chain:
      • Reduction in diameter exceeding 75 per cent of the margin assumed in the design, see Ch 10.8.2.
      • Missing studs.
      • Loose studs in Grade 4 chain.
      • Worn lifters (i.e., gypsies) causing damage to the chain.
   (b) Wire rope:
      • Obvious flattening or reduction in area.
      • Worn cable lifters causing damage to the wire rope.
      • Severe wear or corrosion.

B1.3 Special Surveys

B1.3.1 Special Periodical Surveys are to be carried out at five-yearly intervals in accordance with Pt 1, Ch 3, and will require extensive inspection, usually associated with a sheltered water visit. When considered necessary by LR the interval between Special Periodical Surveys may be reduced.

B1.3.2 The purpose of the Special Survey is to ensure that each anchor line is capable of performing its intended purpose until the next Special Survey, assuming that appropriate care and maintenance is performed in the mooring system during the intervening period.

B1.3.3 The Special Survey should include:
   (a) Close visual inspection (100 per cent) of mooring chains, with cleaning as required.
   (b) Enhanced representative NDT sampling.
   (c) Dimension checks.

B1.3.4 Particular attention is to be given to the following:
   • Cable or chain in contact with fairleads, etc.
   • Cable or chain in way of winches, windlass and stoppers.
   • Cable or chain in way of the splash zone.
   • Cable or chain in the contact zone of the sea bed.
   • Damage to mooring system.
   • Extent of marine growth.
   • Condition and performance of corrosion protection.

B1.3.5 This survey is to ensure that the lengths of anchor line frequently in contact with winches, windlasses and fairleads are suitably rated for this application.

B1.3.6 Joining shackles are to be examined for looseness and pin securing arrangements. All joining shackles of the Kenter type and bolted type which have been in service for more than four years should be dismantled and an MPI performed on all machined surfaces as per B2.6.3.

B1.3.7 Visual surveys of all windlass and fairlead chain pockets are to be carried out with particular attention to the following:
   • Unusual wear or damage to pockets.
   • Rate of wear on pockets including relative rate of wear between links and pockets.
   • Mismatch between links and pockets, and improper support of the links in the pockets.
Guidelines on the Inspection of Positional Mooring Systems

Part 3, Appendix B

Sections B1 & B2

B1.3.8 The thickness (diameter) of approximately one per cent of all chain links should be measured. The selected links should be approximately uniformly distributed through the working length of the chain. The above percentage may be increased/decreased if the visual examination indicates excessive/minimal deterioration.

B1.3.9 A functional test of the mooring system during anchor-handling operation is to be carried out with particular attention given to the following:

- Smooth passageway of chain links and or/wire rope and joining shackles over the windlass and fairleads pockets.
- The absence of chain jumping or other irregularities.

B1.4 Special Continuous Surveys

B1.4.1 As an alternative to the Special Survey, the Owner may agree with LR that the Special Survey may be carried out on a continuous survey basis by providing an extra mooring line which may be regularly inspected on shore and exchanged with lines installed on the unit in accordance with an appropriate schedule.

Section B2

General guidelines on inspection of mooring system components

B2.1 Anchor inspection

B2.1.1 The anchor head, flukes and shank are to be examined for damage, including cracks or bending. The anchor shackle pin should be examined and renewed if excessively worn or bent. Moveable flukes should be free to rotate.

B2.1.2 Bent flukes or shank should be heated and jacked in place according to an approved procedure, followed by Magnetic Particle Inspection.

B2.2 Anchor swivels

B2.2.1 Although swivels are no longer in common use, anchors have been lost due to corrosion of the threads engaging the swivel nut. Swivel nut threads should be carefully examined and if significant corrosion is found, the swivel should be removed or replaced.

B2.3 Chain inspection criteria

B2.3.1 This sub-Section applies only to ‘Offshore’ or ‘Rig Quality’ chains with studs secured by one of the following means:

- Mechanically locked in way of the link’s flash-butt weld and fillet welded on other end (IACS R3 chain for example); or
- Studs mechanically locked in place on both ends (IACS R4 chain for example).

Other types of chain will require special consideration.

B2.3.2 The service environment of offshore mooring chain is more severe than the service environment for conventional ship anchoring chain. Offshore chain is exposed to service loads for a much longer period of time. The long-term exposure to cyclic loadings in sea-water magnifies the detrimental effect of geometric and metallurgical imperfections on fatigue life. Moreover, the increased number of links in offshore chains renders the chain more susceptible to failure from a statistical standpoint.

B2.3.3 Due to the effect of notches, e.g., the stud footprint, higher strength steels such as that used for IACS R4 chain have a lower ratio of fatigue strength to static tensile strength than typical lower strength steel such as used for IACS R3 chain.

B2.3.4 Since chain link diameter loss can be due to abrasion and corrosion, diameter measurements should be taken in the curved or bend region of the link and any area with excessive wear or gouging. Two diameter measurements should be taken 90 degrees apart. Particular attention should be given to the shoulder areas which normally contact the windlass or fairlead pockets.

Links should be rejected if the minimum cross-sectional area is less than the minimum Rule chain size plus a margin for corrosion and wear between surveys, see Ch 10.8.2. If repair is permitted it should be done by qualified personnel using an approved procedure.

Note

WELD REPAIR IS NOT PERMITTED ON IACS R4 CHAIN (see B2.3.6).

Two diameter measurements should be taken 90 degrees apart.

B2.3.5 Since studs prevent knots or twist problems during chain handling and support the sides of the links under load to reduce stretching and bending stresses, missing studs are not acceptable. Links with missing studs should be removed or the studs should be refitted using an approved procedure.

B2.3.6 Where chain studs are secured by fillet welds on one end, the stud is likely to fall out if a stud is loose or the weld is cracked. Any axial or lateral movement is unacceptable and the link must be repaired or replaced.

Links with studs fillet welded on the flash-butt weld end of the stud are unacceptable.

Rejection of links with gaps exceeding 3 mm between the stud and the link at the flash-butt weld end of the stud should be considered. Closing the gap by renewing the fillet weld may be considered but see the note in B2.3.8.
B2.3.7 Field repair of cracked welds should be avoided if at all possible. Welding must be performed by qualified personnel using approved procedures:

NOTE
WELD REPAIR IS NOT PERMITTED IN IACS R4 CHAIN.

Chains with studs mechanically locked in place on both ends may only be repaired by an approved mechanical squeezing procedure to reseat the stud.

B2.3.8 Fillet welding of studs in both ends is not acceptable; nor is welding on the stud end adjacent to the link’s flash-butt weld.

Existing studs with fillet welds on both ends will require special consideration and will be subject to special crack detection methods. A reduction in mechanical properties in way of the flash-butt weld will normally be required.

B2.3.9 Where chain studs are secured by press-fitting and mechanical locking, it is very difficult to quantify excessive looseness of chain studs. The decision to reject or accept a link with a loose stud must depend on the Surveyor’s judgement of the overall condition of the chain complement.

Axial movement of studs of 1 mm or less is acceptable. Links with axial movement greater than 2 mm must be replaced by squeezing or removed. Acceptance of chain links with axial movements from 1 to 2 mm must be evaluated based on the environmental conditions of the unit’s location and expected period of time before the chain is again available for inspection.

Lateral movement of studs up to 4 mm is acceptable.

B2.3.10 Where links are damaged and have cracks, gouges and other surface defects (excluding weld cracks), they may be removed by grinding, provided B2.3.4 is complied with.

Links with surface defects which cannot be removed by grinding should be replaced.

Where defective links are found, they are to be removed and replaced with joining shackles, i.e., connecting links guided by the following good marine practice:
(a) The replacement joining shackle is to comply with IACS W22 or API 2F;
(b) Joining shackles are to pass through fairleads and windlasses in the horizontal plane.
(c) Since joining shackles have much lower fatigue lives than ordinary chain links, as few as possible should be used. On average, joining shackles should be separated by 120 metres or more.
(d) If a large number of links meet the discard criteria and these links are distributed in the whole chain length, the chain should be replaced with new chain.

B2.4 Fairlead and windlass inspection – Chain system

B2.4.1 Fairlead inspections should verify that all fairleads move freely about their respective pivot axes, to the full range of motion required for their proper operation. All bolts, nuts and other hardware used to secure the fairlead shafts should be inspected and replaced as required.

Fairlead attachment to the hull should be verified and NDT conducted as necessary.

NOTE
There have been cases of closing plates on the fairlead shaft coming loose due to corrosion of the securing bolts, resulting in serious damage to the fairlead arrangements and the complete jamming of the fairlead and chain. Consequently, the securing bolts should also be checked to ensure that the bolt material does not corrode preferentially should the sacrificial anode system fail to function in way of the fairlead.

B2.4.2 Special attention should be given to the holding ability of the windlasses. The chain stopper and the resultant load path to the unit’s structure should be inspected and its soundness verified.

B2.4.3 It is essential that a link resting in a chain pocket makes contact with the fairlead at only the four shoulder areas of the link to avoid critical bending stresses in the link. Satisfactory chain support is to be verified, and excessive wear in the pockets should be repaired as required to prevent future damage to the chain.

B2.4.4 Chain pockets may be repaired by welding in accordance with the standard procedures supplied by the fairlead/windlass manufacturer. Normally, the hardness of the pockets should be slightly softer than the hardness of the chain link and procedures must be specific for the chain quality used.

B2.5 Fairleads and windlass – Wire rope systems

B2.5.1 Fairleads are to be inspected in accordance with B2.4.1.

B2.5.2 Special attention should be given to the holding ability of the winch and the satisfactory operation of the pawls, ratchets and braking equipment. The soundness of the resultant load path to the unit’s structure should be verified.

Proper laying down of the wire on the winch drum should be verified to the satisfaction of the Surveyor and drums and spooling gear adjustments made if required.

B2.6 Inspection of miscellaneous fittings

B2.6.1 Anchor shackles, large open links, swivels and connecting links should be visually inspected. Certain areas should be examined by MPI. Areas to be examined should be clearly marked on each item. Links and fittings should be dismantled as required. Damaged items should be replaced as required by the attending Surveyor. Illustrations showing the areas of concern may be found in API RP 2I, Figure 7. General guidance on the areas requiring MPI is listed as follows:

- Large open links: the interior contact surfaces of large open links.
- Bolted shackles: the inside contact surfaces and the pins.
- Swivels: the swivel pin and threads and mating surface.
Guidelines on the Inspection of Positional Mooring Systems

Part 3, Appendix B

Section B2

B2.6.2 Experience has shown that large numbers of anchors and chains are lost in service due to connecting link failure. Fatigue problems have resulted from poorly designed machined faces and corners. Joining shackles of Kenter or similar designs manufactured before 1984 are of particular concern. Joining shackles used for higher strength chains, such as ORQ and above, which do not have certificates of equivalent quality should be rejected.

B2.6.3 All joining shackles of Kenter or similar design which have been in service for more than four years should be dismantled and MPI carried out. Illustrations showing the areas of concern may be found in API RP 2I, Figure 7. General guidance in the areas requiring MPI is listed as follows:

- Joining-shackle links: all machined and ground services of the link and the sides of the curved portions of the link.
- Joining-shackle stud: machined surfaces only.
- Joining-shackle pin: 100 per cent.

Fatigue is considered to be the critical criterion in way of the machined surfaces. On the remaining surface, the profile should be ground smooth and MPI should be carried out upon completion of grinding. In general, the radius of the completed grinding operation should produce a recess with a minimum radius of 20 mm and a length along the link bar greater or equal to six times its depth.

Note
Sandblasting prior to MPI may change the machined surfaces and should be avoided. Alternative methods of cleaning should be used.

Where links are damaged and have cracks, gouges or other surface defects (excluding weld cracks), they may be removed by grinding, provided B2.3.4 is complied with. Links with surface defects which cannot be removed by grinding should be replaced.

Where defective links are found, they are to be removed and replaced with joining shackles, i.e., connecting links guided by the following good marine practice:

(a) The replacement joining shackle is to comply with IACS W22 or API 2F.
(b) Joining shackles are to pass through fairleads and windlasses in the horizontal plane.
(c) Since joining shackles have much lower fatigue lives than ordinary chain links as few as possible should be used. On average, joining shackles should be separated by 120 metres or more.
(d) If a large number of links meet the discard criteria and these links are distributed in the whole chain length, the chain should be replaced with new chain.

B2.6.4 Tapered pins holding the covers of connecting links together should make good contact at both ends and the recess of counterbore at the large end of the pin holder should be solidly plugged with a peened lead slug to prevent the pin from working out.

B2.6.5 Any joining shackles of Kenter or similar designs which are loose upon reassembly should be rejected.

B2.7 Wire rope

B2.7.1 Acceptance criteria should be guided by ISO-Standard 4309-1981(E). Further insight may be gained from the discard guidance provided by API RP 2I, Figures 18 and 19.

B2.7.2 It should be borne in mind that ISO-Standard 4309-1981(E) is primarily intended for lifting appliances where the Factor of Safety may be higher than for mooring wires.

B2.7.3 The Surveyor should exercise great care in his interpretation of the condition of the wire. An obvious acceptance or rejection is comparatively easy, but the grey area between is difficult to evaluate. The Surveyor must make a sound evaluation and technical judgement based on all available evidence.

B2.7.4 In general, the age or time in service of the wire does not directly have a bearing on the acceptance or rejection of the wire other than as a factor to be taken into consideration by the Surveyor when deciding on the extent of the survey.

B2.7.5 100 per cent visual examination of wire ropes is to be carried out and diameter measurements should be performed.

B2.7.6 Visual examination should identify and record the following items for each steel wire anchor line:

(a) The nature and number of wire breaks:
   - Wire breaks at the termination.
   - External wear and corrosion.
   - Localised grouping of wire breaks.

(b) Deformation:
   - Fracture of strands.
   - Termination area.
   - Reduction of rope diameter, including breaking or extrusion of the core.

B2.7.7 Diameter measurements should be taken at approximately 110 metre intervals, at the discretion of the attending Surveyor. If areas of special interest are found, the survey may be concentrated on these areas and diameter measurements taken at much smaller intervals.

B2.7.8 An internal examination should be undertaken as far as practicable if there are indications of severe internal corrosion or possible breakage of the core or wire breaks in underlying areas. See API RP 2I, Section 2.3.6.3, for guidance on the internal inspection of wire rope.

B2.8 Guidance on wire rope damage

B2.8.1 The cause of wire rope failures may be deduced from the observed damage to the rope. The information summarised in this sub-Section covers most types of wire rope failure. More detailed information, including photographic examples, is available in ISO-Standard 4309-1981(E) and API RP 2I.
B2.8.2 Broken wires at the termination indicate high stresses at the termination and may be caused by incorrect fitting of the termination, fatigue, overloading, or mishandling during deployment or retrieval.

(a) Distributed broken wires, illustrated by Figures 9 to 12 of API RP 2I, may indicate the reason for their failure:
- Crown breaks or breakage of individual wire at the top of strands may be caused by excessive tension, fatigue, wear or corrosion.
- Excessive tension is indicated by necking down of the broken end of the wire.
- Fatigue is indicated by broken faces perpendicular to the axis of the wire.
- Corrosion and wear may be indicated by reduced cross-sections of the wire.
- Valley breaks at the interface between two strands indicate tightening of the strands, usually caused by a broken core or internal corrosion which has reduced the diameter of the core.
- Valley breaks can be caused by high loads, tight sheaves of too small a diameter.

(b) Locally grouped broken wires in a single strand or adjacent strand may be due to local damage. Once begun, this type of damage will usually get worse.

B2.8.3 Changes in rope diameter can be caused by external wear, interwire and interstrand wear, stretching or corrosion. A localised reduction in rope diameter may indicate a break in the core. Conversely, an increase in rope diameter may indicate a swollen core due to corrosion.

B2.8.4 Wear on the crown of outer strands in the rope may be caused by rubbing against fairleads, unit structure or the sea bed, depending on the location of the wear. Internal wear between individual strands and wires in the rope is caused by friction and is accelerated by bending of the rope and corrosion.

B2.8.5 Corrosion decreases rope strength by reducing the cross-sectional area and accelerates fatigue by creating an irregular surface which invites stress cracking. Corrosion is indicated by:

(a) The diameter of the rope at fairleads will grow smaller.
(b) The diameter of stationary ropes may actually grow larger, due to rust under the outer continuous layer of strands. Diameter growth is rare for mooring lines.

B2.8.6 Deformation, i.e., distortion of the rope from its normal construction, may result in an uneven stress distribution in the rope. Kinking, bending, scrubbing, crushing, and flattening are common wire rope deformations. Ropes with slight deformations will not lose significant strength. Severe distortions can accelerate deterioration and lead to premature failure.

B2.8.7 Thermal damage, although rare for mooring ropes in normal service, may be indicated by discoloration. Prompt attention should be given to damage caused by excessively high or low temperatures. The effect of very low temperatures on wire rope is unclear except for the known detrimental effect on lubricants.
Guidelines on Scope of Survey Certification of Safety Critical Equipment

Part 3, Appendix C

Sections C1 & C2

Section C1

Introduction

C1.1 Application

This document has been extracted from standard LR Group Oil and Gas project Verification Work Instructions, for issue as part of the LR Quality System and should be read in conjunction with Project-Specific Quality Plan and supporting procedures. It is intended to outline appropriate scopes of survey for typical safety critical items of equipment associated with disconnectable or mobile drilling and production installations where LR is providing Certification or Verification/Validation services. The list is not exhaustive and should be used as a guide for equipment which is to be included within the scope of the service to be provided. The extent to which the Surveyors are required to attend in order to ensure that each item of equipment complies with a recognised Code, specification, or agreed Standard of performance is to be agreed with LR. The attendance required will be indicated on the supplier’s Inspection and Test plan as a minimum. The procedures between Project Vendors and their local LR Surveyors are to be agreed.

C1.1.2 Some typical acceptable Codes and Standards are referenced herein. Other National or International Standards may be considered and accepted if deemed appropriate by LR. Company standards may also be applied where they represent an agreed standard of performance. See also Appendix A, Section 1.

C1.1.3 Where equipment is identified as being safety critical to an installation, survey/examinations undertaken within their examination schemes or codes may be considered to contribute to the validation required of such equipment. Safety critical equipment/elements are those such parts of an installation and such parts of its plant (including computer programs), or any part thereof;
(a) The failure of which could cause or contribute substantially to;
(b) A purpose of which is to prevent, or limit the effect of, a major accident.

Section C2

Scope of survey for equipment

C2.1 Accommodation/temporary refuge units

C2.1.1 Design appraisal and survey of structure, pipework, HVAC arrangements, and fire and overpressure protection is required. See also C2.37 and C2.41.

C2.2 Accumulators

C2.2.1 See C2.29.

C2.3 Air receiver and drier vessels

C2.3.1 Where the maximum air pressure is equal to 7 barg (100 psi) or greater, a survey to Code requirements including design appraisal is required.

C2.3.2 Where the pressures are less than 100 psi, valid manufacturers’ documentation can be accepted. Material is to be manufactured to a recognised pressure vessel standard.

C2.3.3 Typical acceptable standards: BS 5169, ASME VIII Div. 1 and BS 5500.

C2.4 Air winches

C2.4.1 See C2.33.

C2.5 Blast rated boundaries/enclosures

C2.5.1 Design appraisal for rated blast overpressure and construction under survey is required.

C2.6 Blow out preventers and BOP control unit

C2.6.1 See C2.57.

C2.7 Burner (flare) booms or towers

C2.7.1 Design appraisal is required with respect to:
(a) Environmental loads.
(b) Loads onto platform unit.
(c) Location and length with respect to heat radiation hazard.
(d) Construction under survey.

C2.7.2 Typical acceptable Standards are Structural Design A.I.S.C., Fabrication AWS D1.1, BS 4870, BS 4871 and Heat Radiation API RP 521.

C2.8 Coolers/chillers

C2.8.1 See C2.25.
C2.9 Compressors/compressor packages

C2.9.1 Reciprocating machines above 100 kW are to be built under survey with design appraisal of piping systems, any contained pressure vessels and torsional vibration characteristics for large reciprocating machines. Hydrostatic tests to be witnessed and manufacturers’ data examined for other components. See also C2.53 and C2.55.

C2.10 Cranes

C2.10.1 See C2.33.

C2.11 Deluge systems

C2.11.1 Review of P&IDs, hydraulic calculations, area coverage and pump capacities is required. For survey, see C2.12, C2.41 and C2.45.

C2.12 Diesel prime movers

C2.12.1 For air compressors, mud pumps, cement pumps, generators and drawworks except fire.

C2.12.2 Pumps and emergency generators.

C2.12.3 Design appraisal with respect to vibration (i.e., hazardous areas), torsional vibration characteristics of shaft system and witness of commissioning of machines is required.

C2.12.4 For fire pumps, vessel propulsion, auxiliary service and emergency generators.

C2.12.5 Survey is required where the power is equal to or in excess of 100kW and to include above. If power is less than 100kW, manufacturers’ documentation can be accepted. Engines should be suitably marinised, batch and line approved and able to operate under the conditions specified in LR Rules.

C2.13 Distillation plants

C2.13.1 See C2.25.

C2.14 Drums

C2.14.1 See C2.43.

C2.15 Electrical equipment

C2.15.1 Survey at manufacturers’ works is not required for equipment that is not specified in LR Classification Rules requirements. Equipment must be manufactured in accordance with a recognised Standard and manufacturers’ certificates are required. Flameproof and I.S. equipment is to be supplied with relevant certification and documentation issued by a recognised authority and must be suitable for the application. After installation under survey, the integrity of the complete system is to be established.

C2.16 Emergency shut-down systems/fire and gas systems

C2.16.1 Witness of testing and documentation review at suppliers’ works by a specialist LR Surveyor is recommended (mandatory where full Cause and Effect Testing is not repeated during the installation commissioning phase).

C2.16.2 Design appraisal requirements will vary according to the responsibilities assigned to the supplier by the main design contractor. For programmable systems, details of Hardware, system specification and Software QA manuals will be required for review. (Process control systems do not require LR survey at suppliers’ works).

C2.17 Fans

C2.17.1 Survey at manufacturers’ works is not required. Manufacturers’ documentation to be supplied.

C2.17.2 When intended for use in hazardous areas, fans must be of non-sparking type.

C2.18 Filters

C2.18.1 See C2.43.

C2.19 Fire and foam pumps

C2.19.1 See C2.12.

C2.20 Flare booms and towers

C2.20.1 See C2.7.

C2.21 Flexible hoses

C2.21.1 Manufacturers’ documentation, including prototype burst testing is required. Fire test certification is generally required for hydrocarbons, high pressure and essential control service.
C2.22 Fluid transfer systems (fluid swivel type)

C2.22.1 Strength design appraisal and survey during manufacture, assembly and test is required.

C2.23 Gas turbines/compressors

C2.23.1 See C2.53.

C2.24 Geared machinery

C2.24.1 Witness of commissioning and testing after installation is required.

C2.25 Heat exchangers

C2.25.1 Hydrocarbons. Design appraisal and survey during manufacture to Code requirements is required.

C2.25.2 Non-hydrocarbons. Design pressures greater than or equal to 7 barg (100 psi). Design appraisal and survey during fabrication is required. See also C2.43, which applies equally to shell and tube exchangers.

C2.25.3 Non-hydrocarbons. Design pressures less than 7 barg (100 psi). Manufacturers’ documentation can be accepted with hydrostatic tests being witnessed after installation. Material is to be manufactured to a recognised pressure vessel standard.

C2.25.4 Typical acceptable codes: PD 5500, ASME VIII Div. 1 & 2 and TEMA Standards.

C2.26 Helideck

C2.26.1 Design appraisal of structure, markings, lights, obstacle free/drop off zones, fire and escape arrangements is required. Survey under fabrication as for modules.

C2.27 Hoists

C2.27.1 See C2.33.

C2.28 Hydrocyclones

C2.28.1 Survey at manufacturers’ works is not required for proprietary drilling equipment.

C2.28.2 See C2.43.

C2.29 Hydro-pneumatic accumulators – Manifolds, fluid reservoirs

C2.29.1 Design appraisal and construction under survey is required.

C2.29.2 Typical acceptable standards: BS 5045 and ASME VIII Div. 1.

C2.30 Impressed current CP system

C2.30.1 Design appraisal. Survey of installation, witness test and commissioning are required.

C2.31 Inert gas generator

C2.31.1 Design appraisal and survey at manufacturers’ works. Witness test and commissioning are required.

C2.32 Lifeboats, TEMPSs, rescue craft and davits

C2.32.1 Design appraisal and survey at manufacturers’ works. Witness test and commissioning are required.

C2.33 Lifting appliances and cranes

C2.33.1 To be built under survey in accordance with the LR’s Code for Lifting Appliances in a Marine Environment, which would include design appraisal, material identification, weld procedures and welder qualification tests, approval of NDT procedures and testing on completion. Care is to be taken that the appliance is suitable for use under dynamic loading offshore.

C2.33.2 Air winches (non-personnel). No survey required at source. Manufacturers’ documentation will be accepted provided it includes evidence of hydrostatic test of pressure parts.

C2.33.3 Cranes mountings, including pedestals. Design appraisal and construction under survey is required. Witness of testing and commissioning after installation is also required.

C2.33.4 Other typical acceptable construction codes are given in Appendix A1.2.13.

C2.33.5 Personnel hoist. Design appraisal and construction under survey is required. Witness of testing and commissioning after installation is also required.

C2.33.6 Other lifting devices. Where LR Certification is required by the client, design appraisal and survey with load testing after installation on the platform/unit is required.

C2.33.7 Other lifting devices. Where LR Certification is not required, inspection and testing at the manufacturers’ works is required only for devices with a capacity greater than or equal to 10 tonnes. Devices with a capacity of less than 10 tonnes can be accepted if presented with valid manufacturers’ documentation. In addition, they must be tested after installation.

C2.34 Loading instrument

C2.34.1 To be verified for LR Classification compliance – see Part 1. Hardware to be type approved for marine use.
C2.35 Manifolds, choke, production, test, etc.
C2.35.1 Design appraisal and survey is required.
C2.35.2 Typical acceptable standards: ANSI B3 1.3.

C2.36 Metering packages and equipment
C2.36.1 To be built under survey with design appraisal of piping systems aspects and any pressure vessels. Hydrostatic test to be witnessed and manufacturers’ data examined for all other aspects.

C2.37 Modules (all types)
C2.37.1 Design appraisal and survey of structure during construction is required and the following loads should be considered in the design.
(a) Environmental.
(b) Equipment and operational weights.
(c) Construction, including lifting case.
C2.37.2 See also C2.41.

C2.38 Mooring systems (floating installations)
C2.38.1 Structural. Design appraisal and survey during manufacture is required for all components, including anchors, cables, chains, turret structure, etc.
C2.38.2 Machinery. Design appraisal is required for all main bearings, mooring winches and chain stoppers.
NOTE: Quayside mooring equipment can be accepted on the basis of manufacturers’ documentation.

C2.39 Offloading systems
C2.39.1 See C2.21, C2.41 and C2.46.
C2.39.2 Strength design appraisal of mooring winches, breakaway couplings, etc., is required.

C2.40 Pig launchers and receivers
C2.40.1 See C2.43.

C2.41 Pipework and fittings
C2.41.1 All fabricated pipework, e.g., process systems, gas and liquid fuel systems, fire main, compressed air lines, hydraulic systems, mud systems, etc., will be subject to design appraisal and survey during fabrication. Pipe fittings will normally be accepted with manufacturers’ documentation, but significant fabricated items may require survey at manufacturers’ works. Fabricated saddles for use in the fire main should be supplied with a copy of a valid proof test certificate.

C2.41.2 The survey must include:
(a) Review of QA/QC system.
(b) Examination at works during fabrication and test.
(c) Review and acceptance of weld procedures and welder qualification tests.
(d) Review and acceptance of NDT procedures.
(e) Verification of materials against relevant mill certificates.
(f) Appraisal of P&IDs, material and pipe schedules.

C2.42 PLCs/programmable electronic systems
C2.42.1 Hardware to be type approved for offshore use. Software to be developed under suitable software QA system. LR to witness commissioning tests.

C2.43 Pressure vessels
C2.43.1 (Separators, knockout drums, pulsation dampers, etc., including auto sprinkler and fire-extinguishing storage systems).
C2.43.2 Where the system gauge pressure in bar multiplied by the internal volume in litres exceeds 200, vessels are to be built under survey which would include design appraisal, material identification, weld procedure and welder qualification tests and approval of NDT procedures. The vessel is to be built in accordance with a recognised Code or Standard and subject to hydrostatic test and internal examination on completion.
C2.43.3 Typical acceptable codes: PD 5500 and ASME VIII.

C2.44 Process equipment (bulk)
C2.44.1 All equipment, whether installed initially or at a subsequent date, should be manufactured to a relevant Code, Standard or specification and written confirmation of this, together with appropriate test certificates, should be obtained from the manufacturer. See C2.41 and the remainder of this appendix for individual equipment items.

C2.45 Pumps – Fire, water deluge, foam, etc.
C2.45.1 All fire-fighting pumps (and prime movers) to be built under survey.
C2.45.2 Material certificates and certificates for hydrostatic testing of cast casings, etc., to be reviewed.

C2.46 Pumps for other services
C2.46.1 Survey at manufacturers’ works for verification purposes is not required. Manufacturers’ documentation including material certificates is to be supplied.
C2.47 Radio tower

C2.47.1 Design appraisal will be required only in respect of:
(a) Environmental loads.
(b) Loads transmitted to the structure.
(c) Location relating to the helideck.

C2.47.2 No fabrication inspection is required.

C2.48 Regenerators and absorbers, glycol – (fired) boilers and steam receivers – (fired)

C2.48.1 Design appraisal and survey is required – see also C2.43 and C2.25.

C2.49 Separators

C2.49.1 See C2.43.

C2.50 Steel – plate, rolled sectors, tubulars and pipe

C2.50.1 For certification, inspection/validation at mill in accordance with a recognised Standard and specification is required on all material for primary structures. However, certification of other IACS members will in general be acceptable.
(a) Jackets including conductor framing.
(b) Piles.
(c) Any secondary steel that is connected directly to the primary structure.
(d) Any structural steel utilised for the load-bearing framework of the module.
(e) Where floors contribute to the strength and integrity of the module. Where steel is procured from steelworks approved by LR, our scope will normally be limited to witness of mechanical testing and check of results against agreed specifications. In the event of primary steel being procured from stockists, LR involvement will normally consist of verification of test certificates, material identification and confirmation of properties against agreed specifications.

C2.50.2 Materials for secondary structures need not be inspected at source provided the material is manufactured in accordance with a recognised Standard and is supported by manufacturers’ valid mill certificates.

C2.50.3 Examples of secondary structures include gangways, walkways, handrails, cladding, helideck, floors, pipe supports, equipment plinths, mud and similar tanks and installation aids.

C2.51 Strainers

C2.51.1 See C2.43.

C2.52 Tanks

C2.52.1 Dry mud, barytes, bulk cement, chemicals:
(a) Design appraisal and survey is required if the above tanks are to be subjected to any positive or negative pressure conditions.
(b) If not pressurised, the Surveyors may accept a Third Party Inspection Certificate with evidence of testing for the purpose intended.

C2.52.2 Non hazardous liquid storage tanks – Open, vented or hydrostatic head only. Third party Inspection Certificate with evidence of construction and testing to a recognised Code or specification is required.

C2.52.3 Pressurised lubricating oil or seal-oil tanks. Design appraisal and survey is required.

C2.52.4 Fuel tanks and hazardous liquid tanks. Design appraisal and survey is required. Typical acceptable standards: BS 799 part IV and BS 2654.

C2.53 Turbines and compressors

C2.53.1 Design pressure greater than or equal to 7 barg (100 psi). Surveyor is to verify manufacturers’ documentation, witness hydraulic tests of pressure parts and commissioning of machines.

C2.53.2 Design pressure less than 7 barg (100 psi). Surveyor is to verify manufacturers’ documents and witness commissioning. Material is to be manufactured to a recognised pressure vessel standard.

C2.53.3 Gas turbines. Consideration should be given to the codes used for pressure-retaining components and the need for containment, with a view to minimising and localising damage in the event of rotor blade failure. Survey of fabricated pressure-retaining items will generally be required.

C2.54 Umbilicals for subsea completion control systems

C2.54.1 Design appraisal and survey at source to include review of manufacturing and quality plans is required. Witness of factory acceptance tests and documentation review is also required.

C2.55 Valves including emergency shut-down and safety valves

C2.55.1 In general, valves and fittings need not be surveyed at source provided they are manufactured in accordance with a recognised Code or Standard and are identifiable with a manufacturers’ certificate which includes the materials used for pressure-containing parts.

C2.55.2 Details of certain large valves and fittings of welded construction will require to be submitted for special consideration, (e.g., Riser ESDVs, SSIVs, etc.). Design appraisal and survey of these items will be required in most cases.
C2.55.3 Testing of pressure relief valves to be witnessed during commissioning at fabrication sites.

C2.55.4 Typical acceptable standards: Safety Valve Design API RP 520, Valves API 6 series, BS 55351 and Fittings BS 1640.

C2.56 Ventilation and pressurisation systems including fire dampers

C2.56.1 Design appraisal: hazardous area zones and structural fire protection. The systems are to be surveyed and tested during installation and commissioning.

C2.56.2 Fire Dampers are to be type approved.

C2.57 Well control equipment

C2.57.1 Independent Review Certificate from a Certifying Authority is to be issued for manufacture and design. Surveyors will issue a Certificate of Conformity following completion of the equipment and when satisfied that the equipment has been built and tested in accordance with the approved Specification for Manufacture. Manufacturers’ records of materials, inspection and tests should be assessed by the Surveyor.

C2.57.2 For Verification (Wells Examination). Well control equipment will be subject to a design examination and survey during construction/assembly and testing where the equipment is designated as safety critical to the Installation.

C2.57.3 Work done by others to meet the requirements of the well examination scheme will contribute to verification.

C2.58 Well control panel

C2.58.1 Design appraisal and survey, as for pipework and fittings.

C2.59 Winches

C2.59.1 See C2.33.

C2.60 Xmas trees

C2.60.1 See C2.58.