CHINA CLASSIFICATION SOCIETY

RULES FOR CLASSIFICATION OF MOBILE OFFSHORE UNITS

PART EIGHT MULTI-PURPOSE OFFSHORE UNITS AND SPECIAL SYSTEMS AND INSTALLATIONS

CONTENTS

CHAPTER 1 DRILLING/WORKOVER UNITS

Section 1 GENERAL PROVISIONS

1.1.1 General requirements

1.1.1.1 The requirements in this Chapter apply to units with class notations in 1.1.2 and intended for drilling/workover operations for the exploration and exploitation of petroleum, gas or other resources beneath the sea bed.

1.1.1.2 In addition to the requirements in this Chapter, drilling units are to comply with other applicable requirements of the Rules.

1.1.1.3 Workover units are to comply with the requirements in this Chapter, as appropriate.

1.1.2 Class notations

1.1.2.1 Drilling Unit: to be assigned to the drilling units in compliance with the relevant provisions in this Chapter.

1.1.2.2 Workover Unit: to be assigned to the workover units in compliance with the relevant provisions in this Chapter.

1.1.3 Arrangement and safety

1.1.3.1 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:

(1) Drilling area: drill floor area, mud circulation and treatment area;

(2) General-purpose equipment area;

(3) Living quarters' area.

1.1.3.2 The requirements for protection against fire and explosion, including emergency shutdown, are to be in accordance with the applicable requirements of PARTS FIVE and SEVEN in the Rules, taking into account the relevant provisions of the Administration.

1.1.3.3 Living quarters, survival craft and other evacuation equipment are to be located in non-hazardous areas and be protected and separated from the drilling area and general-purpose equipment area.

1.1.4 Plans and information

In addition to those plans and information as specified in other PARTS of the Rules, the following plans and information are to be submitted to CCS for approval or information, as applicable:

(1) General arrangement plans of drilling derrick and equipment;

(2) Structural plans and strength calculations of drill floor, drilling derrick foundation, essential drilling equipment foundation, pipe rack and supports as well as supporting structures;

(3) Structural arrangements in way of drilling wells;

(4) Structural plans of moveable drilling cantilevers and skid beams, and strength calculations of their structures including supporting structures;

(5) Structural plans of mud compartments, mud tanks and pump rooms.

Section 2 STRUCTURE

1.2.1 General requirements

1.2.1.1 The main structure strength is to comply with the requirements in PART TWO of the Rules, taking into account the weights of drilling structures and applied equipment and the forces introduced by the drilling operations.

1.2.1.2 Drilling derrick and equipment foundations as well as supporting structures are to be designed for all applicable conditions, and supporting structures are to be strengthened as necessary.

1.2.1.3 The design loads for the strength of the drill floor and substructure as well as drilling derrick foundation are to be defined by designers/builders and in compliance with the applicable standards. The loads of and load effects from drill pipe seat, hook, rotary table and tensioning equipment are to be taken into account.

1.2.1.4 The structural arrangements and scantlings of surface-type drilling units are to be comply with CCS Rules for Classification of Sea-Going Steel Ships, but all respects which relate to the specialized offshore function of the unit are to be in accordance with the Rules.

1.2.1.5 The primary structural members of the unit is to be maintained in way of drilling wells and other large deck openings and sufficient strengthening is to be fitted as necessary. A sound structural transition is to be arranged to ensure continuity of strength in way of connection of well boundary bulkheads and longitudinal or transverse members of the main structure.

1.2.1.6 The scantlings of mud compartments or tanks are to be determined in accordance with relevant requirements for deep tanks, using the design density of the mud.

1.2.1.7 The strength of containerized modules which do not form part of the main structure is to be specially considered in association with the design loads.

1.2.1.8 The pipe rack is to be designed for gravity loads, wind loads and static and dynamic loads due to unit motions. The pipe rack supports are to have sufficient strength. Special arrangements are to be made to restrain the pipes in their stowed position in normal operation, transit and emergency conditions.

Section 3 HAZARDOUS AREAS AND VENTILATION

1.3.1 General requirements

1.3.1.1 The hazardous area classification and ventilation for drilling units are to comply with relevant requirements in PART SEVEN of the Rules.

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

Section 4 HIGH-PRESSURE PIPING SYSTEM FOR DRILLING OPERATIONS

1.4.1 General requirements

Fixed high-pressure piping system for drilling operations is to be in compliance with CCS Guidelines for Certification of Drilling Plants and the recognized standards.

Section 5 ADDITIONAL REQUIREMENTS FOR WORKOVER UNITS

1.5.1 General requirements

1.5.1.1 Compartments and tanks for retrieving hydrocarbon oil are to be so arranged to take the risk of fire and leakage of hydrocarbon oil into account.

1.5.1.2 Gas accumulation induced by the leakage of combustible gas beneath the sea bed is to be avoided carefully.

1.5.1.3 Means are to be taken to rescue the personnel falling into moon-pool and escape ladders are to be provided in the moon-pool.

CHPATER 2 ACCOMMODATION UNITS

Section 1 GENERAL PROVISIONS

2.1.1 General requirements

2.1.1.1 The requirements in this Chapter apply to accommodation units with class notations in 2.1.2 for industrial personnel engaged in exploration, exploitation and production of petroleum and gas at sea.

2.1.1.2 In addition to the requirements in this Chapter, accommodation units are to comply with other applicable requirements of the Rules.

2.1.1.3 During the jacking or transit operation of the self-elevating accommodation units and descending/ascending or transit operation of the column-stabilized accommodation units, only working staff necessary for these operations are to be retained on the units.

2.1.1.4 The requirements in this Chapter do not apply to passenger's accommodation units. Special consideration is to be given to the passenger's accommodation units.

2.1.2 Class notations

Accommodation Unit: to be assigned to the accommodation units in compliance with the relevant provisions in this Chapter.

2.1.3 Definitions

The following definitions are applied in this Chapter only:

(1) Crew: the personnel engaged in operation and maintenance of structure, machinery, system and equipment and the personnel providing services to others onboard the units.

(2) Industrial personnel: the personnel living on the units except the crew, including the relevant personnel from other offshore structures, such as mobile and fixed offshore drilling units (excluding passengers).

2.1.4 Arrangement and safety

2.1.4.1 Living quarters, survival craft and other evacuation equipment are to be located in non-hazardous areas.

2.1.4.2 The requirements for fire safety are to be in accordance with PART SEVEN of the Rules as applicable and requirements in Section 4 of this Chapter, taking into account the relevant requirements of the Administration.

2.1.4.3 The gangway is to be made of non-slip grating and at least 600 mm in width.

2.1.5 Plans and information

In addition to those plans and information as specified in other PARTS of the rules, the following plans and information are to be submitted to CCS for approval or information, as applicable:

(1) Structural plans of accommodation modules, including module support frames and details of attachments;

(2) Strength calculations for containerized modules and attachments.

Section 2 STRUCTURE

2.2.1 General requirements

The main structure strength is to comply with the requirements in PART TWO of the Rules, taking into account the applied weights and forces due to the accommodation, and the local structure is to be suitably reinforced.

2.2.2 Containerized modules

2.2.2.1 The strength of containerized modules which do not form part of the structure is to be specially considered in association with the design loads. When containerized modules can be subjected to wave loads on deck or protect openings leading into buoyant spaces, the scantlings are to comply with the requirements of the Rules for deckhouses.

2.2.2.2 The structural strength of the connections between containerized modules and the supporting frame or structure are to comply with relevant requirements in PART TWO of the Rules, taking account into the unit motions and marine environmental aspects.

2.2.2.3 The connections of containerized modules are also to satisfy an assumed damage condition with an applied horizontal force F_H in any direction as follows. The stress obtained is not to be greater than the permissible stress for the combination condition specified in 3.3.2.1 of PART THREE:

$$F_H = Mg\sin\theta \qquad \text{kN}$$

Where: M ——weight of the modules supported, in t;

g —— gravitational acceleration;

θ —— Inclining angle assumed for damage condition, to be taken as 25 °for column -stabilized units and 17 °for other types of units.

2.2.3 Gangway

The gangway is to be designed for environmental effects, with loading not less than 4.5kN/m^2 and maximum permissible bending deflection not greater than 1/250 of the space of stanchions.

Section 3 ELECTRICAL INSTALLATIONS

2.3.1 Scope and period of supply of the emergency source for all accommodation units

2.3.1.1 The following requirements apply to units accommodating more than 60 industrial persons.

2.3.1.2 In addition to complying with the requirements of 2.2.2 of PART FIVE of the Rules, the emergency source of power is to provide:

(1) For a period of 36 hours, emergency lighting:

① in all services and accommodation alleyways, stairways and exits, personnel lift cars;

② in alleyways, stairways and exits giving access to the muster and embarkation stations;

③ in the machinery spaces and main generating stations including their control positions;

④ in all control stations, machinery control rooms and at each main and emergency switchboard;

⑤ at all stowage positions for firemen's outfits;

⑥ at the steering gear;

⑦ at the fire pump, the sprinkler pump, the emergency bilge pump and at the starting position of their motors;

⑧ at every survival craft muster and embarkation station;

⑨ over the sides for the area of water into which the survival craft is to be launched;

⑩ on helicopter landing decks.

(2) For a period of 36 hours:

① navigation lights, other signaling lights and sound signals, required by the International Regulations for Preventing Collisions at Sea in force;

② the navigational aids as required in Chapter 5 of the 1974 SOLAS Convention (if applicable);

③ general alarm and communication systems required in an emergency;

④ intermittent operation of the daylight signaling lamps and the unit's whistles;

⑤ fire and gas detection and their alarm systems;

⑥ the emergency fire pump, the automatic sprinkler pump (if any), the emergency bilge pump and all the equipment essential for the operation of electrically powered remote controlled bilge valves;

⑦ refrigeration equipment for low-pressure carbon dioxide systems;

⑧ the ballast valve control system, ballast valve position indicating system, draft indicating system, tank level indicating system and the largest single ballast pump on column-stabilized units;

⑨ abandonment systems dependent on electric power.

(3) For a period of 18 hours:

① permanently installed diving equipment necessary for safe conduct of diving operations, if dependent on the unit's electrical power;

② the capacity of closing blow-out preventer and of disengaging the unit from the wellhead arrangement (if electrically controlled) for 18 hours, unless an independent supply for the period of 18 hours from an accumulator battery suitably located for use in an emergency is provided.

(4) For a period of 0.5 hours:

① electrically operated watertight doors, including their control, indication and alarm circuits;

② the emergency arrangements to bring the lift cars to deck level for the escape of persons.

Section 4 FIRE PROTECTION

2.4.1 General requirements

2.4.1.1 The fire protection for accommodation units is to comply with the following requirements in addition to the applicable requirements in PART SEVEN of the Rules.

(1) Main vertical area

① The unit hull, superstructure and deckhouse are to be divided into at least two or more main vertical zones through A-class division;

② The length or width range of the main vertical zones is equal to the maximum distance between the remotest points of the main vertical zone bulkhead;

③ In general, its average length and width on any deck must not exceed 40m;

④ The length and width of the main vertical zone may extend to a maximum of 48m to allow the two ends of the main vertical zone to be consistent with the watertight bulkhead of the subdivision, or to allow the main vertical zone to accommodate a large public space within its entire length, however, the total area of the main vertical zone on any deck is not to exceed 1600 m2;

⑤ Where practicable, the bulkhead above the bulkhead deck, which constitutes the boundary of the main vertical zone, is to be in a straight line with the watertight subdivision bulkhead directly under the bulkhead deck;

⑥ The bulkhead that constitutes the boundary of the main vertical zone is to extend from deck to deck and extend to the shell or other boundaries.

(2) Corridor bulkhead All corridor bulkheads, where A-class division is not required, are to be B-class divisions extending from deck to deck, unless:

① When continuous B-class ceiling or lining is provided on two sides of the bulkhead, the bulkhead portion behind the continuous ceiling or lining is to be made of materials with a thickness and composition allowed for B-class division structures,however, it may only need to meet the requirements of B-class integrity standards to the extent deemed reasonable and practicable by CCS;

② On units protected by automatic sprinkler systems that comply with the provisions in Chapter 8 of IMO International Code for Fire Safety Systems, the corridor bulkhead made of B-class material may terminate at the ceiling of the corridor, but this ceiling is to be of the thickness and material allowed for B-class division structures. However, abovementioned bulkhead and ceiling may only need to meet the requirements of B-class integrity standards to the extent deemed reasonable and practicable by CCS. All doors and door frames of the abovementioned bulkheads are to be made of non-combustible material, and constructed and installed to provide reliable fire resistance.

(3) Exterior boundaries of accommodation spaces

① Exterior boundaries of deckhouses and superstructures enclosing living accommodation, including any overhanging deck which supportssuch accommodation, are to be constructed to A-60 class division standards for the whole of the portion within 30m away from the drilling or production platform served by the accommodation unit where a hydrocarbon fire may arise. If the distance is more than 30m but less than 100m, A-0 class division is required;

② For boundaries requiring A-60 class division, A-0 class division with a sprinkler system having a fire-extinguishing capacity of at least 6.1 for the exposed surface may be deemed to have equivalent effects;

③ Ventilation inlets/outlets and other openings on the exterior boundaries of superstructures and deckhouses are to be located as far as possible away from the adjacent drilling or production platform according to the actual conditions.

(4)Fire water supply arrangement

① To guarantee ready supply of fire water, the fire water supply is to be arranged so that, as a minimum, an effective water jet can be immediately available from any fire hydrant at an internal location, and fire water is continuously supplied by a required fire pump which starts automatically. In addition, the fire hose is to be always connected with the fire hydrant at each internal location;

② Periodically unattended machinery spaces are to be provided with fixed fire water arrangements equivalent to those required for ordinary attended machinery spaces.

(5) Fixed fire detection and alarm system, automatic sprinkler, fire detection and alarm system Except for those spaces generally free of fire risks such as empty compartment, sanitary spaces, etc., each independent vertical division of all accommodation spaces and service spaces as well as the locationsand control stations deemed necessary by CCS are to be provided with one of the following three systems based on their overall coverage:

① A fixed fire detection and alarm system which has been type approved and complies with the provisions in Chapter 4, PART SEVEN of the Rules, so installed and arranged as to detect fires in the abovementioned spaces and detect smoke in the corridors, stair cases and escape trunks within the accommodation spaces;

② An automatic sprinkler, fire detection and alarm system which has been type approved and complies with the provisions in Chapter 8 of IMO International Code for Fire Safety Systems, so installed and arranged as to protectthe abovementioned spaces, and in addition, a fixed fire detection and alarm system which has been type approved and complies with the provisions in Chapter 4, PART SEVEN of the Rules, so installed and arranged as to detect smoke in the corridors, stair cases and escape trunks within the accommodation spaces;

③ An automatic sprinkler, fire detection and alarm system which has been type approved and complies with the provisions in Chapter 8 of IMO International Code for Fire Safety Systems, so installed and arranged as to protect the abovementioned spaces including the corridors, stair cases and escape trunks.

2.4.2 Exterior boundaries of accommodation spaces

2.4.2.1 Exterior boundaries of superstructures and deckhouses enclosing accommodation, including any overhanging decks which support such accommodation, are to be constructed to “A-60” standard for the whole of the portion which faces and is within 30m of any area in the adjacent drilling or production platform served by the accommodation unit where a hydrocarbon fire may arise. If the distance is more than 30 m, but less than 100 m, “A-0” standard boundary is required.

2.4.2.2 Ventilation inlets/outlets and other openings on the exterior boundaries of superstructures and deckhouses are to be located as far as possible from the adjacent drilling or production units.

CHAPTER 3 CRANE/INSTALLATION AND MAINTENANCE UNITS

Section 1 GENERAL PROVISIONS

3.1.1 General requirements

3.1.1.1 The requirements in this Chapter apply to the mobile units with class notation in 3.1.2, which require to be provided with appliances on the deck and intended for lifting heavy objects during drilling and production operations, offshore installation and maintenance and/or rescue operations at sea.

3.1.1.2 In addition to the requirements in this Chapter, crane/installation and maintenance units are to comply with the other applicable requirements of the Rules.

3.1.2 Class notations

3.1.2.1 Crane Unit: to be assigned to the crane units in compliance with the relevant provisions in this Chapter. Notation of Lifting Appliance is to be added.

3.1.2.1 Installation Maintenance Repair Unit: to be assigned to the installation and maintenance units in compliance with the relevant provisions in this Chapter. Notation of Lifting Appliance is to be added.

3.1.3 Cranes

All cranes permanently installed on the unit except those used for food supply and maintenance of the unit are to comply with the requirements in the CCS Rules for Lifting Appliances of Ships and Offshore Installations and hold the certificates as required in Appendix 3 of Chapter 3 of PART ONE of the Rules. CCS certificates are not to be required for mobile cranes not permanently installed on the unit, such as caterpillar cranes.

3.1.4 Plans and information

In addition to those plans and information as specified in other PARTS of the rules, the following plans and information are to be submitted to CCS for approval or information, as applicable:

(1) General arrangement plans of cranes, including working and positioning conditions and corresponding forces;

(2) Technical specifications of cranes, including principle dimensions, main working parameters and restricted operating and ambient conditions, etc.

(3) Structural plans and strength calculations of crane pedestals and strengthened main structure;

(4) Structural plans and strength calculations of crane securing and locking arrangements and strengthened main structure;

(5) Calculations of stability and floating condition for lifting operations;

(6) Operation manual, including stability and floating condition of the unit in all modes of operation, and operating restrictions;

(7) Plans of deck cargo containment, lashing and locking arrangements.

Section 2 STRUCTURE

3.2.1 General requirements

3.2.1.1 Longitudinal or transverse supporting bulkheads or other efficient structures with sufficient strength and stiffness are to be provided in way of the crane supporting structure. Such strengthening structure could transit loads efficiently. The deck of such structure is to be thickened enough. The main structures where other deck machinery and large load are located are to be strengthened as appropriate.

3.2.1.2 The main structure strength is to comply with the requirements in PART TWO of the Rules, taking into account the weights of lifting appliances and the forces introduced by lifting operation and positioning condition.

3.2.2 Crane pedestals

3.2.2.1 The crane pedestal is to pass through the deck and effectively connect to the main structure. If the pedestal is interrupted by the deck, the Z-direction steel plates are to be used for the deck.

3.2.2.2 The crane pedestal, boom racks and/or other storage appliances and supporting structures are to be designed for static and dynamic loads in all applicable conditions, including the loads due to unit motions, and to comply with requirements in the CCS Rules for Lifting Appliances of Ships and Offshore Installations or other international recognized standards.

3.2.3 Deck cargo containment

3.2.3.1 Means are to be provided to enable deck cargoes to be adequately secured and protected in deck cargo storage spaces. In general, suitable rails or storage racks of substantial construction are to be provided and properly secured to adequately strengthened parts of the main structure.

3.2.3.2 Properly designed locking equipment or efficient means for lashing the deck cargoes are to be fitted where appropriate.

3.2.3.3 Small hatches (including escape hatches, control valves, ventilators, air pipes, etc., are to be situated clear of the cargo containment areas and fitted in protected positions.

Section 3 STABILITY

3.3.1 General requirements

3.3.1.1 In addition to the applicable requirements in PART THREE of the Rules, the stability, subdivision and load lines of crane/installation and maintenance units are to comply with the requirements in this Chapter.

3.3.1.2 Stability in different modes of operation is to be checked for crane/installation and maintenance units, including the stability in lifting operations.

3.3.1.3 The following documents are to be included in the operation manual:

(1) The maximum overturning moment and corresponding counter ballast moment (if counter ballast system is provided) under each direction of boom. The counter ballast moment is to be related with the height of centre of gravity of the unit;

(2) Loading conditions in all modes of lifting operations and the maximum permissible lifting loads;

(3) Righting moment curves before and after load drop in each loading condition, as applicable;

(4) Crane operation and/or ambient conditions restriction, including the maximum permissible angle of heel of the crane, if provided;

(5) Operating instructions of the crane, including the operating instructions of counter ballast system (if counter ballast system is provided);

(6) Instructions of righting of the unit after incidental load drop, including ballast and/or deballast procedures.

3.3.2 Floating stability of lifting operations

3.3.2.1 The requirements of this paragraph only apply to the column-stabilized crane/installation and maintenance units.

3.3.2.2 Intact stability and damage stability of the unit are to be checked for all loading conditions of lifting operations and to comply with the requirements in this paragraph.

3.3.2.3 Overturning moment of lifting weights (including overturning moment of the boom), wind heeling moment at the maximum design wind velocity for lifting operation and possible overturning moment of asymmetric loads are to be calculated for the full range of draughts corresponding to afloat modes of lifting operation, taking into account direction, range and elevation of boom as well as the full scope of lifting weights to find out the most unfavorable combination and the maximum deck cargo and equipment in the most unfavorable position as applicable.

3.3.2.4 The centre of the areas subject to wind loading of lifting weights is to be assumed as the suspending point of the lift hook. The area subject to wind loading, A_f , could be calculated by the following formula:

$$A_f = 2.78W^{0.556} \qquad \text{m}^2$$

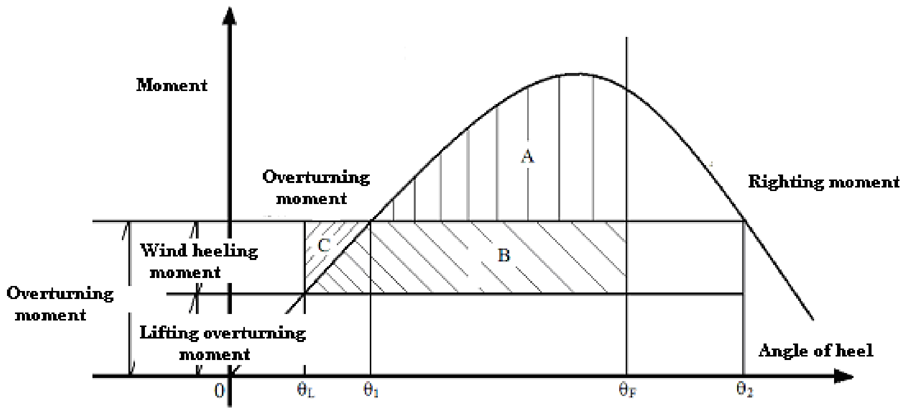
Where: W — weight of lifting, in t.

3.3.2.5 In the calculation of righting moment, in addition to the influence of the free surface of liquids in tanks being considered, the centre of gravity of lifting weights is to be assumed as the suspending point of the lift hook.

3.3.2.6 The intact stability of crane/installation and maintenance units in each loading condition of lifting operation is to meet the following criteria (Fig. 3.3.2.6).

(1) The angle of heel corresponding to the first intercept of the overturning moment curve and righting moment curve is to be smaller than the submergence angle on the edge of the deck of the maximum permissible angle of heel for crane operations, whichever is the less.

(2) When wind is applied under the most unfavorable direction, the area under the righting moment curve from the angle of static equilibrium to the second intercept or angle of flooding, whichever is the less, is not to be less than 30% in excess of the area under the wind heeling moment curve to the same limiting angle (Fig. 3.3.2.6).



A+B≥1.3(B+C)

Fig. 3.3.2.6

θ_L——angle of static equilibrium, i.e. the angle of heel corresponding to the first intercept of the lifting overturning moment curve (including overturning moment of asymmetric loads) and the righting moment curve,

θ_F——angle of flooding,

θ_1——angle of heel corresponding to the first intercept of the overturning moment curve and righting moment curve,

θ_2———angle of heel corresponding to the second intercept of the overturning moment curve and righting moment curve.

3.3.2.7 The damage stability of crane/installation and maintenance units in lifting operation condition is to comply with the applicable provisions for column-stabilized units in PART THREE of the Rules. However, the wind heeling moment applied simultaneously with the overturning moment of the crane could be determined in accordance with the limited wind velocity for lifting operation stipulated in the operation manual.

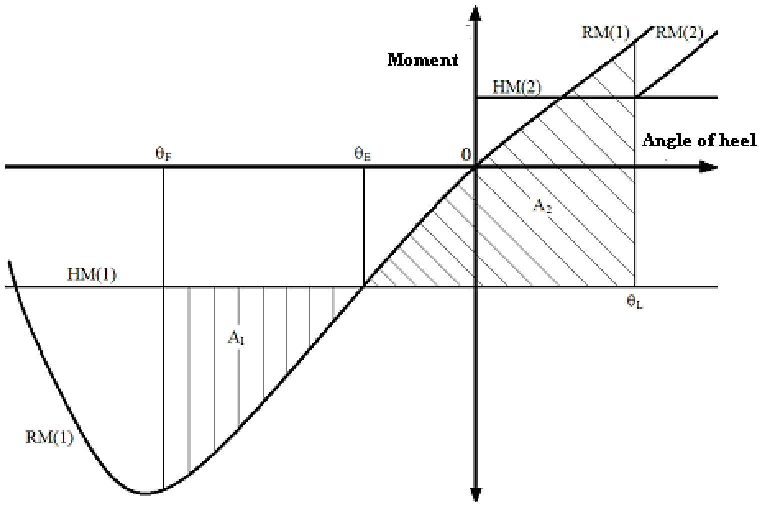
3.3.2.8 If the crane/installation and maintenance unit is provided with counter ballast system, the influence of accident load drop on the intact stability in each loading and operating conditions is to be investigated and to comply with the following criteria:

(1) The following requirements apply to the condition that the column-stabilized crane/installation and maintenance unit is operating in favorable weather conditions, i.e. the influence of wind may not be taken into consideration;

(2) The angle of static equilibrium θ_E before the loss of lifting weights (angle of heel corresponding to the first intercept of the lifting overturning moment curve and the righting moment curve before the loss of lifting weights)is to be smaller than the submergence angle on the edge of the deck in each loading condition;

(3) The angle of static equilibrium θ_L after the loss of lifting weights (angle of heel corresponding to the first intercept of the righting moment curve after the loss of lifting weights and the overturning moment curve induced by counter ballast at the displacement without lifting weights) is not to exceed 15°;

(4) The residual area between the angle of the first intercept and the angle of flooding, or the second intercept or 30°, whichever is the least (area of A_1 in Fig. 3.3.2.8) is not to be less than 1.3 times of A_2 in Fig. 3.3.2.8.



$A_1 \geq 1.3A_2$

Fig. 3.3.2.8

RM(1)——the righting moment curve at displacement without lifting weights;

RM(2)——the righting moment curve at displacement with lifting weights;

HM(1)——the overturning moment introduced by counter ballast at displacement with lifting weights;

HM(2)——the overturning moment induced by forces combined of lifting weights and counter ballast at displacement with lifting weights;

θ_F——the angle of flooding, angle of heel corresponding to the second intercept or 30°, whichever is the least;

θ_L——angle of static equilibrium applied with the combination of lifting weights and counter ballast;

θ_E——angle of static equilibrium induced by counter ballast after the loss of lifting weights.

3.3.3 On-bottom stability of lifting operation

3.3.3.1 The anti-overturning stability of self-elevating crane/installation and maintenance units under standing and lifting operation condition is to comply with the requirements in 2.5.1 of PART THREE of the Rules. The overturning moment includes that of lifting, wind heeling moment at the maximum design wind velocity for lifting operation and possible overturning moment of asymmetric loads.

3.3.4 Deck cargo

3.3.4.1 The influence of deck cargo on the stability is to be considered for each operating condition, and analysis is to be carried out for all the possible deck cargo loads from zero to the maximum. The free surface is to be corrected accordingly where the deck cargo intended to carry may accumulate water, such as open cargo bins or open pipes. It is to take into account the maximum deck cargo and equipment on the most unfavorable position as applicable in the stability calculation.

CHAPTER 4 CABLE LAYING/PIPE-LAYING UNITS

Section 1 GENERAL PROVISIONS

4.1.1 General requirements

4.1.1.1 The requirements in this Chapter apply to units with class notations in 4.1.2 and intended for cable or pipe-laying beneath the sea bed.

4.1.1.2 In addition to the requirements in this Chapter, cable laying or pipe-laying units are to comply with other applicable requirements of the Rules.

4.1.2 Class notations

4.1.2.1 Cable Laying Unit: to be assigned to the cable laying units in compliance with the relevant provisions in this Chapter.

4.1.2.2 Pipe-laying Unit: to be assigned to the pipe-laying units in compliance with the relevant provisions in this Chapter.

4.1.3 Plans and document

In addition to those plans and document as specified in other PARTS of the Rules, the following plans and information are to be submitted to CCS for approval or information, as applicable:

(1) General arrangement and technical specifications of cable laying/pipe-laying equipment, including main working parameters, restrictions of operation and ambient condition, etc.

(2) Structural plans and strength calculations of foundations of cable laying/pipe-laying equipment and strengthened main structure,

(3) Electrical (optical fiber) cable storage appliances and structural plans and strength calculations of supporting structures.

Section 2 STRUCTURE

4.2.1 General requirements

The main structure strength is to comply with the requirements in PART TWO of the Rules, taking into account the imposed weights from cable laying/pipe-laying equipment and forces from laying operation and positioning condition.

4.2.2 Foundations of cable laying/pipe-laying equipment

The foundation of cable laying/pipe-laying equipment, ramp and base of other auxiliary appliances as well as supporting structures are to be designed for static and dynamic loads in all applicable conditions, including the loads due to unit's motions. The permissible stress is to comply with the requirements in Chapter 3 of PART TWO of the Rules.

4.2.3 Cable/pipe storage appliances

4.2.3.1 Pipe rack/base of electrical (optical fiber) cable reel and strengthened main structure are to be designed for static and dynamic loads in all applicable conditions, including the loads due to unit motions. The permissible stress is to comply with the requirements in Chapter 3 of PART TWO of the Rules.

In addition, strength check is to be carried out for the pipe rack/base of electrical (optical fiber) cable reel and strengthened main structure of the unit in damage condition so as to withstand the loads caused by the inclination of the unit. The permissible stress is to comply with the relevant requirements in Chapter 3 of PART TWO of the Rules, but the safety factor is taken as 1.0.

Section 3 STABILITY

4.3.1 General requirements

4.3.1.1 In addition to the applicable requirements in PART THREE of the Rules, the stability, subdivision and load lines of cable laying/pipe-laying units are to comply with the requirements in this Section.

4.3.1.2 Stability under various modes of operation is to be checked for cable laying/pipe-laying units, including the stability in laying operations.

4.3.1.3 The ambient conditions restriction of laying operations is at least to include the maximum wind velocity (i.e. the sustained wind velocity in 1 minute at 10m height above sea level), current velocity, significant wave height, and the combination. The restrictions of ambient condition of laying operations are to be included in the operation manual.

4.3.2 Floating stability of laying operation

4.3.2.1 Intact stability of the unit is to be checked for each loading condition of laying operations and to comply with the requirements in this paragraph.

4.3.2.2 Overturning moment of the maximum wind velocity or current velocity for laying operations or overturning moment of appropriate combination of wind and current is to be calculated for the full range of draughts corresponding to laying operations, taking into account the influence of laying loads acting on the laying equipment.

4.3.2.3 Influence of all or part of the pipes or electrical (optical fiber) cables in storage on the stability is to be considered for a sufficient number of conditions covering the full range of draughts corresponding to laying operations.

4.3.2.4 The free surface is to be corrected accordingly where the deck cargo intended to carry may accumulate water, such as open cargo bins or open pipes. In the calculation of stability, it is to take into account the maximum deck cargo and equipment on the most unfavorable position as applicable.

CHAPTER 5 DRILLING SUPPORT UNITS

Section 1 GENERAL PROVISIONS

5.1.1 General requirements

5.1.1.1 The requirements in this Chapter apply to units with class notations in 5.1.2 and intended for supporting offshore drilling/other operations. The unit includes power supply (electricity), circulation system (connecting to the served unit by hoses), storage tanks, drill pipes, casings, pipe racks, cement, storage spaces, living quarters, etc.

5.1.1.2 In addition to the requirements in this Chapter, drilling support units are to comply with the applicable requirements of the Rules.

5.1.2 Class notations

5.1.2.1 Drilling Support Unit: to be assigned to the drilling support units in compliance with the relevant provisions in this Chapter.

5.1.3 Plans and information

5.1.3.1 The plans and information as specified in other PARTS of the Rules are to be submitted to CCS for approval or information, as applicable.

Section 2 STRUCTURE

5.2.1 General requirements

The main structure strength is to comply with the requirements in PART TWO of the Rules. The local structure in way of essential machinery is to be suitably reinforced.

5.2.2 Pipe rack

5.2.2.1 The pipe rack and its strengthened structure are to be designed for gravity loads and wind loads in all applicable conditions and static and dynamic loads due to unit motions. The permissible stress is to comply with the requirements in Chapter 3 of PART TWO of the Rules. Special means are to be made to prevent the pipes moving from their stowed position in all applicable conditions including damage condition.

In addition, strength check is to be made on the pipe rack and its strengthened structure of the unit in damage condition to withstand the loads caused by the inclination of the unit. The allowable stress is to comply with the relevant requirements in Chapter 3 of PART TWO of the Rules, but the safety factor is taken as 1.0.

Section 3 HAZARDOUS AREAS

5.3.1 General requirements

If one or certain intended operating modes require a temporary storage or installation on the deck of the equipment which will be hazardous areas, the areas installed with such equipment are to be regarded as hazardous areas. The electrical equipment, ventilation and accesses to adjacent spaces in the areas are to comply with the provisions of Chapter 7 of the Rules as applicable.

Section 4 FIRE PROTECTION

5.4.1 Exterior boundaries of accommodation spaces

5.4.1.1 Exterior boundaries of superstructures and deckhouses enclosing accommodation, including any overhanging decks which support such accommodation, are to be constructed to "A-60" standard for the whole of the portion which faces and is within 30m of any area in the adjacent drilling or production platform served by the accommodation unit where a hydrocarbon fire may arise. If the distance is more than 30 m, but less than 100 m, “A-0” standard boundary is required.

5.4.1.2 Ventilation inlets/outlets and other openings on the exterior boundaries of superstructures and deckhouses are to be located as far as possible from the adjacent drilling or production units.

CHAPTER 6 PRODUCTION AND OIL STORAGE UNITS

Section 1 GENERAL PROVISIONS

6.1.1 General requirements

6.1.1.1 The requirements in this Chapter apply to units engaged in production and/or storage of crude oil other than surface-type ones.

6.1.1.2 Surface-type units engaged in production and/or storage of crude oil are to comply with CCS Rules for the Construction and Classification of Offshore Floating Units. In addition to the requirements in this Chapter, other types of units engaged in production and/or storage of crude oil are to comply with applicable requirements of the Rules.

6.1.2 Class notations

6.1.2.1 Production Unit: to be assigned to the production units in compliance with the relevant provisions in this Chapter.

6.1.2.2 Storage Unit: to be assigned to the oil storage units in compliance with the relevant provisions in this Chapter.

6.1.3 Plans and information

In addition to those plans and information as specified in other PARTS of the Rules, the following plans and information are to be submitted to CCS for approval or information, as applicable:

(1) General arrangement of the production plant and process equipment;

(2) Supporting structures of production plant and process equipment, flare tower and derrick, if applicable;

(3) Supporting structure of mooring system and marine risers;

(4) Structural plans of crude oil tanks, ballast tanks, cofferdams, void spaces, pump rooms and machinery spaces;

(5) Risk analysis and evaluation report (as appropriate, for information).

6.1.4 Arrangement and safety

6.1.4.1 In principle, production and/or storage units are to be divided into main functional areas to ensure that the following areas as applicable are isolated and protected from each other:

(1) Production area: including wellhead area and processing area;

(2) Drilling area (as appropriate): including drill floor area, mud circulation area and treatment area;

(3) Crude oil tank area: including side ballast tanks, crude oil tanks, cofferdams at both ends of crude oil tank area or between crude oil tanks. For storage units with oil storage tanks fitted on weather deck, crude oil tank area means oil storage tanks;

(4) General-purpose machinery area;

(5) Living quarters.

6.1.4.2 The requirements for protection against fire and explosion, including emergency shutdown, are to be in accordance with PARTS FIVE AND SEVEN of the Rules as applicable, taking into account relevant requirements of the Administration.

6.1.4.3 Living quarters, survival craft and other evacuation appliances are to be located in non-hazardous areas and be protected and isolated from other areas.

6.1.4.4 For oil storage units, the arrangement and isolation of living quarters, storage tanks and machinery spaces, subdivision, dimensions of crude oil tanks, spacing between double hulls as well as the arrangement of ballast tanks, slop tanks, etc. are in principle to comply with relevant international conventions.

6.1.5 Risk Analysis

A comprehensive analysis is to be carried out for the risks possibly exist at the design, construction, transit, commissioning and put into service stages to the mobile production/oil storage units. In addition, means are to be provided to reduce the possible risks to the minimum.

Section 2 STRUCTURE

6.2.1 General requirements

6.2.1.1 The main structure strength is to comply with the requirements in PART TWO of the Rules, taking into account the imposed equipment weights of production and process plant, storage tanks, etc. and forces induced by production, process, mooring and marine risers.

6.2.1.2 If the unit is fitted with a drilling derrick, the requirements of Chapter 1 are to be complied with as appropriate.

6.2.1.3 The supports of production and process plant and storage tanks as well as supporting structures are to be designed for all applicable conditions, and supporting structure are to be strengthened as necessary.

Section 3 HAZARDOUS AREAS AND VENTILATION

6.3.1 General requirements

6.3.1.1 The hazardous area classification and ventilation are to comply with relevant requirements in PART SEEVN of the Rules.

6.3.1.2 Adequate ventilation is to be provided for all areas and enclosed compartments associated with the oil production and process plant.

Section 4 PIPING SYSTEM FOR PRODUCTION OPERATIONS

6.4.1 General requirements

6.4.1.1 Piping system permanently fixed for production operations is to comply with CCS Rules for the Construction and Classification of Offshore Floating Units and recognized standards.

Section 5 Ballast System

6.5.1 General requirements

The piping system of ballast tanks in crude oil areas is to be separated from the ballast piping system outside the crue oil areas. Ballast pumps within crude oil areas are to be set inside the crude oil pump room or at proper locations within the crude oil areas.

CHAPTER 7 IN-WATER SURVEYS

Section 1 GENERAL PROVISIONS

7.1.1 General requirements

The requirements in this Chapter apply to the units which is applicable for class notation stipulated in 7.1.2 and subjected to in-water survey in lieu of docking survey.

7.1.2 Class notations

IWS: to be assigned to the mobile offshore drilling units in compliance with the relevant provisions in this Chapter.

7.1.3 Plans and information

7.1.3.1 The following plans and information are to be submitted to CCS for information, as applicable:

(1) Gauging of clearances of rudder pintle/shaft and bearing and verification method of conditions;

(2) Details and methods of inspection, maintenance and removal of the thruster

(3) Inspection and measurement methods of screwshaft bearings;

(4) Maintenance and inspection details of sea chests and sea valves;

(5) Underwater marking diagram and welding procedures;

(6) Coating and cathodic protection for underwater structures.

7.1.3.2 The approved plans and information including those mentioned in 7.1.3.1 are to be kept on the unit.

Section 2 UNDERWATER MARKINGS

7.2.1 General requirements

7.2.1.1 Permanent markings for diver’s positioning are to be made on shell plating of the underwater part of the platform intended to carry out in-water survey so as to indicate the positions of frames, bulkheads, unit and joints clearly and to be consistent with the underwater markings diagram.

7.2.1.2 Markings are to be consisting of raised lines, numerals and letters.

7.2.1.3 If marking is to be carried out by welding, the welds are to be made with continuous runs and the quality of the workmanship is to be to an equivalent standard as the main structures. Substantial runs are to be lad, continuously, using large diameter electrodes and avoid light runs. The surface of welds is to be formed continuously, tightly and smoothly transited to the parent material and without any cracks and defects could not be existed, such as overlap, crater and undercut. Marking by welding is not permitted in highly stressed areas or over existing butts or seams.

7.2.1.4 On steel of Grade D or E or on higher tensile steel, low hydrogen electrodes are to be used of a grade suitable for the parent material. The electrodes are to be pre-heated to around 100 ℃ for welding markings on the high tensile steels.

Section 3 PHYSICAL FEATURES

7.3.1 General requirements

7.3.1.1 The following physical features are to be incorporated into the unit’s design in order to facilitate the underwater inspection. The results of inspection and measurement are to be noted in the unit's records and in the survey report for reference at subsequent surveys:

(1) Screwshaft 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 wear-down of the bearing is not excessive. For use of the wear-down 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 wear-down gauge are to be re-established and noted in the unit's records and in the survey report;

(2) 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;

(3) 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;

(4) Sea valves

For the docking survey associated with the special survey, means must be provided to examine any sea valve;

(5) Paint

The protecting coating of the unit below the waterline is to be high resistant paint.

CHAPTER 8 POSITION MOORING SYSTEM

Section 1 GENERAL PROVISIONS

8.1.1 General requirements

8.1.1.1 This Chapter applies to position mooring systems normally fitted on bottom-stabilized or surface-type units with class notations as required in 8.1.2 of this Section, which only involve the radiation-type catenary position mooring systems or thruster assisted position mooring systems.

8.1.1.2 Position mooring systems will be considered for classification on the basis of operating restrictions and procedures specified by the owner/designer. Such operating restrictions and procedures as conditions for classification are to be recorded in the operation manual.

8.1.1.3 In addition to the requirements of this Chapter, the position mooring systems are also to be in compliance with the other applicable provisions of the Rules and the relevant provisions of the Administration.

8.1.2 Class notations

PM or PM-TA: to be assigned to the drilling units in compliance with the relevant provisions of this Chapter.

8.1.3 Components of position mooring systems

8.1.3.1 Position mooring systems are to be composed by:

(1) Anchors, suction anchors or anchor piles,

(2) Mooring lines, including chain cables and steel wires,

(3) Mooring lines fittings, including shackles, connecting links, wire rope terminations and quick release devices,

(4) Fairleads, including bent pipes, guide rollers and guide holes,

(5) Chain/wire stoppers,

(6) Winches/windlasses,

(7) Other structural or mechanical items forming part of the position mooring system.

8.1.3.2 Thruster assisted position mooring systems also include:

(1) Thruster and its prime mover, gearing, shafting, electrical installations,

(2) Control, alarm and safety systems for thruster.

8.1.4 Plans and information

8.1.4.1 The applicant is to submit the following plans in quadruplicate to CCS for approval:

(1) Position mooring arrangement showing mooring patterns, mooring fittings and equipment,

(2) Details of mooring fittings and equipment, showing foundation and connections with the unit,

(3) Structure and power system of winches,

(4) Additional plans for thruster assisted position mooring systems:

① Thruster assisted position mooring system arrangement, showing thruster arrangement, mooring patterns, mooring fittings and equipment,

② Thruster and its power system,

③ Control, alarm and safety systems for thruster.

8.1.4.2 One copy of each of the following supporting plans and information are to be submitted for information:

(1) Design criteria showing operating and survival environment in respect to wind, wave, current, tide and water depth,

(2) Calculations or model test reports showing forces of wind, current and wave acting on the unit,

(3) Calculations or model test reports showing wave frequency and low frequency motions of the unit,

(4) Mooring analysis including computer printout,

(5) Strength calculations for anchors, mooring lines and fittings, fairleads, chain/wire stoppers, winches and other items,

(6) Calculations for thruster power and thrusts, including interactions between thrusters, thruster and unit, thruster and current, respectively.

Section 2 ENVIRONMENTAL LOADS AND UNIT'S MOTIONS

8.2.1 General requirements

8.2.1.1 This Section covers only the environmental loads necessary for analysis of the mooring system and the motions of the moored unit due to wind, wave and current.

8.2.1.2 The normal operating and survival environmental conditions of mooring system are to be specified by the owner/designer and in general. Moorings for mobile floating units such as MODUs operating away from other structures should use a maximum design environment with a return period of at least 5 years. The maximum design environment for mobile units operating in the vicinity of other structures should have a return period of at least 10 years. The environmental conditions generally include wind, wave, current, tide and water depth, seabed soil parameters, as well as air temperature and water temperature. As water depth will have a large influence on the capability of mooring system, the extreme conditions of the system (wind, wave and current) may be varied at different water depths.

8.2.1.3 In design analysis of the position mooring system, sufficient numbers of heading angles together with the most severe combination of wind, current and wave are to be considered, usually from the same direction, to determine the maximum tension of each mooring line. Where a unit is intended to operate in a particular area, any applicable combined sea conditions of wind, wave and current from various directions are also to be considered in the event that they might induce higher mooring loads.

8.2.1.4 When the environmental loads and the moored unit's motions are determined by model testing, the shape of the test model above or under water is to reflect the actual conditions, taking due account of thrusters (if fitted), bilge keel and other fittings. The flowing characteristics of the test model are to be the same as those of the actual unit. The procedures and methods of the model testing are to be agreed by CCS.

8.2.2 Environmental loads

8.2.2.1 Wind loads

(1) Normally, steady wind force on the moored units is only considered. If necessary, low frequency wind force induced by wind fluctuating component is also to be considered. The wind loads may be obtained through model testing or calculation. For the calculation methods for wind loads, refer to the relevant requirements in Chapter 2 of PART TWO.

(2) When only steady wind force is to be determined, the design wind velocity could be taken as the 10 minute mean value referenced to 10 m above sea level. Where low frequency wind force is to be additionally taken into account, the steady wind velocity is in general to be taken as the 1 hour mean value and its fluctuating wind velocity based on appropriate empirical gust spectra. The time span of the steady wind velocity is to be consistent with the mean speed used for determining wind velocity spectra.

8.2.2.2 Current loads

(1) The current load is normally taken as steady force. The current loads may be obtained through model testing or calculation.

(2) For the calculation methods for current loads, refer to the relevant requirements in Chapter 2 of PART TWO.

8.2.2.3 Wave loads and motions

(1) The interaction between waves and the moored unit will result in three forces acting on the unit:

① First order force based on wave frequency oscillation, which will induce first order motion (also called oscillatory motion) of the moored unit,

② Second order force lower than wave frequency oscillation, which will induce second order motion (also called low frequency motion) of the moored unit,

③ Steady component of the second order force (also called wave-drift force).

The wave loads may be determined by model testing or analytical calculation.

(2) The wave loads may be obtained in general through integration of the total water pressure acting on wet surfaces of the unit by applying diffraction analysis.

8.2.3 Motions of the moored unit

8.2.3.1 Under combined actions of steady wind, current and wave-drift forces, the moored unit will move from its initial equilibrium position where zero environmental force is acting on the unit, to a new mean position where the mooring system will have developed sufficient restoring force to balance the steady applied forces. Wave-induced oscillatory motions and low frequency motions of the unit take place about this new mean position.

8.2.3.2 The oscillatory motions and low frequency motions are to be determined by model testing or analytical calculation. In general, the oscillatory motions may be calculated apart from low frequency motions. In analyzing oscillatory motions, due to the fact that the natural period of the unit's surging, swaying and yawing motions are much greater than wave period, the effects of the mass and elasticity of the mooring system on oscillatory motions may generally be neglected. In analyzing low frequency motions, it is only to take consideration of the low frequency surging, swaying and yawing motions of the unit. The low frequency motions are responses of the extremely narrow band concentrated near the natural frequency of the unit. The amplitude of motions depends on the stiffness and damping of the mooring system. The accurate evaluation of damping is therefore essential for calculating the low frequency motions.

Section 3 MOORING ANALYSIS AND DESIGN CRITERIA

8.3.1 General requirements

8.3.1.1 The position mooring system is to be designed so that a sudden failure of any single mooring line will not cause progressive failure of the other remaining ones.

8.3.1.2 Designed working conditions

The following designed working conditions are to be considered for mooring analysis:

(1) Intact operating condition: The moored unit is in an intended operating mode with mean offset and mooring line tension not exceeding the specified values under the specified operating environmental conditions. The operating mode may be divided to drilling operation and/or production operation, depending on the purpose of the unit,,

(2) Intact survival working condition: the maximum offset and mooring line tension of the moored unit do not exceed the specified values under the specified survival environmental conditions,,

(3) Damaged operating condition: failure of any single mooring line of the mooring system under

the specified operating environmental conditions,,

(4) Damaged survival condition: failure of any single mooring line of the mooring system under the specified survival environmental conditions,,

Transient performances of the moored unit under damaged condition are also to be analyzed if there are any other structures adjacent to the unit. This analysis is to include the moving path taken by the unit during the transient motion before it arrives to a new equilibrium position, the location of the unit and the tension of mooring line.

(5) Transient operating condition: transient motions of the unit caused by failure of any mooring line under the specified operating environmental conditions,,

(6) Transient survival condition: transient motions of the unit caused by failure of any mooring line under the specified survival environmental conditions.

8.3.1.3 Methods of analysis

The analyzing methods of mooring system is divided into:

(1) Quasi-static analysis,

(2) Dynamic analysis, which is divided into frequency-domain method and time-domain method.

8.3.2 Offset and mooring line tension

8.3.2.1 Offset

(1) Mean offset is the displacement due to the combined effects of wind, current, and wave-drift forces.

(2) Maximum offset is the mean offset plus the amplitude of appropriately combined oscillatory motions and low frequency motions of the unit. The maximum offset is to be taken as the greater value obtained by the two following formulae:

$$X_{\max} = \overline{X} + X_{\max,lf} + X_{1/3,wf}$$
$$X_{\max} = \overline{X} + X_{1/3,lf} + X_{\max,wf}$$

Where: $X_{\max}$ — maximum offset, in m,

$\overline{X}$ — mean offset, in m,

$X_{\max,lf}$ — maximum single amplitude of unit's low frequency motion, in m,

$X_{1/3,lf}$ — significant single amplitude of unit's low frequency motion, in m,

$X_{\max,wf}$ — maximum single amplitude of unit's oscillatory motion, in m,

$X_{1/3,wf}$ — significant single amplitude of unit's oscillatory motion, in m.

Any other method used for determining the maximum offset is to be approved by CCS.

8.3.2.2 Mooring line tension

(1) The mean tension means the mooring line tension corresponding to the mean offset of the unit.

(2) The maximum tension means the sum of the mean tension and the appropriately combined oscillatory tension and low frequency tension. The maximum tension is to be taken as the greater value obtained by the following formulae:

$$T_{\max} = \overline{T} + T_{\max,lf} + T_{1/3,wf}$$
$$T_{\max} = \overline{T} + T_{1/3,lf} + T_{\max,wf}$$

Where: $T_{\max}$ — maximum tension, in kN

$\bar{T}$ — mean tension, in kN,

$T_{\max,lf}$ — maximum low frequency tension, in kN,

$T_{1/3,lf}$ — significant low frequency tension, in kN,

$T_{\max,wf}$ — maximum oscillatory tension, in kN,

$T_{1/3,wf}$ — significant oscillatory tension, in kN.

Any other method used for determining the maximum tension is to be approved by CCS.

8.3.3 Statistical characteristics of random responses

8.3.3.1 For wave frequency or low frequency responses (motions, tension, etc.) that can be represented by a narrow band Gaussian process with Rayleign distributed peaks, statistical peak values used in the frequency domain approach can be calculated by the following equations:

$$Max.Value = \sqrt{2\ln N}\,RMS$$
$$Sig.Value = 2RMS$$

Where: RMS— root mean square of random process, $RMS = \sqrt{m_0}$ when expressed in spectrum moment,

N — number of oscillations, $N = \frac{T}{T_a}$;

T — duration of storm, in seconds,

T_a —average zero up crossing period, in seconds, $T_a = 2\pi\sqrt{\frac{m_0}{m_2}}$;

m_i — i th order spectrum moment, $m_i = \int_0^\infty \omega^i S_x(\omega)\,d\omega$;

$S_x(\omega)$— spectral density.

For low frequency motions, T_a could be taken as the natural period T_e of the unit and obtained as follows:

$$T_e = 2\pi\sqrt{m/c}$$

Where: m — mass of moored unit, including low frequency added mass, in kg,

c — stiffness of mooring system taken at the unit's mean position, in kN/m.

The duration of storm is to be determined according to specific conditions, generally not less than 3 hours.

When the model testing or time-domain simulation is used to determine the maximum value, it is to be repeated to get several records of motion responses or tension responses, and the mean value of the recorded maximum values is to be taken as the maximum value of random responses.

It is to be noted that any non-Gaussian process may be underestimated in the above formulae for calculating maximum values.

8.3.4 Quasi-static analysis procedure

8.3.4.1 In the quasi-static analysis, static offset of the moored unit is done first, then proper wave motions are applied to the fairlead in way of the largest mooring line to take dynamic loads of waves into account. For this method, the vertical motion of fairlead and dynamic effects associated with the mass, damping hydrodynamic properties, etc. of mooring lines may be neglected.

8.3.4.2 The general procedure of the quasi-static analysis is summarized below:

(1) Determining the characteristics of static stiffness of the mooring system based on recognized theories, numerical analysis or model testing. The catenary equation applies normally to mooring lines made of a single material. Consideration is to be given to the elastic elongation of mooring lines, in particular to the mooring systems tensioned in shallow water. In addition, the effects of current, sloping seabed, friction between seabed and mooring lines, etc. are to be considered as appropriate,,

(2) Determining the mean offset $\bar{X}$ of the moored unit. The current, wind and wave-drift forces are to be taken as static forces to determine the steady environmental forces acting on the unit. Then, the static offset, i.e. the mean offset $\bar{X}$ of the unit from its initial position is to be determined according to the characteristics of static stiffness of the mooring system,,

(3) Determining the mooring stiffness for the mean offset. The low frequency motions of the moored unit are to be analyzed on the basis of this mooring stiffness to determine the significant and maximum single amplitudes of such motions,,

(4) Determining the significant and maximum single amplitudes of oscillatory motions of the moored unit are to be determined,,

(5) Determining the maximum offset of the moored unit and the maximum mooring line tension. The oscillatory motions and low frequency motions of the unit are to be appropriately combined according to 8.3.2.1 to determine the maximum offset of the unit. The maximum mooring line tension is to be determined according to the characteristics of static stiffness of mooring lines,,

(6) Determining the maximum hanging length of mooring lines. For anchor equipment not capable of bearing uplift forces, the maximum hanging length of the line is to be less than the outboard length of lines,

(7) Determining the maximum loading of anchors. The maximum loading P to which an anchor is subjected is to be calculated as follows:

$$P = T_{\max} - Wh - F \quad \text{kN}$$

Where: $T_{\max}$ — maximum tension of mooring line, in kN,

W — weight of mooring line in water per unit length, in kN/m,

h — water depth, in meters,

F — friction force between mooring line and seabed, in kN.

(8) Checking the mooring line tension, mean and maximum offsets of the unit and maximum loading of anchors according to the design criteria for mooring systems specified in 8.3.5.

8.3.4.3 The above quasi-static analysis method applies to the mooring analysis of intact mooring systems, and of damaged mooring systems with failure of any one mooring line. For the analysis of transient motions of damaged mooring systems, however, this method is not applicable, and time-domain analysis is generally required. For the purpose of simplification, time-domain (transient motions) analysis and frequency-domain (unit’s motions) analysis are often combined to carry out.

8.3.5 General requirements of dynamic analysis procedures

8.3.5.1 Dynamic analysis applies to all analyses for mooring system. Dynamic analysis is to take the account of the effects of time varying due to mass, damping, and fluid acceleration.

Generally, frequency domain analysis or time domain analysis may be used to determine mooring line responses to the fairlead motions.

The fairlead motions are to be obtained by conversion of surging, swaying, heaving, pitching, rolling, and yawing motions of the moored unit. Normally, only the horizontal and vertical motions of the fairlead within the mooring line plane are taken into consideration.

8.3.5.2 In the dynamic analysis, the following nonlinear factors that have an important influence on mooring line behavior are to be considered:

(1) Nonlinearity of the strain or tangential stretch and tension of mooring lines — Chain and wire rope may be regarded as linear. Nonlinear behavior of this type typically occurs only in synthetic materials such as polyester, and a linearized behavior may be assumed by using a representative tangent or secant modulus.

(2) Geometric nonlinearity of mooring lines — The geometric nonlinearity is associated with changes in shape of the mooring line,

(3) Nonlinearity of fluid load on mooring lines — Where the Morrison equation is used to calculate fluid load on mooring lines, the drag force on the line is proportional to the square of the relative velocity between the fluid and the mooring line so as to cause the fluid load nonlinearity.

(4) Nonlinearity of bottom effects — The interaction between the mooring line and the seafloor is usually considered to be a frictional process and is hence nonlinear. In addition, the length of grounded line constantly changes so as to cause the geometric nonlinearity.

8.3.5.3 The motion coupling effects between unit motion and dynamic displacement of mooring line could be ignored.

In the dynamic analysis, it is firstly to move the moored unit to a corresponding position of mean offset plus significant or maximum low frequency motion in a static condition, then impose the wave frequency fairlead motion on the mooring line intended to analyze, and calculate the wave frequency response by using the dynamic mooring analysis procedures.

8.3.5.4 The dynamic analysis model of mooring line is a two-dimensional plane consisting of a series of mass, springs and dampers.

8.3.6 Frequency domain dynamic analysis

8.3.6.1 In a frequency domain analysis, all nonlinearities are to be linearized either directly or iteratively. It is recommended that the nonlinearities as specified in 8.3.5.2 are to be linearized by the following methods:

(1) Nonlinearity of the mooring line stretching — Linearization could be achieved by assuming a defined modulus at each point of mooring lines,

(2) Geometric nonlinearity of mooring lines — Changes in catenary shape due to the dynamic motion of moored units are generally not severe. Hence, a linearization at the mean position (the position determined by the static environmental forces) of moored units is acceptable,

(3) Nonlinearity of fluid loads — The quadratic relationship in the relative velocity is to be replaced by an equivalent linear relationship,

(4) Nonlinearity of s bottom effects — The frictional behavior between the grounded line and the seafloor cannot be represented exactly in the frequency domain. The average or equivalent behavior of the line could be linearized.

8.3.6.2 The relative effects of all nonlinearities are associated with many parameters, especially water depths, mooring components and motion amplitudes.

The importance of such parameters is to be reflected by the method to approximate nonlinearity in frequency domain.

8.3.6.3 For highly nonlinear mooring systems, for example, a large portion of the mooring line contacting the seabed, plugs or elastic buoys near the grounded starting point of mooring lines, elastic buoys pushed closer to the water surface, vertical load imposed on anchors, the frequency domain analysis may lead to large errors, and the dynamic analysis is to be carried out by time domain.

8.3.6.4 The general procedure of the frequency domain dynamic analysis is summarized below:

(1) Determining the characteristics of static stiffness of the mooring system, based on recognized theories, numerical analysis or model testing. The catenary equation applies normally to mooring lines made of a single material. Consideration is to be given to the elastic elongation of mooring lines, in particular to the mooring systems tensioned in shallow water. In addition, the effects of current, sloping seabed and friction between seabed and mooring lines are to be considered as appropriate,

(2) Determining the mean offset $\overline{X}$ of the moored unit. The current, wind and wave-drift forces are to be taken as static forces to determine the steady environmental forces acting on the unit. Then, the static offset, i.e. the mean offset $\overline{X}$ of the unit from its initial position is to be determined according to the characteristics of static stiffness of the mooring system,

(3) Determining the mooring stiffness for the mean offset. The low frequency motions of the moored unit are to be analyzed on the basis of this mooring stiffness to determine the significant and maximum single amplitudes of such motions,

(4) Determining the significant and maximum single amplitudes of oscillatory motions of the moored unit,

(5) Determining the maximum offset of the moored unit and the maximum hanging length of the mooring line. The oscillatory motions and low frequency motions of the unit are to be appropriately combined according to 8.3.2.1 to determine the maximum offset of the unit and the maximum hanging length of the mooring line,

(6) Determining the maximum tension of mooring lines and the maximum load of anchors. The maximum tension of mooring lines and the maximum load of anchors are to be determined by the following steps:

① Moving the unit to a corresponding position of mean offset plus significant low frequency motion. Calculating the static response of mooring system in this position. Then imposing the wave frequency fairlead motion on the mooring line intended to analyze, and calculating the wave frequency response of mooring line tension by using the frequency domain dynamic mooring analysis procedures. The root mean square of wave frequency tension, maximum wave frequency tension, maximum tension of mooring lines and maximum load of anchors are also obtained,

② Moving the unit to a corresponding position of mean offset plus maximum low frequency motion. Calculating the static response of mooring system in this position. Then imposing the wave frequency fairlead motion on the mooring line intended to analyze, and calculating the wave frequency response of mooring line tension by using the frequency domain dynamic mooring analysis procedures. The root mean square of wave frequency tension, significant wave frequency tension, maximum tension of mooring lines and maximum load of anchors are also obtained,

③ Comparing the maximum tension of mooring lines and maximum load of anchors obtained from ① and ② respectively, the maximum tension of mooring lines and maximum load of anchors are to be taken, whichever is the greater,

(7) The mean offset and maximum offset of the unit, maximum tension of mooring lines and maximum load of anchors obtained from above steps are to comply with the requirements of 8.3.10.

8.3.7 Time domain dynamic analysis

8.3.7.1 Except that the maximum tension or significant wave frequency tension of mooring lines as specified in 8.3.6.4 (6) ① and ② are to be determined by the time domain dynamic mooring analysis procedures, the other calculating procedures of time domain dynamic mooring analysis are the same as frequency domain.

8.3.7.2 When time domain is used to determine the wave frequency tension of the mooring line, at least a three hour time history, representing the wave elevation is generated from the sea-state spectrum. The fairlead motion RAOs are used to convert the wave elevation time history into a horizontal and vertical motion of fairlead within the plan of mooring line. The tension response time history is to be calculated by the use of time domain dynamic analysis procedures according to this fairlead motion time history. Finally, the maximum and significant wave frequency tensions are determined.

8.3.7.3 The wave elevation time history is generated by the following method:

$$h(t) = \sum_{j=1}^{N} A_j \cos\left(\omega_j t + \varphi_j\right)$$

Where: $h(t)$ — wave elevation time history, in m,

A_j — wave amplitude, $A_j = \sqrt{2S\left(\omega_j\right)\Delta\omega}$, in m,

ϕ_j — random phase [0,2π],

$S\left(\omega_j\right)$ — spectral density in way of wave frequency ωj, in m2·s,

$\Delta\omega$ — frequency spacing (see Fig. 8.3.7.3).

At least 50 frequencies are required to develop a realistic time history. Care is to be taken in generating the wave elevation, that the time history does not repeat itself prematurely. This is normally achieved by using varied frequency spacing.

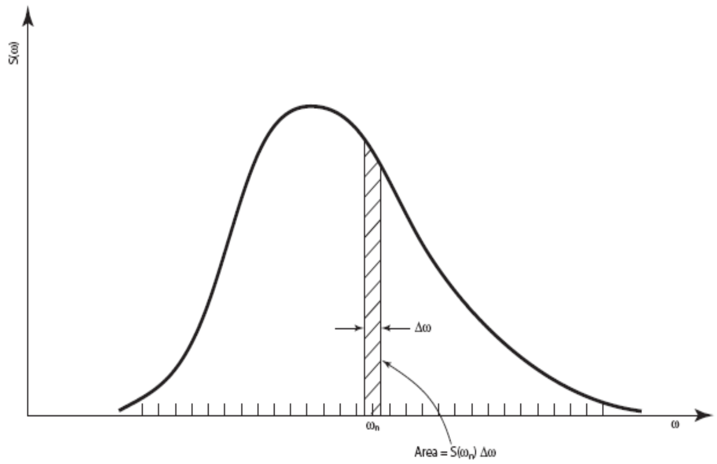


Fig. 8.3.7.3 Density of Spectral

8.3.7.4 Different wave elevation time history may be generated by different random phases, and hence numerous different fairlead time history may be generated by the same fairlead motion RAO, and totally different maximum or significant wave frequency tension are obtained. The following approximation method is recommended to be used for obtaining reasonable approximate values.

For maximum wave frequency tension of mooring lines, there are:

(1) Method A — For some fairlead motion time histories, calculating the maximum wave frequency tension repeatedly until the mean value of maximum wave frequency tension achieves to a stable value.

(2) Method B — Correcting the maximum wave frequency tension obtained by single calculating operation. The process is as follows:

① generating a fairlead motion time history in a storm duration, calculating the ratio (R) of maximum value of fairlead tangential motion X_m and root mean square $X_{max,}$ i.e. $R = X_m / X_{max}$,

② selecting a segment of fairlead motion time history in the above-mentioned storm duration, and the center of such segment is located near the maximum value of tangential motion. The length of such segment is sufficient to eliminate the transient effects in dynamic mooring analysis,

③ applying the time domain dynamic mooring analysis procedures to obtain maximum wave frequency tension according to such segment of fairlead motion time history,

④ correcting the maximum wave frequency tension obtained in (c) by the following formula:

$$T_{\max,wf} = T'_{\max,wf} \frac{\sqrt{2\ln N}}{R}$$

Where: $T_{\max,wf}$ — corrected maximum wave frequency tension, in kN;

$T'_{\max,wf}$ — maximum wave frequency tension obtained in ③, in kN,

R — ratio, as determined in ①,

N — wave cycles within the storm duration, as determined in 8.3.3.1.

(3) Method C — Applying the time domain dynamic mooring analysis procedures to obtain a tension time history according to a fairlead motion time history, and then obtain a tension spectrum according to such segment of tension time history and calculating the root mean square of tension based on the spectrum. Finally, calculating the maximum wave frequency tension by the following formula:

$$T_{\max,wf} = T_{rms}\sqrt{2\ln N} \quad \text{in kN}$$

Where: T_{rms} —root mean square of wave frequency tension, in kN.

In this method, sufficient tension time history is required to provide corresponding tension component for all important frequencies. For highly nonlinear mooring systems, the maximum wave frequency tension obtained by this method may be underestimated.

For significant wave frequency tension of mooring lines, there are:

(1) Method A — calculating significant tension according to a segment of tension time history, but such segment of time history is to be sufficiently long to generate a stable and significant value,

(2) Method B — except for ④ of Method B for calculating the maximum wave frequency tension, the other processes are the same. The significant wave frequency tension is to be corrected by following formula:

$$T_{1/3,wf} = T'_{1/3,wf} \frac{2}{R} \qquad \text{kN}$$

Where: $T_{1/3,wf}$ — corrected significant wave frequency tension, in kN,

$T'_{1/3,wf}$ — significant wave frequency tension obtained in (c) of Method B for maximum wave frequency tension, in kN,

R — ratio, as determined in (a) of Method B for maximum wave frequency tension of mooring lines.

(3) Method C — the same as the Method C for calculating maximum tension, except for calculating the significant wave frequency tension by the following formula:

$$T_{1/3,wf} = 2T_{rms} \quad \text{in kN}$$

Other methods used for calculating the maximum or significant wave frequency tension are to be use with the approval by CCS, however, documents are provided to prove that these methods could provide a statistically real response level.

8.3.8 Damaged mooring system analysis

8.3.8.1 In addition to the mooring analysis and check of intact mooring systems, mooring analysis under damage condition in the event of failure of any one mooring line is also to be carried out.

If necessary, transient motion analysis is also required to be carried out.

8.3.8.2 Damaged mooring system analysis is to be carried out by the methods as specified in 8.3.4, 8.3.6 and 8.3.7of this Section, according to the specific case.

8.3.8.3 Damaged mooring system analysis is to be carried out by the following procedures:

(1) Breaking a mooring line in way of the mean (equilibrium) position for an intact mooring,

(2) Determining a new equilibrium position under mean load for the mooring system after a mooring line breakage,

(3) Determining the maximum tension of mooring lines by the methods as specified in 8.3.4, 8.3.6 and 8.3.7of this Section,

(4) If necessary, analyzing the transient motion of the moored unit before it settles at a new equilibrium position of the damaged mooring system from the equilibrium position of the intact mooring system,

(5) Repeating the above-mentioned (1) ~ (3) for each mooring line or (1) ~ (4) so as to obtain the values under worst condition,

(6) Checking the maximum tension of mooring lines as specified in 8.3.10.

8.3.9 Transient analysis

8.3.9.1 A moored unit will experience transient motions after a mooring line breakage or thruster system failure before it settles at a new equilibrium position. Transient analysis of a moored unit under wind, wave, current, and thruster loading generally requires a time domain solution. To simplify the analysis, a combination of time domain and frequency domain approaches could be used.

8.3.9.2 Transient analysis is to be performed to check unit offset and mooring line tension under any one of the following conditions:

(1) A unit is moored in the vicinity of another structure,

(2) A MODU conducts a deep-water drilling operation where excessive transient motions may cause damage to the drilling riser such as stroke-out of the slip joint or exceeding the flex joint limit.

8.3.9.3 Combination of Time and Frequency Domain Analysis

In this approach, the maximum transient motion is first determined using a time domain approach. Then unit motions obtained from frequency domain approach are superimposed on the transient motion. The recommended procedure is as follows:

(1) Calculating the equilibrium position under mean load for an intact mooring,

(2) Breaking a line and calculating the new equilibrium position under mean environmental load,

(3) Calculating the maximum transient motion in the time domain with mean load only and with the mooring system stiffness corrected at each time step,

(4) Determining the maximum offset of unit and tension of mooring line.

The maximum offset of unit is to be determined by the following equation:

$$X_{\max} = \bar{X} + X_t + X_{1/3,wf} + X_{1/3,lf} \quad \text{m}$$

Where: $\bar{X}$ — mean offset as calculated in (1), in m,

X_t — maximum transient motion with respect to the equilibrium position from (1) as determined in (3), in m,

$X_{1/3,wf}$ — significant wave frequency motion, calculated in the frequency domain, in m,

$X_{1/3,lf}$ — significant low frequency motion, calculated in the frequency domain using the damaged mooring system stiffness, in m.

The mooring line tension is to be determined by the following equation:

$$T_{\max} = \bar{T} + T_t + T_{1/3,wf} + T_{1/3,lf} \quad \text{kN}$$

Where: $\bar{T}$ — mooring line tension under mean environmental load as calculated in (1), in kN,

T_t — mooring line tension under maximum transient motion Xt as calculated in (3), in kN,

$T_{1/3,wf}$ — significant wave frequency tension, in kN,

$T_{1/3,wf}$ — significant low frequency tension, in kN.

8.3.9.4 Time domain analysis

Transient analysis is to be carried out repeatedly for a certain number of wave force time history, calculation is to be carried out repeatedly for the mooring line breakage occurs at different time in each wave force time history. The selected designed value is to be the maximum one obtained by these simulations or the probable maximum one evaluated in accordance with the simulation results.

8.3.9.5 The spacing between the unit and adjacent structures is to be maintained sufficient, and may generally be required no less than 10m.

8.3.10 Design criteria for mooring systems

8.3.10.1 The following elements of mooring systems are to be checked in accordance with this paragraph:

(1) Mean offset and maximum offset,

(2) Tension of mooring lines,

(3) Length of mooring line,

(4) Holding power of anchors.

8.3.10.2 Offset

The owner/designer is to specify the permissible mean offset and the permissible maximum offset for drilling or production operations on the basis of the water depth of operating area(s), environmental conditions and clearance requirement and limitation of drilling/production riser system.

8.3.10.3 Tension of mooring lines

(1) The safety factor of mooring lines tension depends on design conditions, any adjacent marine structures or not and the method used for mooring analysis.

(2) When the quasi-static analysis method and dynamic analysis method are used, the safety factor of chain cables or wire ropes is not to be less than that given in Table 8.3.10.3. The safety factors of mooring lines made of other materials are to be specially approved by CCS.

(3) The safety factor *F* is specified as：

$$F = \frac{P_B}{T_{max}}$$

Where: P_B — minimum rated breaking strength of mooring line, in kN,

T_{max} — maximum tension of mooring line obtained according to this paragraph, in kN.

Safety Factors of Mooring Line Table 8.3.10.3

Design condition	Quasi-static analysis		Dynamic analysis	
	Unit adequately clear from any adjacent structures	Unit with any adjacent structures	Unit adequately clear from any adjacent structures	Unit with any adjacent structures
Intact operating condition	2.70	3.00	2.25	2.47
Intact survival condition	2.00	2.20	1.67	1.84
Damaged operating condition	1.80	2.00	1.57	1.73
Damaged survival	1.43	2.00/1.57(1)	1.25	1.37
Transient operating condition	-	-	1.22	1.34
Transient survival condition	-	-	1.05	1.16

Notes: (1) The safety factor 2.0 applies to the mooring line which is critical to maintain the moored unit clear from any adjacent structures.

8.3.10.4 Length of mooring lines

Where a high holding power anchor is used, the mooring line is to be sufficient in its outboard length so that a portion of the line still touches seabed when the maximum offset of the mooring system is reached in a damaged condition.

Shorter mooring lines could be used for mooring systems with other anchor systems (such as anchor piles).

8.3.10.5 Holding power of anchor system

(1) It is the responsibility of the owner/operator to ensure that the anchor system has adequate holding power and is fit for the seabed conditions in the anticipated operating area(s),

(2) The nominal holding power of anchors are to be documented,

(3) The bending stresses of the anchor pile and its transverse and axial bearing capacities are to be considered. The anchor piles are to be designed in compliance with a standard acceptable to CCS.

8.3.11 Analysis for thruster assisted mooring

8.3.11.1 For moored units fitted with a thruster, consideration may be given to net effect of part or all thrusters under all design conditions. Such effect is dependent on the thruster control system and design conditions. Thrusters may be manually or automatically controlled. The allowable thrust is to be taken from Table 8.3.11.1.

Allowable Thrust Effects of Thruster Assisted Mooring System(1) Table 8.3.11.1

Design condition	Thruster control system	
	Manual remote control	Automatic remote control(3)

Intact operating condition	70% of net effect of all thrusters, other than one (2)	100% of net effect of all thrusters, other than one (2)
Intact survival condition		
Damaged operating condition	70% of net effect of all thrusters	100% of net effect of all thrusters
Damaged survival condition		
Notes: (1) This Table applies to thruster systems with standby power source; (2) Where thrusters have different thrust effects, the most effective one is to be deducted; (3) If no standby control system is available, 70% of net effect of thrusters is to be considered.		

8.3.11.2 The net thrust calculations are to be based on the effective bitt thrust under zero speed, and the effects of any directional limitations, of mutual interference between unit's motions, current, thruster and unit hull and between thrusters are to be taken into account.

8.3.11.3 The allowable thrusts used in mooring systems are to be proved by documents provided by the manufacturers, and to be verified during the thruster system testing at sea.

8.3.11.4 In thruster assisted systems, the load sharing between thrusters and mooring systems are complex, and could only be taken into fully consideration by a time-domain system dynamic analysis. In general, a simple mean load reduction method may be used for analysis of thruster assisted mooring. Where the system dynamic analysis method is used, special consideration is to be given.

Section 4 MOORING EQUIPMENT

8.4.1 General requirements

8.4.1.1 The materials, design, manufacture and testing of anchors, mooring lines and their fittings and fairleads, as well as chain/wire stoppers are to be in compliance with applicable requirements of Chapter 10 of PART ONE of CCS Rules for Materials and Welding or the recognized GB or international standards.

8.4.1.2 Means are to be provided to enable the mooring lines to be released from the unit after loss of main power.

8.4.1.3 Means are to be provided for measuring mooring line tensions.

8.4.2 Anchors

8.4.2.1 The number and holding power of anchors used for position mooring are to be sufficient for their intended purpose, refer to 8.3.10.5

8.4.2.2 Type and design of anchors are to be to the satisfaction of CCS.

8.4.2.3 All anchors are to be stowed to prevent movement during transit.

8.4.3 Mooring lines

8.4.3.1 Mooring lines are generally to be of stud link chain cable, wire rope, synthetic fiber rope or any combination thereof.

8.4.3.2 Stud link chain cables and accessories are generally to be of grades OM3、OM3S、OM4，OM4S and OM5 in respect to their strength, meeting the requirements for offshore mooring chain cables and accessories in Section 3, Chapter 10 of PART ONE of CCS Rules for Materials and Welding. Other equivalent materials may also be used, subject to the agreement of CCS.

8.4.3.3 Wire rope for mooring lines is to have a suitable construction for its purpose, and 6 ×37 construction with independent wire rope core is generally acceptable. The wire rope is to be galvanized. Wire rope and its terminal fittings are to comply with a recognized standard.

8.4.3.4 The synthetic fiber rope is to comply with the relevant requirements in Section 2, Chapter 7 of PART TWO of CCS Rules for Materials and Welding.

8.4.3.5 The strength of mooring line accessories is not to be less than that of the mooring line.

8.4.4 Fairleads

8.4.4.1 Fairleads and sheaves are to be designed to permit free movement of the mooring line in all mooring configurations and designed to prevent excessive bending and wear of the mooring lines.

8.4.4.2 Fairleads and their supporting structures are to be designed for a load equivalent to the nominal minimum breaking strength of the mooring line, and the allowable stresses are to comply with the requirements of Chapter 3 of PART TWO for combined loading conditions.

8.4.4.3 Chain cable fairleads are to have a minimum of 5 pockets. Wire rope fairleads are generally to have a minimum diameter of 20 times the wire rope diameter.

8.4.5 Chain/wire stoppers

8.4.5.1 Chain/wire stoppers may require to be provided depending on the windlass/winch arrangements.

8.4.5.2 Chain/wire stoppers and their supporting structures are to be designed for a load equivalent to the nominal minimum breaking strength of the mooring line, and the allowable stresses are to comply with the requirements of Chapter 3 of PART TWO for combined loading conditions.

Section 5 WINDLASSES AND THRUSTERS

8.5.1 General requirements

8.5.1.1 The windlasses/winches provided for position mooring are to comply with Chapter 5 of PART FOUR of the Rules.

8.5.1.2 Thrusters are to comply with the relevant requirements of CCS Rules for Classification of Sea-Going Steel Ships or the recognized standards.

Section 6 ELECTRICAL AND CONTROL EQUIPMENT

8.6.1 General requirements

8.6.1.1 Control stations, display, control and alarm systems, as well as control mode are to comply with Chapter 2 of PART FIVE of the Rules.

8.6.1.2 For thruster assisted position mooring system, the thruster control system is to comply with Chapter 2 of PART FIVE of the Rules.

CHAPTER 9 DYNAMIC POSITIONING SYSTEMS

Section 1 GENERAL PROVISIONS

9.1.1 General requirements

9.1.1.1 This Chapter applies to mobile offshore units with class notations as specified in 9.1.2 of this Section.

9.1.1.2 Dynamic positioning systems are to comply with the applicable requirements of PART FIVE and Chapter 11 of PART EIGHT in CCS Rules for Classification of Sea-Going Steel Ships. The relevant tests of dynamic positioning systems are to comply with 6.2.6, Chapter 6, PART ONEof CCS Rules for Classification of Sea-Going Steel Ships and the supplementary requirements in 9.1.4 of this chapter.

9.1.2 Class notations

9.1.2.1 The following class notations are to be assigned correspondingly to the mobile offshore units installed with dynamic positioning systems, respectively:

(1) DP-1 could automatically keep their position and heading under the specified environmental conditions, and at the same time, independent, concentrated manual position control and automatic heading control is to be provided,

(2) DP-2 could automatically keep their position and heading in case of single failure (excluding loss of a compartment or compartments) under the specified environmental conditions and in the specified operating fields,

(3) DP-3 could automatically keep their position and heading in case of any failure (including total loss of a compartment caused by fire or flooding) under the specified conditions and in the specified operating fields.

9.1.3 Arrangement of cables and piping systems

9.1.3.1 For with arrangement of cables and piping systems with class notation DP-3, redundant piping systems or cables are not to pass through the same compartment together with the main systems. Where it is unavoidable, such piping system or cables could be installed in A-60 division. Where redundant piping system or cables and main system are in low risk areas, A-0 division is acceptable, subject to approval by plan approval department or agreement by site surveyor.

9.1.4 Supplementary requirements for system tests

9.1.4.1 The relevant tests of dynamic positioning system generally include dock test/quay and sea trial, and also redundancy verification tests for DP-2 and DP-3. Test program for these tests must be submitted to CCS for review and approval.

9.1.4.2 The dock test of the dynamic positioning system normally include testing and calibration of the installation, arrangement, network of the equipment and the system (software, hardware, drive) as well as the system functions to prepare for the sea trial.

9.1.4.3 The sea trial of the dynamic positioning system must be carried out in the predetermined sea area mainly to test and verify the basic functions and system integrity of the dynamic positioning system. Such tests generally include but are not limited to the following items:

(1) System and equipment power supply;

(2) Single/multiple measuring components function test;

(3) Power management system (PMS) function test;

(4) Function test in each control mode;

(5) Control mode switchover function test (when with redundant system);

(6) Positioning accuracy (position, heading) with single position reference system and combinations of multiple position reference systems;

(7) Positioning capacity (including manual operation mode) with single position reference system and combinations of multiple position reference systems;

(8) Endurance test, etc.

9.1.4.4 The redundancy verification tests for DP-2 and DP-3 must be carried out in the predetermined sea areas. These testsare to cover all failure modes analyzed in the FEMA report with the system in all power distribution and operating conditions. These failures generally include but not limited to the following:

(1) Power system failures

① including failures of prime mover speed regulator and voltage regulator;

② Main switchboard failure;

③ Bus-tie switch failure;

④ Power management system failure;

(2) Propulsion system failure;

(3) Control system failure;

(4) Measuring system failure;

(5) Auxiliary system failure;

(6) Network and communication system failure;

(7) Common failures analyzed in FMEA.

CHAPTER 10 HELICOPTER DECK FACILITIES

Section 1 GENERAL PROVISIONS

10.1.1 General requirements

10.1.1.1 This Chapter applies to all mobile offshore units provided with areas and facilities for normal lift-off and touchdown of helicopters.

10.1.1.2 Helicopter deck facilities covered by this Chapter mean all deck structures and fire-fighting appliances used exclusively for lift-off, touchdown and (as necessary) stowage of helicopters and other equipment necessary for the safe operation of helicopters on the units as specified in Chapter 2 of PART ONE of the Rules. The helicopter deck facilities of surface-type units may be based on Section 18, Chapter 2 of PART TWO and Chapter 5 of PART SIX of CCS Rules for Classification of Sea-Going Steel Ships.

10.1.1.3 In addition to this Chapter, the design, construction and arrangement as well as safety requirements of helicopter deck facilities must comply with relevant regulations of the International Civil Aviation Organization, the civil aviation administration and maritime administration of the State with territorial jurisdiction over the sea area in which the unit is to operate.

10.1.1.4 The Owner/designer of the unit is to clarify the specific requirements in10.1.1.3 based on the sea areas in which the unit is to operate.

10.1.1.5 Where the helicopter deck is a part of a weather deck or a deck used for other purposes, the scantlings are to be not less than those required for such decks in the same position.

10.1.2 Class notations

10.1.2.1 HELDK: to be assigned to the mobile offshore units in compliance with the relevant provisions of this Chapter.

10.1.3 Definitions

10.1.3.1 *LD or LD-value* referred in this Chapter means the largest dimension of the helicopter when rotor(s) are turning measured from the most forward position of the main rotor tip path plane to the most rearward position of the tail rotor path plane or helicopter structure.

10.1.3.2 *Final approach and take-off area(FATO)*referred in this Chapter is a defined area over which the final phase of the approach manoeuvre to hover or touchdown of the helicopter is intended to be completed and from which the take-off manoeuvre is intended to be commenced.

10.1.3.3 *Limited obstacle sector (LOS)* referred in this Chapter is a sector extending outward which is formed by that portion of the 360° arc, excluding the obstacle-free sector, the centre of which is the reference point from which the obstacle-free sector is determined. Obstacles within the limited obstacle sector are limited to specified heights.

10.1.3.4 *Obstacle* referred in this Chapter is any object, or part thereof, that is located on an area intended for the movement of a helicopter on a helideck or that extends above a defined surface intended to protect a helicopter in flight.

10.1.3.5 *Obstacle-free sector* referred in this Chapter is a complex surface originating at, and extending from, a reference point on the edge of the FATO of a helideck, comprised of two components, one above and one below the helideck for the purpose of flight safety within which only specified obstacles are permitted.

10.1.3.6 *Touchdown and lift-off area (TLOF)* referred in this Chapter is a dynamic load-bearing area on which a helicopter may touch down or lift off. For a helideck, it is presumed that the FATO and the TLOF will be coincidental.

10.1.3 Plans and information

10.1.3.1 The following plans and information are to be submitted in quadruplicate to CCS for approval or examination:

(1) Details of helicopter deck arrangement, including overall dimensions, landing area, stowing, securing, tie-down points on deck and fittings,

(2) Structural plan and strength calculations for helicopter deck,

(3) Arrangement of stowage and securing of helicopters (if applicable),

(4) Arrangement of structural fire protection of helicopter deck, including fire division, means of escape, openings, drainage facilities,

(5) Arrangement of fire-fighting appliances provided for helicopter deck, including calculations of quantity of extinguishing agents to be used.

10.1.3.2 The operation manual with information on models and parameters of the largest helicopters, for which the deck is designed, including maximum lift-off weight, diameter of rotor, LD-value, tyre print dimensions and track width, is to be submitted to CCS for information.

Section 2 CONSTRUCTION AND ARRANGEMENT OF HELICOPTER DECK

10.2.1 Construction of helicopter deck

10.2.1.1 The helicopter deck is to be of sufficient size and located so as to provide a clear approach to enable the largest helicopter using the deck to operate under the most severe conditions anticipated for helicopter operations.

10.2.1.2 The arrangement of the helicopter deck is to take account of the largest helicopter to be used, the environmental and weather elements such as wind, turbulence, sea state, water temperature and ice, and comply with the following:

(1) Adverse weather conditions:

① the helideck is to be of sufficient size to contain an area within which can be drawn a circle of diameter not less than LD for single main rotor helicopters (LD as defined in 10.1.3.1 of this Chapter),

② a helideck obstacle-free sector is to comprise of two components, one above and one below helideck level (see Fig. 10.2.1.2 (1) a):

(a) above helideck level: The surface is to be a horizontal plane level with the elevation of the helideck surface that subtends an arc of at least 210° with the apex located on the periphery of the LD reference circle extending outwards to a distance that will allow for an unobstructed departure path appropriate to the helicopter(s) the helideck is intended to serve, and

(b) below helideck level: Within the (minimum) 210° arc, the surface is to additionally extend downward at a 5:1 falling gradient from the edge of the safety net below the elevation of the helideck to water level for an arc of not less than 180° that passes through the centre of the FATO and outwards to a distance that will allow for safe clearance from the obstacles below the helideck in the event of an engine failure for the type of helicopter the helideck is intended to serve (see Fig. 10.2.1.2(1) a),

③ for single rotor helicopters, within the 150° LOS out to a distance of 0.12 LD, measured from the point of origin of the LOS, objects are not to exceed a height of 0.25 m above the helideck. Beyond that arc, out to a distance of an additional 0.21 LD, the maximum obstacle height is limited to a gradient of one unit vertically for each two units horizontally originating at a height of 0.05 LD above the level of the helideck (see Fig. 10.2.1.2 (1) b[1]),

④ objects with the function of which requires that they be located on the helideck within the FATO are to be limited to landing nets (if required) and certain lighting systems and are not to exceed the surface of the landing area by more than 0.025 m. Such objects are only to be present provided they do not cause a hazard to helicopter operations, and

⑤ operations by tandem main rotor helicopters are to be specially considered by the Administration.

(2) Benign climate conditions:

① the helideck is to be of sufficient size to contain a circle of diameter no less than 0.83 LD (LD as defined in 10.1.3.1 of this Chapter),

② a helideck obstacle-free sector is to comprise of two components, one above and one below helideck level (see Fig. 10.2.1.2 (1) a):

(a) above helideck level: The surface is to be a horizontal plane level with the elevation of the helideck surface that subtends an arc of at least 210° with the apex located on the periphery of the LD reference circle extending outwards to a distance that will allow for an unobstructed departure path appropriate to the helicopter(s) the helideck is intended to serve, and

(b) below helideck level: Within the (minimum) 210° arc, the surface is to additionally extend downward at a 5:1 falling gradient from the edge of the safety net below the elevation of the helideck to water level for an arc of not less than 180° that passes through the centre of the FATO and outwards to a distance that will allow for safe clearance from the obstacles below the helideck in the event of an engine failure for the type of helicopter(s) the helideck is intended to serve (see Fig. 10.2.1.2 (1) a),

③ for single rotor helicopters, within 0.415 LD to 0.5 LD objects are not to exceed a height of 0.025 m. Within the 150° LOS out to a distance of 0.12 LD, measured from the point of origin of the LOS, objects are not to exceed a height of 0.05 m above the helideck. Beyond that arc, out to a distance of an additional 0.21 LD, the LOS rises at a rate of one unit vertically for each two units horizontally originating at a height of 0.05 LD above the level of the helideck (refer to Fig. 10.2.1.2 (2) [2]),

④ objects with the function of which requires that they be located on the helideck within the FATO are to be limited to landing nets (where required) and certain lighting systems and are not to exceed the surface of the landing area by more than 0.025 m. Such objects are only to be present provided they do not cause a hazard to helicopter operations, and

⑤ operations by tandem main rotor helicopters are to be specially considered by the Administration.

10.2.1.3 The helideck is to have a skid-resistant surface.

10.2.1.4 Where the helideck is constructed in the form of a grating, the underdeck is to be such that the ground effect is maintained.

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[1] Where the dynamic load bearing area of the helideck enclosed by the FATO perimeter marking is a shape other than circular, the extent of the LOS segments are represented as lines parallel to the perimeter of the landing area rather than arcs. Fig, 10.2.1.2(1)b has been constructed on the assumption that an octagonal helideck is provided.

[2] Where the dynamic load bearing area of the helideck enclosed by the FATO perimeter marking is a shape other than circular, the extent of the LOS segments are represented as lines parallel to the perimeter of the landing area rather than arcs. Fig. 10.2.1.2 (2) has been constructed on the assumption that an octagonal helideck is provided.

10.2.2 Arrangement of helicopter deck

10.2.2.1 The helideck is to recessed tie-down points for securing a helicopter.

10.2.2.2 The periphery of the helideck is to be fitted with a safety net except where structural protection exists. The net is to be inclined upwards at an angle of 10 °and outwards from below the edge of the helideck to a horizontal distance of 1.5 m and is not to rise above the edge of the deck.

10.2.2.3 The helideck is to have both a main and an emergency personnel access route located as far apart from each other as practicable.

10.2.2.4 The helicopter deck is to have drainage facilities to prevent the collection of liquids and prevent liquids from spreading to or falling on other parts of the unit, and the drainage facilities are to be:

(1) constructed of steel or other arrangements providing equivalent fire safety,

(2) lead directly overboard independent of any other system, and

(3) designed so that drainage does not fall onto any part of the unit.

10.2.3 Visual aids

10.2.3.1 Wind direction indicator

(1) A wind direction indicator is to be located on the unit which, in so far as is practicable, indicates the wind conditions over the TLOF in such a way as to be free from the effects of airflow disturbances caused by nearby objects or rotor downwash. It is to be visible from a helicopter in flight or in a hover over the helideck. Where the TLOF may be subject to a disturbed air flow then additional wind direction indicators located close to the area are to be provided to indicate the surface wind on those areas. Placement of the wind direction indicators is not to compromise obstacle-protected surfaces,

(2) Units on which night helicopter operations take place are to have provisions to illuminate the wind direction indicators,

(3) A wind direction indicator is to be a truncated cone made of lightweight fabric and is to have the following minimum dimensions:

Length 1.2 m

Diameter (larger end) 0.3 m

Diameter (smaller end) 0.15 m

(4) The colour of the wind direction indicator is to be so selected as to make it clearly visible and understandable from a height of at least 200 m above the heliport, having regard to background. Where practicable, a single colour, preferably white or orange, is to be used. Where a combination of two colours is required to give adequate conspicuity against changing backgrounds, they are preferably to be orange and white, or red and white, and are to be arranged in five alternate bands the first and last band being the darker colour.

10.2.3.2 A heliport identification marking is to be located at the centre of the touchdown/positioning marking described in paragraph 10.2.3.6. It is to consist of a white "**H**" that is 4 m high, 3 m wide, with a stroke width of 0.75 m.

10.2.3.3 LD-value marking

(1) The actual LD-value of the helideck is to be painted on the helideck inboard of the chevron provided in accordance with paragraph 10.2.3.7 in alphanumeric symbols of 0.1 m in height,

(2) The helideck LD-value is also to be marked around the perimeter of the helideck in the manner shown in Fig. 10.2.3.3 (2) in a colour contrasting (preferably white: avoid black or grey for night use) with the helideck surface. The D-value is to be to the nearest whole number with 0.5 rounded

down, e.g., 18.5 marked as 18. Markings for some helicopters may require special consideration.[3]

10.2.3.4 Maximum allowable mass marking

(1) A maximum allowable mass marking is to be located within the TLOF and so arranged as to be readable from the preferred final approach direction, i.e. towards the obstacle-free sector origin,

(2) The maximum allowable mass marking is to consist of a two- or three-digit number followed by a letter “t” to indicate the allowable helicopter mass in t (1,000 kg). The marking is to be expressed to one decimal place, rounded to the nearest 100 kg,

(3) The height of the figures is to be 0.9 m with a line width of approximately 0.12 m and be in a colour (preferably white) which contrasts with the helideck surface. Where possible the mass marking is to be well separated from the installation identification marking in order to avoid possible confusion on recognition.

10.2.3.5 The TLOF perimeter marking is to be located along the perimeter of the TLOF and is to consist of a continuous white line with a width of at least 0.3 m. TLOF perimeter markings are typically for a 1 LD or 0.83 LD value (see Fig. 10.2.1.2 (1) b and10.2.1.2 (2)).

10.2.3.6 Touchdown/positioning marking

(1) A touchdown/positioning marking is to be located so that when the pilot’s seat is over the marking the whole of the undercarriage will be within the TLOF and all parts of the helicopter will be clear of any obstacle by a safe margin,

(2) The centre of the touchdown/positioning marking is to be concentric to the centre of the TLOF,[4]

(3) A touchdown/positioning marking is to be a yellow circle and have a line width of 1 m. The inner diameter of the circle is to be half the LD-value of the largest helicopter for which the TLOF is designed.

10.2.3.7 Helideck obstacle-free sector marking

(1) Except as provided in paragraph 10.2.3.7 (2), a helideck obstacle-free sector marking is to be located on the TLOF perimeter marking and indicated by the use of a black chevron, each leg being 0.8 m long and 0.1 m wide forming the angle in the manner shown in Fig. 10.2.3.3 (2). The obstacle-free sector marking is to indicate the origin of the obstacle-free sector, the directions of the limits of the sector and the verified LD-value of the helideck. Where there is no room to place the chevron where indicated, the chevron marking, but not the point of origin, may be displaced towards the circle centre,

(2) For a helideck less than 1 LD (i.e. a helideck meeting paragraph 10.2.1.2 (2)), a helideck obstacle free sector marking is to be located at a distance from the centre of the TLOF equal to the radius of the largest circle which can be drawn in the TLOF or 0.5 LD whichever is greater,

(3) The height of the chevron is to be equal to the width of the TLOF perimeter marking, but is not to be less than 0.3 m. The chevron is to be black in colour and may be painted on top of the TLOF perimeter marking in paragraph 10.2.3.5 of this Chapter.

10.2.3.8 Unit identification markings

(1) The name of the unit is to be clearly displayed on unit identification panels located in such positions that the unit can be readily identified from the air and sea from all normal angles and directions of approach. The height of the figures is to be at least 0.9 m with a line width of approximately 0.12 m. The unit identification panels are to be highly visible in all light conditions

[3] Helidecks designed specifically for AS332L2 and EC 225 helicopters, each having a D-value of 19.5 m, are to be rounded up to 20 in order to differentiate between helidecks designed specifically for L1 models.

[4] The marking may be offset away from the origin of the obstacle-free sector by no more than 0.1 LD where an aeronautical study indicates such offsetting to be beneficial, provided that the offset marking does not adversely affect the safety of operations.

and located high up on the unit (e.g., on the derrick). Suitable illumination is to be provided for use at night and in conditions of poor visibility,

(2) The unit's name is to be provided on the helideck and be positioned on the obstacle side of the touchdown/positioning marking with characters not less than 1.2 m in height and in a colour contrasting with the background.

10.2.3.9 Perimeter lights

(1) The perimeter of the TLOF is to be delineated by green lights visible omnidirectionally from on or above the lanidng area. These lights are to be above the level of the deck but are not to exceed 0.25 m in height for helidecks sized in accordance with paragraph 10.2.1.2 (1) of this Chapter and 0.05 m in height for helidecks sized in accordance with paragraph 10.2.1.2 (2) of this Chapter. The lights are to be equally spaced at intervals of not more than 3 m around the perimeter of the TLOF, coincident with the white line delineating the perimeter in paragraph 10.2.3.5 of this Chapter. In the case of square or rectangular decks there are to be a minimum of four lights along each side including a light at each corner of the TLOF. Flush fitting lights may be used at the inboard (150 °limited obstacle sector origin) edge of the TLOF where there is a need to move a helicopter or large equipment off the TLOF,

(2) Perimeter lights are to meet the chromaticity characteristics given in table 10.2.3.9-1, and the vertical beam spread and intensity characteristics given in table 10.2.3.9-2.

Perimeter Lighting Chromaticity Table 10.2.3.9-1

Yellow boundary	x = 0.36 - 0.08y
White boundary	x = 0.65y
Blue boundary	y = 0.9 - 0.171x

Green Perimeter Lighting Intensity Table 10.2.3.9-2

Elevation	Intensity (cd)
0 °- 90 °	60 max(1)
> 20 °- 90 °	3 min
> 10 °- 20 °	15 min
0 °- 10 °	30 min
Azimuth +180 °- 180 °	

Notes: If higher intensity lighting is provided to assist in conditions of poor visibility during daylight, it is to incorporate a control to reduce the intensity to not more than 60 cd for night use.

10.2.3.10 Helideck floodlights are to be located so as to avoid glare to pilots, and provision is to be made for periodically checking their alignment. The arrangements and aiming of floodlights are to be such that helideck markings are illuminated and that shadows are kept to a minimum. Floodlights are to conform to the same height limitations specified in paragraph 10.2.3.9 of this Chapter for perimeter lights.

10.2.3.11 Obstacle marking and lighting

(1) Fixed obstacles and permanent equipment, such as crane booms or the legs of self-elevating units, which may present a hazard to helicopters, are to be readily visible from the air during daylight. If a paint scheme is necessary to enhance identification by day, alternate black and white, black and yellow, or red and white bands are recommended, not less than 0.5 m nor more than 6 m wide,

(2) Omnidirectional red lights of at least 10 cd intensity are to be fitted at suitable locations to provide the helicopter pilot with visual information on objects which may present a hazard to helicopters and on the proximity and height of objects which are higher than the landing area and which are close to it or to the limited obstacle sector boundary. Such lighting is to comply with the following:

① Objects which are more than 15 m higher than the landing area are to be fitted with intermediate red lights of the same intensity spaced at 10 m intervals down to the level of the landing area (except where such lights would be obscured by other objects), ② Structures such as flare booms and towers may be illuminated by floodlights as an alternative to fitting the intermediate red lights, provided that such lights are so arranged that they will illuminate the whole of the structure and not interfere with the helicopter pilot’s night vision,

③ On self-elevating units the leg(s) nearest the helideck may be illuminated by floodlights as an alternative to fitting the intermediate red lights, provided that such lights are so arranged that they will not interfere with the helicopter pilot’s night vision,

④ Alternative equivalent technologies to highlight dominant obstacles in the vicinity of the helideck may be utilized in accordance with the recommendations of the ICAO.

(3) An omnidirectional red light of intensity 25 to 200 cd is to be fitted to the highest point of the unit and, in the case of self-elevating units, as near as practicable to the highest point of each leg. Where this is not practicable (e.g., flare towers) the light is to be fitted as near to the extremity as possible.

10.2.3.12 Status lights are to be installed to provide warning that a condition exists on the unit which may be hazardous for the helicopter or its occupants. The status lights are to be a flashing red light[5] (or lights), visible to the pilot from any direction of approach and on any touchdown heading. The system is to be automatically initiated when the toxic gas alarm under Chapter 3 of PART FIVE is initiated as well as being capable of manual activation at the helideck. It is to be visible at a range in excess of the distance at which the helicopter may be endangered or may be commencing a visual approach. The status light system is to:

(1) be installed either on or adjacent to the helideck. Additional lights may be installed in other locations on the unit where this is necessary to meet the requirement that the signal be visible from all approach directions, i.e. 360 °in azimuth,

(2) have an effective intensity of at least 700 cd between 2 °and 10 °above the horizontal and at least 176 cd at all other angles of elevation,

(3) be provided with a facility to enable the output of the lights (if and when activated) to be dimmed to an intensity not exceeding 60 cd while the helicopter is landed on the helideck,

(4) be visible from all possible approach directions and while the helicopter is landed on the helideck, regardless of heading with a vertical beam spread as describe above,

(5) use lights that are ‘red’ as defined by ICAO [6],

(6) flash at a rate of 120 flashes per minute and, if two or more lights are needed to meet this requirement, they are to be synchronised to ensure an equal time gap (to within 10%) between flashes. Provision is to be made to reduce the flash rate to 60 flashes per minute if a helicopter is provided on the helideck. The maximum duty cycle is to be no greater than 50%,

(7) have facilities at the helideck to manually override the automatic activation of the system,

(8) reach full intensity in not less than three seconds at all times,

(9) be designed so that no single failure will prevent the system operating effectively. In the event that more than one light unit is used to meet the flash rate requirement, a reduced flash frequency of at least 60 flashes per minute is acceptable in the failed condition for a limited period, and

(10) where supplementary ‘repeater’ lights are employed for the purposes of achieving the ‘on deck’ 360° coverage in azimuth, these are to have a minimum intensity of 16 cd and a maximum intensity of 60 cd for all angles of azimuth and elevation.

[5] The aeronautical meaning of a flashing red light is either “do not land, aerodrome not available for landing” or “move clear of landing area”.

[6] Reference is made to the ICAO Convention, Annex 14, Volume 1, Appendix 1, Colours for aeronautical ground lights.

10.2.4 Motion sensing system

10.2.4.1 Vessel motions represent a potential hazard to helicopter operations. The surface-type units are to be equipped with an electronic motion-sensing system capable of measuring or calculating the magnitude and rate of pitch roll and heave at the helideck about the true vertical datum. A motion-sensing system display is to be located at the aeromobile VHF radiotelephone station provided in accordance with the relevant requirements, so that this information may be relayed to the helicopter pilot. The form of the report is to be agreed with the aeronautical service provider.

Section 3 HELICOPTER DECK STRUCTURE

10.3.1 General requirements

The structure in the helicopter deck area is to be designed in accordance with the largest helicopter type which it is intended to use.

10.3.2 Design conditions

10.3.2.1 The following three working conditions are to be taken into consideration for the design of the helicopter deck:

(1) Homogeneously distributed loading:

A homogenously distributed loading of 2 kN/m^2 is to be taken over the entire helicopter deck.

(2) Helicopter landing impact loading: combination of the following loads is to be taken into account:

① For normal landing, vertical impact loading $P_H = 1.5P$ (*P* being the maximum lift-off weight), homogenously distributed on both tyre prints when landing (landing of both tyres at the same time is generally assumed). Where no data on actual print dimensions are available, the print dimensions may be taken as a square area of 0.30 m $\times$ 0.30 m. The structural members are to be designed for the most unfavorable landing position with regard to forces acting on them.

Where the upper deck of a superstructure or deckhouse is used as a helicopter deck and the spaces below are normally manned (control room, quarters, etc.), the above vertical impact loading $P_H = 1.75P$,

② Self-weight of the helicopter deck structure,

③ Where necessary, an homogeneously distributed loading of 0.5 kN/m^2, representing wet snow, ice or other environmental loads, is also to be considered.

(3) Stowed helicopter loading: combination of the following loads is to be taken into account:

① Wheel loads sustaining the maximum lift-off weight, with tyre print dimensions as assumed for the landing impact loading,

② Self-weight of the helicopter deck structure,

③ Where necessary, a homogenously distributed loading of 0.5 kN/m^2, representing wet snow, ice or other environmental loads, is also to be considered,

④ In addition, where stowage of helicopters is possible, the static and dynamic loads of helicopter and helicopter deck structure induced by the unit's motion and inclination under corresponding environmental conditions are to be considered. If no proper data are available, both the horizontal and vertical inertial forces may be taken as 0.5 times the loading corresponding to the self-weight of helicopter and helicopter deck structure.

10.3.2.2 For helicopters fitted with landing gear other than wheels, the tyre print dimensions are to be determined according to the data provided by manufacturers.

10.3.3 Strength check

10.3.3.1 The safety factors of structural members of the helicopter deck are given in Table 10.3.3.1.

Safety Factors of Structural Members on Helicopter Deck Table 10.3.3.1

Structural member / Design condition	Deck plating(1)	Longitudinals, beams and other secondary members	Girders, deck transverses and other main deck members, stanchions, bracing memmber, etc. (2)
Homogenously distributed loading	1.67	1.67	1.67
Landing impact loading	1.00(1)	1.00	1.10
Stowed helicopter loading	1.00	1.10	1.25

Notes: (1) For calculation of stresses, the deck plating may be considered as plating articulated at four sides and subjected to vertically distributed loading. CCS may allow proper increase of stress for landing impact loading, provided the rationale of the analysis is sufficiently conservative,

In addition to the above direct calculations, the thickness of the deck plating is to comply with the minimum thickness required by Table 10.3.3.1 (1).

(2) For members subjected to axial compression, the allowable bending stress or allowable critical buckling stress, whichever is less, is to be considered.

Minimum Thickness Requirement Table 10.3.3.1 (1)

Stiffener spacing (mm)	Minimum thickness (mm)
460	4.0
610	5.0
760	6.0

10.3.3.2 The allowable bending stress and allowable critical buckling stress of structural members of the helicopter deck are to be determined by the methods specified in Chapter 3, on the basis of safety factors obtained under 10.3.3.1.

10.3.3.3 The strength of structural members of the helicopter deck is to be calculated in accordance with the relevant requirements of Chapter 3, on the basis of 10.3.3.2.

Section 4 Fire Protection

10.4.1 General requirements

10.4.1.1 Fire protection of the helicopter deck and its associated facilities are to meet the following functional requirements:

(1) helideck structure is to be adequately to protect the unit from the fire hazards related to helicopter operations,

(2) fire-fighting appliances are to be provided to adequately protect the unit from the fire hazards related to helicopter operations,

(3) refuelling facilities and operations are to provide the necessary measures to protect the unit from the fire hazards related to helicopter operations, and

(4) helicopter facility operation manuals and training are to be provided.

10.4.1.2 The construction of the helidecks is to be of steel or other equivalent materials. If the helideck forms the deckhead of a deckhouse or superstructure, it is to be insulated to "A-60" class standard. Where the Administration permits aluminium or other low melting point metal construction that is not made equivalent to steel, the following provisions are to be satisfied:

(1) if the helideck is cantilevered over the side of the unit, after each fire that may have an effect on the structural integrity of the helideck or its supporting structures, the helideck is to undergo a

structural analysis to determine its suitability for further use, and

(2) if the helideck is located above the unit's deckhouse or similar structure, the following conditions are to be satisfied:

① the deckhouse top and bulkheads under the helideck are to have no openings,

② windows under the helideck are to be provided with steel shutters, and

③ after each fire on the helideck or supporting structure, a structural analysis for the helideck is to be carried out to determine its suitability for further use.

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

10.4.1.4 In close proximity to the helideck, the following fire-fighting appliances are to be provided and stored near the means of access to that helideck:

(1) at least two dry powder extinguishers having a total capacity of not less than 45 kg but not less than 9 kg each,

(2) carbon dioxide extinguishers of a total capacity of not less than 18 kg or equivalent,

(3) a foam application system consisting of monitors or foam-making branch pipes capable of delivering foam to all parts of the helideck in all weather conditions in which the helideck is intended to be available for helicopter operations. The minimum capacity of the foam production system will depend upon the size of the area to be protected, the foam application rate, the discharge rates of installed equipment and the expected duration of application:

① a minimum application rate of 6 l/m^2 within a circle having a diameter equal to the LD-value,

② a minimum of 5 min discharge capability is to be provided,

③ foam delivery at the minimum application rate is to start within 30 s of system activation,

(4) the principal agent is to be suitable for use with salt water,

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

(6) the provision and storage of fire-fighter's outfits are to comply with the relevant requirements of Section 1, Chapter 6 of PART SEVEN,

(7) at least the following equipment is to be stored in a manner so as to provide for immediate use and protection from the elements:

① adjustable wrench,

② blanket, fire-resistant,

③ cutters, bolt, 600 mm,

④ hook, grab or salving,

⑤ hacksaw, heavy duty complete with six spare blades,

⑥ ladder,

⑦ lift line 5 mm diameter and 30 m in length,

⑧ pliers, side-cutting,

⑨ set of assorted screwdrivers,

⑩ harness knife complete with sheath, and

⑪ crowbar.

10.4.1.5 Where the unit has helicopter refuelling, the following provisions are to be complied with:

(1) a dedicated area is to be provided for the storage of fuel tanks which is to be:

① as remote as is practicable from accommodation spaces, escape routes and embarkation stations, and

② isolated from areas containing a source of vapour ignition,

(2) the fuel storage area is to be provided with arrangements whereby fuel spillage may be collected and drained to a safe location,

(3) tanks and associated equipment are to be protected against physical damage and from a fire in an adjacent space or area,

(4) where portable fuel storage tanks are used, special attention is to be given to:

① design of the tank for its intended purpose,

② mounting and securing arrangements,

③ electric bonding, and

④ inspection procedures.

(5) storage tank fuel pumps are to be provided with means which permit shutdown from a safe remote location in the event of a fire. Where a gravity-fuelling system is installed, equivalent closing arrangements are to be provided to isolate the fuel source,

(6) the fuel pumping unit is to be connected to one tank at a time. The piping between the tank and the pumping unit is to be of steel or equivalent material, as short as possible, and protected against damage,

(7) electrical fuel pumping units and their associated control equipment are to be of a type suitable for the location and potential hazards,

(8) fuel pumping units are to incorporate a device which will prevent over-pressurization of the delivery or filling hose,

(9) equipment used in refuelling operations is to be electrically bonded, and

(10) "NO SMOKING" signs are to be displayed at appropriate locations.

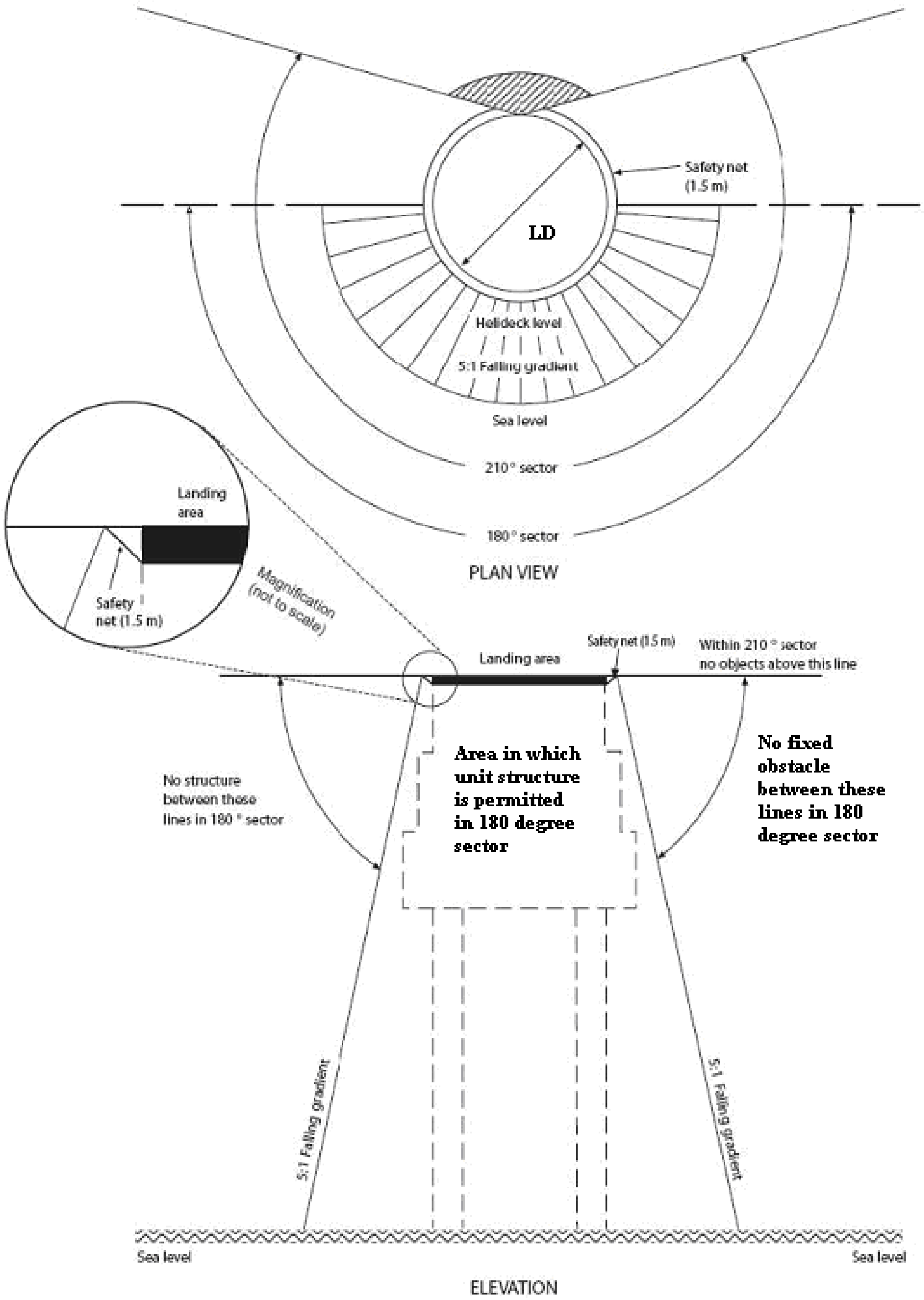

Fig. 10.2.1.2 (1) a Obstacle Free Areas – Below Landing Area Level

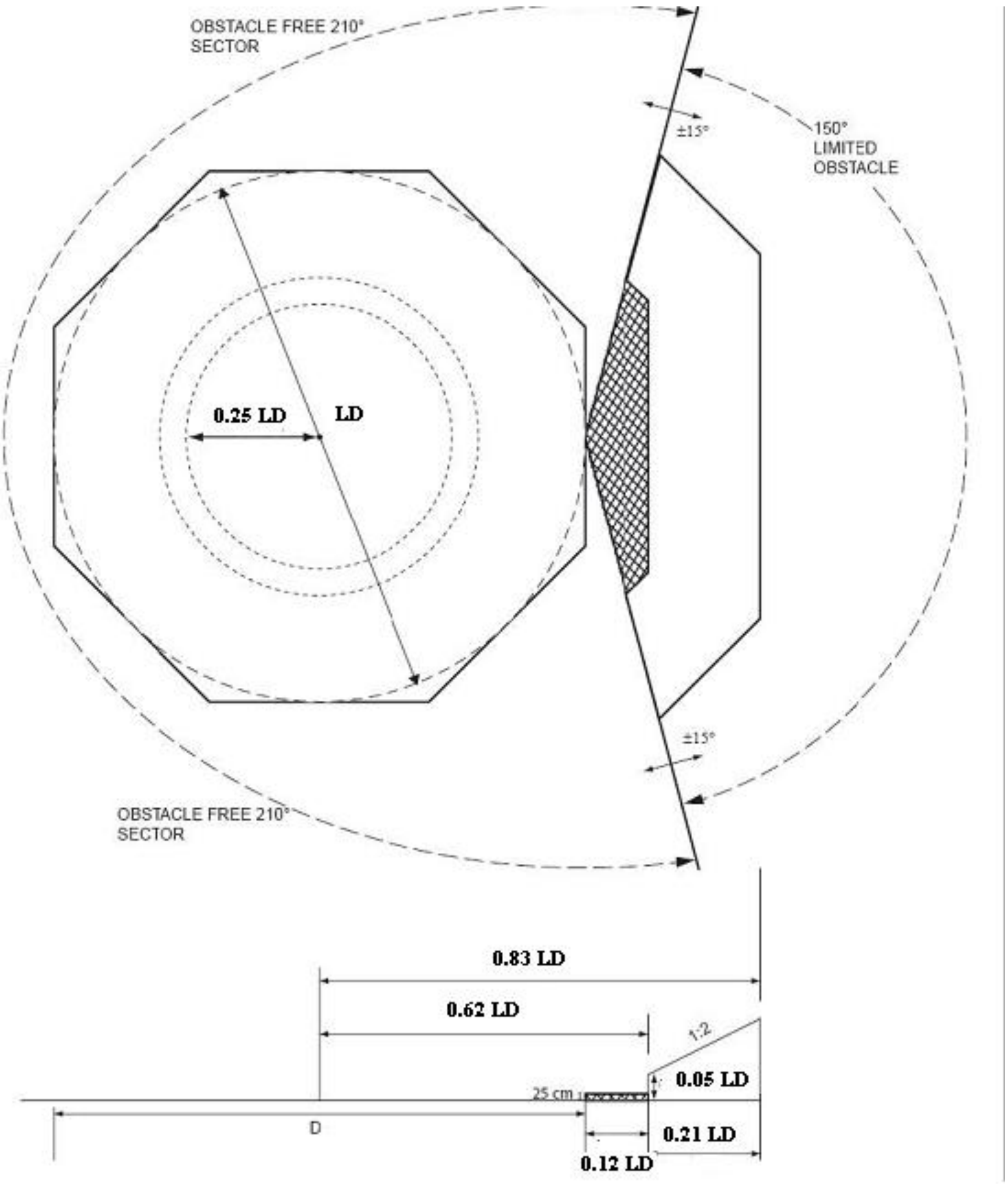

Fig. 10.2.1.2 (1) b Helideck Obstacle Limitation Sector: Single Main Rotor Helicopters

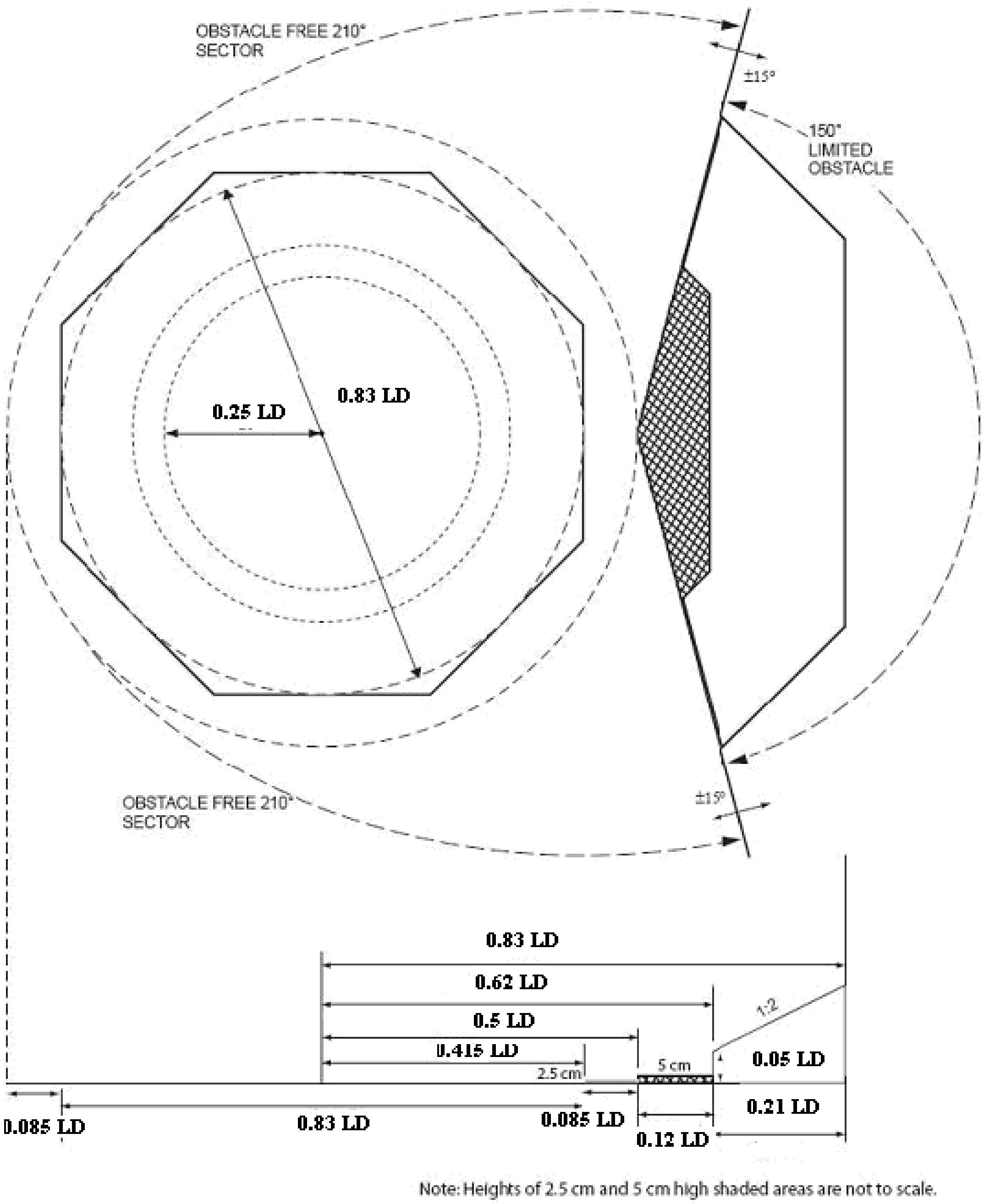

Fig. 10.2.1.2 (2) Helideck Obstacle Limitation Sector: Single Main Rotor Helicopters for Benign Climate Conditions as Accepted by the Coastal State

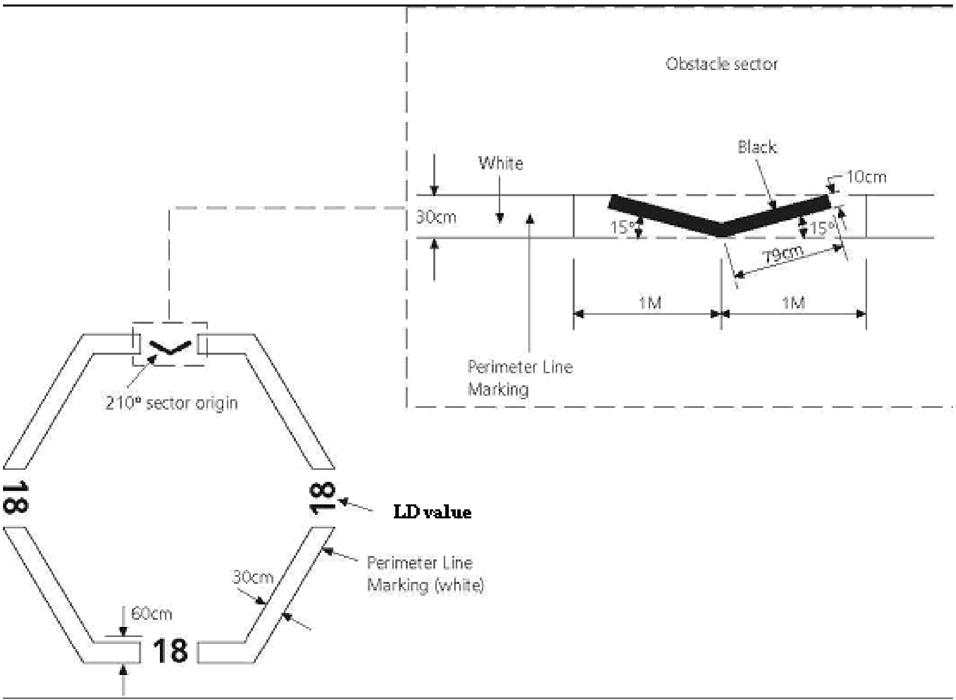

Fig. 10.2.3.3 (2) Obstacle-Free Sector Marking