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CLASSIFICATION NOTES

Wind Turbine Installation Units

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Section 1

Regulations

1.1 General

1.1.1 This Classification Note is applicable to the Classification and Certification of Wind Turbine Installation Units (hereinafter referred to as WTIUs).

1.1.2 Reference is made to Part 1, Chapter 1, Section 1 of the *Rules and Regulations for the Construction and Classification of Steel Ships* (hereinafter referred to as the Main Rules), for general information regarding IRS.

1.1.3 Reference is also made to Chapter 1 of the *Rules and Regulations for the Construction and Classification of Mobile Offshore Drilling Units* (hereinafter referred to as the MODU Rules) for general requirements pertaining to Classification of WTIUs.

1.2 Scope of Classification

1.2.1 The scope of items for classification includes the following items to the extent, as specified within this Classification Note:

a) Hull & Appendages (this includes the legs & foundations for self-elevating type units where applicable)
b) Machinery & Systems
c) Electrical Installations
d) Stability and Watertight integrity
e) Control & Safety systems relevant for safe operation of the WTIU
f) Cranes
g) Additional items in Section 1.3.

1.2.2 Reference is also made to Part 1, Chapter 1, Section 2 of the Main Rules for Classification Regulations.

1.2.3 The present Rules are not to be used for Units which perform other operations which support Wind Turbine Installation such as cable laying. For such type of Units/ Ships, requirements in Part 5, Chapter 13 of Main Rules are to be complied with.

1.2.4 Definitions

1.2.4.1 *Wind Turbine Installation Units*: Units which are involved in the operations of installation (see 1.2.4.11) of offshore wind turbines (fixed or floating).

1.2.4.2 *Self-Elevating Unit*: Self-elevating unit is a unit with movable legs capable of raising its hull above the surface of the sea and lowering it back into the sea. It has a hull with sufficient buoyancy to safely transport the unit to the desired location, after which the hull is raised to a predetermined elevation above the sea surface on its legs, which are supported on the seabed. The legs of such units may penetrate the sea bed, may be fitted with enlarged section or footings to reduce penetration, or may be attached to a bottom pad or mat. These are commonly non-self-propelled.

1.2.4.3 *Column Stabilized Unit*: Column stabilized units depend upon the buoyancy of widely spaced columns for flotation and stability for all afloat modes of operation or in the raising or lowering of the unit, as may be applicable. The columns are connected at their top to an upper structure supporting the installation equipment. Lower hulls or footings may be provided at the bottom of the columns for additional buoyancy or to provide sufficient area to support the unit on the seabed. Bracing members of tubular or

structural sections may be used to connect the columns, lower hulls or footings and to support the upper structure. Installation operations may be carried out in the floating condition, in which condition the unit is described as a semisubmersible, or when the unit is supported by the sea bed, in which condition the unit is described as a submersible. A semisubmersible unit may be designed of operate either floating or supported by the sea bed, provided each type of operation has been found to be satisfactory. These units do not have their own means of propulsion.

1.2.4.4 *Surface Type Unit*: These may be Ship type units or barge type units. Ship type units are seagoing ship or barge shaped units having a displacement type hull or hulls, of the single, catamaran or trimaran types, which have been designed or converted for installation operations in the floating condition. These usually have their own means of propulsion.

1.2.4.5 *Surface Type – Self Elevating Units*: These are Surface type units which are also self-elevating units. These have their own means of propulsion.

1.2.4.6 *Modes of operation*: A mode of operation is a condition or manner in which a unit may operate or function while on location or in transit.

1.2.4.7 *Operating condition(s):* Conditions wherein a unit is on location for installation, and combined environmental and operational loadings are within the appropriate design limits established for such operations. Unit is supported on the seabed in this condition, as applicable.

1.2.4.8 *Survival Condition(s):* Condition(s) during which a unit may be subjected to the most severe environmental loadings for which the unit is designed. Installation operations are discontinued due to the severity of the environmental loadings. Unit may be afloat or supported on the seabed as applicable.

1.2.4.9 *Transit Condition(s):* All unit movements from one geographical location to another, including the stages of retrieval and jacking/Preload.

1.2.4.10 *Accident Condition:* Condition where unit is subject to an accident such as dropped object, helicopter crash, accidental flooding, collision, etc.

1.2.4.11 *Installation:* Installation implies the activities of installation, major maintenance and major repairs of wind turbine components such as jacket/monopoles/tripods, tower, nacelle, blade and equipment.

1.2.4.12 Definitions for other items not covered in this Section may be referred from Chapter 1, Section 2 of the MODU Rules.

1.2.5 Class Notations

1.2.5.1 In addition to the character of class assigned by IRS, the WTIU will also be applicable for Class Notations as given below:

a. Type Notation
b. Service Restrictions
c. Additional Notations
d. Description

E.g. A typical class notation would be as follows:

卐 SUL, IY, WTIU, Surface Type – Self Elevating Unit – Unrestricted Navigation & Transit – Operation at XX, YY, ZZ sites.

1.2.5.2 Type Notation – A notation indicating the functional purpose of the WTIU. The following are applicable for the Type Notation

- Self-Elevating
- Column Stabilized
- Surface Type
- Surface Type – Self Elevating

1.2.5.3 Service Restrictions – This notation specifies the operational limitations of the WTIU considering its steady operation sites as well as the navigation & transit between sites. The following are the applicable notations:

- [Site (s) of Operation] – Unrestricted Navigation & Transit]
- [Site (s) of Operation] – [Specific Criteria for Navigation & Transit]

1.2.5.4 Additional Notations as listed in Section 1.3 may be assigned to the WTIU if it is in compliance with the relevant requirements stipulated within this Classification Note.

1.2.5.5 Description: In some cases, there may be a need to assign a 'description' to amplify the purpose or role of a unit. In general, there would be no specific rule requirements to be complied with for assignment of a description.

1.3 Additional Class Notations

1.3.1 INWATER SURVEY

1.3.1.1 This optional class notation may be assigned to WTIUs where In-water survey is carried out in lieu of a dry docking survey. The WTIU is to comply with applicable requirements as provided within Chapter 2, Section 3.2 of the MODU Rules.

1.3.2 DYNAMIC POSITIONING SYSTEMS

1.3.2.1 This optional class notation may be assigned to WTIUs provided with dynamic positioning systems which comply with the requirements in Part 5, Chapter 24 of the Main Rules. WTIUs are to be provided with at least DP2 systems.

1.3.3 HELIDECK

1.3.3.1 This optional class notation may be assigned to WTIUs provided with Helidecks.

1.3.3.2 The design and arrangement of Helideck and supporting facilities are to be in accordance with requirements provided for Helicopter decks and facilities within the MODU Rules. IRS may also consider design and arrangement of helidecks based on other recognized standards such as CAP 437 and API RP 2L

1.3.3.3 Structural Design of the Helideck is to be verified in accordance with Section 3.5.5.

1.3.4 DSV (Diving Support)

1.3.4.1 This optional class notation may be assigned to WTIUs provided with arrangements and equipment for diving support in accordance with the requirements in Part 5, Chapter 26 of the Main Rules.

1.3.5 CCS

1.3.5.1 This optional class notation may be assigned to WTIUs provided with propulsion and auxiliary machinery which can be controlled and monitored with continuous supervision from a centralized control station, in accordance with the requirements in Part 4, Chapter 7 of the Main Rules.

1.3.6 PMS

1.3.6.1 This optional class notation may be assigned to WTIUs which have opted for planned maintenance scheme for the propulsion and auxiliary machinery in accordance with the requirements in Part 1, Chapter 2 of the Main Rules.

1.3.7 SYJ

1.3.7.1 This class notation will be assigned to WTIUs complying with the requirements in Part 5, Chapter 22 of the Main Rules.

1.3.8 CRANE

1.3.8.1 This class notation will be assigned to WTIUs installed with cranes in compliance with API Spec 2C standard. This is a mandatory notation for all WTIUs. IRS may consider other recognized standards used for certification of cranes at its discretion. Additional requirements as specified in other Sections of this Classification Note are also to be complied with.

1.3.9 PM

1.3.9.1 This class notation is to be assigned to WTIUs when position mooring systems and equipment provided comply with the provisions of this Classification Note.

1.4 Plans, Documentation and Information

1.4.1 General

1.4.1.1 This sub-section is applicable to new build WTIUs as well as WTIUs built from conversions of existing vessels. For additional class notations; applicable drawings may be required by the corresponding Rules/ requirements, referred for those specific class notations.

1.4.1.2 In general, the following plans are to be submitted for information (including but not limited to):

- General arrangement of the WTIU
- List of machinery and electrical equipment
- Machinery layout and equipment layout for the unit
- Loading manual
- Loading instrument details
- Capacity plan
- Lines plan
- Design brief/ Design basis/ Technical specification document for the WTIU
- Site geotechnical data
- Typical wind turbine configurations (tower, blade, nacelle etc.) to be installed
- Operational manual (the manual will be reviewed in relation only to items relevant to Class)
- Towing arrangements

1.4.2 Hull

1.4.2.1 The plans, information and calculations for hull to be submitted for approval are listed in the Main Rules, Part 3, Chapter 1, Section 3.4 or MODU Rules Chapter 1, Section 4.3 (as applicable). Additional documentation required to be submitted is as described below:

- Hull structure i.w.o of supports for cranes, blade racks, towers, nacelles loaded on deck etc.
- Footings, mats, spud cans etc. (if applicable)
- Structural plans for legs and the interfacing structure with the hull (for self-elevating units)
- Helideck and support structure (if applicable).
- Deckhouses and accommodation (where provided)
- Trim and Stability booklet
- Corrosion protection and monitoring plan
- In-water survey plan (if applicable) as per Chapter 2, Section 3.3 of MODU Rules.

1.4.2.2 Analyses reports and calculations as required by Section 3.7 – 3.10 are to be submitted to IRS for review. If deemed necessary by IRS, the analysis model files used for the various analyses are to be submitted to IRS.

1.4.2.3 IRS may request additional details to ascertain the structural integrity of the hull, where required.

1.4.3 Machinery

1.4.3.1 In addition to those required by Chapter 1, Section 4.3 of the MODU Rules (as applicable), the following plans are to be submitted for approval:
For self-propelled units

- Jacking system (for surface type – self-elevating units)
- Machinery for Cranes
- Installation and Testing plans

For non-self-propelled units

- Power Generation equipment (or manufacturer make, model and rating information)
- Jacking system (for self-elevating units)
- Ballast Pumps and Control Systems (for column stabilized units)
- Installation and Testing plan for various machineries

1.4.3.2 For dynamic positioning systems, documents and plans are to be submitted as per requirements in Part 5, Chapter 24, Section 1.5 of the Main Rules.

1.4.4 Electrical Installations

1.4.4.1 Documentation as required by Chapter 1, Section 4.3 of the MODU Rules (as applicable) is to be submitted. In addition, the following is also required to be submitted:

- Design basis/philosophy describing the power generation systems and their operation under normal and emergency modes. The documentation should also demonstrate the provisions of power supply for essential services. The documentation should encompass all utilities and services.

- Electrical equipment arrangement and plan in hazardous areas (as applicable, a schedule of related electrical equipment is to be provided listing the certifying authority and the associated standards. Copies of the certificates also are to be provided.)

- IRS may request additional details, if deemed necessary.

1.4.5 Safety & Control Systems

1.4.5.1 Documentation as required by Part 4, Chapter 7, Section 1.3 of the Main Rules is to be submitted for approval. In addition, the following plans/documentation are also to be submitted for approval:

- Ballast Control systems (for column stabilized units)
- Layout and arrangement of Emergency Shutdown systems
- Design philosophy of the safety and control systems to demonstrate how the provided systems are adequate and effective during normal operations and emergency modes. The documentation should encompass safety and control systems for all utilities and services including those of the process equipment.
- Layout and arrangement of the control station(s) on the unit. In case of multiple control stations, the controls and monitoring by each control station and the modes of communication between the various control stations. The documentation is to also illustrate the ventilation arrangements for such control stations.
- Other miscellaneous documentation as may be referred to within the other chapters.
- Hazardous area plan of the unit (If explosive atmospheres are anticipated to be present on the Unit)

1.4.6 Fire Safety

1.4.6.1 Plans/ documentation required by Chapter 14, Section 1.2 of the MODU Rules is to be submitted for approval.

1.4.7 Operating Manual

1.4.7.1 Operating manuals are to be submitted to IRS. These will be reviewed and approved as applicable from the point of view of classification requirements as provided in this Classification Note.

1.4.7.2 The Operating manuals are to be readily available on-board the Unit. They are to include information applicable to the particular WTIU, so as to provide suitable guidance to the operating personnel with regard to safe operation of the unit for anticipated normal and emergency conditions. The manuals are to, in addition to providing the necessary general information about the unit, contain guidance on and procedures for the operations that are vital to the safety of personnel and the unit. The manuals are to be concise and be compiled in such a manner that they are easily understood. Each manual is to be provided with a contents list, an index and wherever possible be cross-referenced to additional detailed information which is to be readily available on board.

1.4.7.3 Specific information to be included (as applicable) within the manuals may be referred from Chapter 1, Section 4.6 of the MODU Rules.

1.4.8 Construction File/ Booklet

1.4.8.1 A set of plans showing the exact location and extent of application of different grades and strengths of structural materials, together with a description of the material and welding procedures employed, is to be placed aboard the WTIU. Any other relevant construction information is to be included in the Construction File, including restrictions or prohibitions regarding repairs or modifications.

1.4.9 Records

1.4.9.1 Records to be maintained on board the WTIU are to be in accordance with Chapter 1, Section 4.8 of the MODU Rules.

1.5 List of Recognized Codes and Standards

A list of recognized codes and standards that may be used for design of the WTIU are indicated below:

Standard/ Code	Title
API RP 2SK	Recommended Practice for Design and Analysis of Stationkeeping systems for Floating Structures
API RP 2L	Recommended Practice for Planning, Designing and Constructing Heliports for Fixed Offshore Platforms
API Spec 2C	Specification for Offshore-Pedestal mounted Cranes
CAP 437	Standards for Offshore Helicopters landing areas
EN 1993-1-1:2005 / EC3	Design of Steel Structures
HSE	Offshore Installations: Guidance for Design, Construction and Certification.
ISO 2394:2015	General principles on reliability for structures
ISO 4309:2017	Cranes – Wire Ropes: Care, maintenance, inspection and discard.
ISO 9089:2019	Marine structures — Mobile offshore units — Mooring positioning windlasses and winches.
ISO 19901-4:2016	Petroleum and natural gas industries — Specific requirements for offshore structures — Part 4: Geotechnical and foundation design considerations.
ISO 19901-7:2013	Petroleum and natural gas industries — Specific requirements for offshore structures — Part 7: Station keeping systems for floating offshore structures and mobile offshore units.
ISO 19904-1:2019	Petroleum and natural gas industries — Floating offshore structures — Part 1: Ship-shaped, semi-submersible, spar and shallow-draught cylindrical structures.
ISO 19905-1:2016	Petroleum and natural gas industries — Site-specific assessment of mobile offshore units — Part 1: Jack-ups.
NORSOK N-004	Design of Steel Structures

Section 2

Surveys

2.1 Surveys - General

2.1.1 General

2.1.1.1 All WTIUs are to be subjected to Periodical Surveys for the purpose of maintenance of Class. In general, the scope and schedule of surveys for hull, machinery and equipment is to be in accordance with the requirements given in Chapter 2 of the MODU Rules.

2.1.2 Means of Access for Inspection

2.1.2.1 Surface Type Units: Means of access for inspections of Surface Type Units may be provided in accordance with the requirements given in the Main Rules.

2.1.2.2 Self-elevating and Column Stabilized Units: Means of access for inspections of Self-elevating and Column Stabilized Units may be provided in accordance with the requirements given in Chapter 6, Section 5 of the MODU Rules.

Section 3

Design and Arrangements

3.1 General

3.1.1 General

3.1.1.1 Requirements of this Section are applicable to all types of WTIUs. Specific requirements for particular Unit types are also listed in sub-sections 3.7 to 3.10.

3.1.2 Scope and Application

3.1.2.1 The following items are covered within the scope of the present section, but not limited to:

- Hull & Appendages
- Crane Pedestal and foundations
- Foundations for stowage of the tower, blade racks, nacelle and other heavy equipment/items.
- Helideck and support structures
- Accommodation and Deckhouses
- Mooring & towing equipment
- Legs & mats/spud cans (as applicable) for Self-Elevating Units.
- Stability, Watertight integrity, Loadline
- Temporary Mooring

3.2 Materials

3.2.1 General

3.2.1.1 The materials used for construction or repair of hull and machinery of the WTIU are to be manufactured, inspected and tested in accordance with the requirements of Part 2 of the Main Rules.

3.2.1.2 Materials complying with recognized national or international standards such as API/ ISO/ NORSOK Standards with specifications equivalent to the above may also be accepted.

3.2.2 Classification of Structural Members

3.2.2.1 For Self-elevating and Column Stabilized units, the structural members are to be grouped into three application categories of increasing importance as follows:

- **Secondary**: Structural elements of minor importance, failure of which is unlikely to affect the overall integrity of the unit.
- **Primary**: Structural elements essential to the overall integrity of the unit.
- **Special**: Those portions of primary structural elements which are in way of critical load transfer points, stress concentrations, etc.

3.2.2.2 Typical examples of classification of structural elements for Self-elevating and Column stabilized units may be referred from Chapter 3, Section 2, Table 2.1.5 of MODU Rules.

3.2.2.3 For Surface-type units, members are to be classified in accordance with the Main Rules considering Special, Primary and Secondary categories to be equivalent to Class III, II and I respectively.

3.2.2.4 For Surface-type Self Elevating Units, the classification is to be as follows:

- For structural members constituting the hull, the classification will be in accordance with 3.2.2.3.

- For other members such legs, spud cans, mats etc., the classification will be in accordance with 3.2.2.2.

3.2.2.5 The plating of the deck used for stowage of wind turbine components (blades, nacelles, towers, etc.) and for supporting crane pedestal and foundation will be classified as Special category.

3.2.3 Determination of Steel grades for Structural Members

3.2.3.1 For Self-elevating and Column Stabilized units, the steel grades are to be selected in accordance with Chapter 3, Section 2, Table 2.1.4 of the MODU Rules.

3.2.3.2 For Surface type units, steel grades are to be determined in accordance with Part 3, Chapter 2, Table 2.3.4 of the Main Rules.

3.2.3.3 For Surface-Type Self Elevating Units, determination of steel grades is to be in accordance with the type of the member (whether hull structural member or non-hull structural member (legs, spud cans etc.) as shown in 3.2.2.4).

3.2.3.4 The design temperatures to be used for selection of steel grades are indicated in Section 3.2.4.

3.2.3.5 Selection of the steel grades for steels subject to stress relieving, cold forming, special manufacturing processes or other methods may be permitted taking into account the guidance provided in Chapter 3, Section 2.1.4 of the MODU Rules .

3.2.4 Design Temperatures

3.2.4.1 For selection of steel grades the design temperature is to be the minimum temperature which the material will be exposed to during the service life of the Unit.

3.2.4.2 The minimum service temperature of the steel is to be assumed equal to the lowest of the average daily atmospheric temperatures, based on meteorological data, for any anticipated area of operation. If data for the lowest daily average temperature is not available and some other criterion is used (e.g. lowest monthly average temperature), then such data will be specially considered by IRS

3.3. Design Principles

3.3.1 General

3.3.1.1 Various modes of operation of a WTIU are to be considered with realistic loading conditions, including gravity loadings together with relevant environmental loadings due to the effects of wind, waves, currents, ice and, where deemed necessary by the owner/designer, the effects of earthquake, sea bed supporting capabilities, temperature, fouling, etc. Where applicable, the design loadings indicated herein are to be adhered to for all types of WTIUs.

3.3.1.2 The owner/ designer is to specify the environmental conditions for which the unit is to be approved. Where possible, the design environmental criteria determining the loads on the unit and its individual elements is to be based upon significant statistical information and are to have a return period (period of recurrence) of not less than 50 years for the most severe anticipated environment. If a unit is restricted to seasonal operations in order to avoid extremes of wind and wave, such seasonal limitations are to be specified in the operating manual and also notes to the certificate of Classification.

3.3.1.3 Evaluations are to also include structural integrity of the unit in intact and accident/damaged conditions. For accident/ damaged conditions, the environment loads are to be considered for a return period not less than 1 year, unless suitably justified by the designer.

3.3.1.4 Limiting design data for each mode of operation is to be stated in the operating manual.

3.3.1.5 Design is to consider measures to minimize the impact of green water loads on structure and equipment. Adequate drainage is to be provided.

3.3.1.6 Critical connections that depend upon the transmission of tensile stresses through the thickness of the plating of one of the members may result in lamellar tearing and are to be avoided wherever possible. Where unavoidable, plate material with suitable through thickness (Z direction) properties may be required with appropriate inspection procedures.

3.3.1.7 Strengthening should be provided in way of structures which will be placed on the block during dry-docking. A docking arrangement plan is to be submitted to IRS.

3.3.1.8 Direct calculations will be considered by IRS for evaluation of loads and structural integrity.

3.3.2 Model Tests

3.3.2.1 Where considered necessary, IRS will require model tests to be performed to ascertain the response and motions of the unit for the environments expected during operations of the unit.

3.3.2.2 The model testing plan is to be submitted to IRS. The plan is to take into account the various levels of wind, wave, current loads expected to be encountered by the Unit during its operations and also consider various combinations (considering various directions of each type of load). The tests should be carried out for a sufficient duration so as to capture the requisite details and trends of the response and motions of the Unit.

3.3.2.3 The testing facilities and setup are to be acceptable to IRS.

3.3.3 Limit States

3.3.3.1 The following limit states are to be considered for design of the Unit:

- Ultimate (ULS)
- Fatigue (FLS)
- Accident (ALS)

3.3.3.2 Accident Limit State is to consider possibility of impact of dropped objects on deck during lifting operations of the WTIU, collisions with support vessels, accidental flooding (applicable for Column Stabilized Units) etc.

3.4. Loads

3.4.1 General

3.4.1.1 This sub-section indicates the applicable loads to be considered for assessment of the integrity of the WTIU structural members as well as the stability.

3.4.1.2 Consideration is to be given to dynamic effects of loads on structural members due to development and shedding of vortices.

3.4.1.3 Self-weights (Dead Load in form of steel weights, equipment weights, Personnel, material etc.), Live Loads and Buoyancy forces (as applicable) are to be considered.

3.4.1.4 Any other relevant loads apart from those described in Sections 3.4.2-3.4.6 are also to be considered.

3.4.2 Wind Loads

3.4.2.1 Wind loads are to be considered in accordance with Chapter 4, Section 2 of the MODU Rules.

3.4.2.2 Alternatively, for legs of self-elevating units, wind loads evaluated using other recognized standards such as API RP 2A will be accepted.

3.4.3 Wave Loads

3.4.3.1 Wave loads are to be considered in accordance with Chapter 4, Section 3 of the MODU Rules.

3.4.3.2 Alternatively for legs of self-elevating units, wave loads evaluated using other recognized standards such as API RP 2A will be accepted.

3.4.3.3 Reference is also made to ISO 19904, ISO 19905, NORSOK N – 004 etc. which provide additional guidance on evaluation of wave loads using suitable techniques depending upon the operating environment, type of unit and the required level of complexity to be considered.

3.4.4 Current Loads

3.4.4.1 Current loads are to be considered in accordance with Chapter 4, Section 4 of the MODU Rules.

3.4.4.2 Alternatively for leg of self-elevating units, loads evaluated using other recognized standards such as API RP 2A will be accepted.

3.4.5 Deck Loads

3.4.5.1 Except for work decks utilized for lifting and laydown of wind turbine components, all decks are to be designed considering loads as indicated in Chapter 4, Section 6 of the MODU Rules.

3.4.5.2 The design loading to be considered for work deck areas (over which the lifting operations will be performed) is not to be taken less than 20 tonnes/m^2 unless suitable justification is provided to select lower values.

3.4.5.3 For storage areas for wind turbine components, the actual loading anticipated is to be considered. This may be in terms of distributed loads (tonnes/m^2 or tonnes/m) or concentrated loads (tonnes).

3.4.5.4 The loads from dropped objects on the deck are also to be considered (as applicable).

3.4.6 Ice Loads

3.4.6.1 For WTIUs which operate in ice infested areas, ice loads should be calculated in accordance with Part 5, Chapter 21 of the Main Rules based upon the ice profiles the ship is anticipated to encounter.

3.4.7 Other Loads

3.4.7.1 Other loads must be considered during the design of the unit as applicable (e.g. pile driving loads etc.).

3.4.8 Load Combinations

3.4.8.1 Load combinations are to be established keeping in view all the applicable modes of operations of the WTIU, i.e. Normal Operation, Field Transit, Navigation, Survival etc.

3.4.8.2 Loads due to motions of the WTIU are to be considered within all combinations where the WTIU is operating in afloat condition.

3.5 Design Assessment for Common Structures

3.5.1 General

3.5.1.1 Where the WTIU is fitted with an acceptable corrosion protection system, the scantlings may be determined considering limit states in Section 3.3.3 in conjunction with allowable stresses given in Section 3.6 without consideration of corrosion allowances.

3.5.1.2 Where no corrosion protection system is fitted or where the system is considered by IRS to be inadequate, an appropriate corrosion allowance will be required on scantlings determined from Section 3.6.

3.5.1.3 The common structural members are also to comply with requirements of the Main Rules or MODU Rules as applicable. Supporting structures designed as grillage or stiffened plates may alternatively comply with other recognized standards such as NORSOK N-004, AISC or EC3.

3.5.2 Pile Driving Equipment Support Structure

3.5.2.1 For WTIUs for whom pile driving equipment is installed onboard, the supporting structure is to be suitably reinforced so as to withstand all combinations of static and dynamic forces & moments arising during operation of the pile driving equipment, transit and survival conditions.

3.5.2.2 The structural integrity of the support structure is to be verified using direct calculations using the acceptance criteria specified in Section 3.6.

3.5.2.3 The fatigue life of the structural details of the support structures is not to be less than 20 years.

3.5.3 Crane Pedestal and Supporting Structures

3.5.3.1 Crane Pedestal is to be designed in accordance with API Spec 2C for Offshore Cranes. IRS may consider other recognized standards in lieu of API Spec 2C.

3.5.3.2 The crane pedestal and support structure design is to take into account all combinations of static and dynamic forces & moments arising during normal crane operations, transit and survival conditions. Motions of the WTIU should also be considered while determination of the loading conditions and combinations.

3.5.3.3 The structural integrity of the crane pedestal and support structures is to be verified using direct calculations. The acceptance criteria to be used are specified in Section 3.6.

3.5.3.4 The fatigue life of the structural details and connections in the pedestal and supporting structure is not to be less than 20 years.

3.5.4 Wind Turbine Foundation Piles, Towers, Blade racks, Nacelle and other wind turbine component stowage areas and support structures

3.5.4.1 The foundations and support structures for the areas used for stowage of wind turbine components such as foundation piles, towers, blade racks, nacelles and other wind turbine components are to be designed by taking into account all combinations of static and dynamic forces and moments arising during normal crane operations, transit and survival conditions. Motions of the WTIU are also to be considered while determination of the loading conditions and combinations.

3.5.4.2 The structural integrity of the foundation and support structures is to be verified using direct calculations. The acceptance criteria to be used are specified in Section 3.6.

3.5.4.3 Damaged conditions of the WTIU leading to static heel should also be considered. The acceptance criteria in Section 3.6 are to be used.

3.5.4.4 Fatigue life of the structural details is not to be less than 20 years.

3.5.5 Helideck

3.5.5.1 The requirements in Chapter 6, Section 2.2.2 of the MODU Rules are to be complied with.

3.5.6 Bulwarks and Guard Rails

3.5.6.1 Except for helicopter landing decks and areas not normally occupied, the unprotected perimeter of all floor or deck areas and openings is to be protected with efficient guard rails or bulwarks of height not less than 1 [m] above the deck. Where this height would interfere with the normal operation of the unit, a lesser height may be considered. The clear opening below the lowest course of the guard rails is not to exceed 230 [mm]. The other courses are not to be more than 380 [mm] apart. In the case of units with rounded gunwales the guard rail supports are to be placed on the flat of the deck.

3.5.7 Life Saving Appliances (LSA) Supporting Structure

3.5.7.1 The strength of the LSA supporting structure is to be evaluated so that safe launching of LSA is ensured (with the safe working load, considering the certified number of persons onboard). This evaluation may be preferably demonstrated using direct calculations.

3.5.7.2 Adverse combinations of the heel and trim of the WTIU are to be considered within the analysis.

3.5.7.3 Acceptance criteria to be used are to be in accordance with Section 3.6.

3.5.8 Deckhouses

3.5.8.1 For Self-Elevating Units, Deckhouses located near the side shell of a unit may be required to have scantlings similar to those of an unprotected house front. Other deckhouses are to have scantlings suitable for their size, function and location.

3.5.8.2 For Column Stabilized Units, Deckhouses fitted to the upper hull are to be designed in accordance with the Main Rules, with due consideration given to their location and to the environmental conditions in which the unit will operate.

3.5.8.3 For Surface Type Units, deckhouses are to be designed in accordance with the Main Rules.

3.5.9 Protective Coatings of dedicated seawater ballast tanks

3.5.9.1 All dedicated seawater ballast tanks are to be coated during construction. Pre-load tanks on self-elevating units are also to be considered dedicated seawater ballast tanks. Mat tanks and spud cans on such units are not to be considered as dedicated seawater ballast tanks.

3.5.9.2 Maintenance of the protective coating system is to be included in the overall unit’s maintenance scheme. The effectiveness of the protective coating system is to be verified during the life of a unit through periodical surveys.

3.5.10 Anti-Fouling Systems

3.5.10.1 If anti-fouling systems are installed, they are to conform to the requirements of the International Convention on the Control of Harmful Anti-fouling Systems on Ships, 2001 (AFS Convention).

3.6 Structural Analysis

3.6.1 General

3.6.1.1 The present section outlines the modeling, stress evaluation and acceptance criteria for direct calculations based analyses.

3.6.1.2 Sufficient conditions, representative of all modes of operation, are to be considered, to enable critical design cases to be determined. Calculations for relevant conditions are to be submitted for review. The analysis is to be performed using an appropriate calculation method/program and is to be appropriately documented and referenced.

3.6.2 Modeling and Analysis Techniques

3.6.2.1 The modeling & analysis techniques to be used for global analysis are discussed within the Sections 3.7 to 3.10 for each Unit Type.

3.6.2.2 For modeling of structural members of common structures (Section 3.5), 3D finite element model may be created using plate/shell elements or combination of plate/shell and beam elements (for modeling plating & stiffeners respectively). Grillage models may also be used alternatively. 3D FEM models are to use a mesh size which is sufficient to accurately simulate the stress and strain gradients due to the applied loads and boundary conditions. Good engineering judgment may be used or convergence studies with different mesh sizes may be performed to arrive at a suitable mesh size.

3.6.2.3 For common structures, appropriate extent of the model is to be considered. This may be taken to be bound by primary structural members (e.g. girders, stringers, bulkheads etc.). The boundary conditions at the ends of such models may be assumed as fixed.

3.6.3 Loads and Load Combinations

3.6.3.1 The loads and load combinations to be used for global analysis are referred to the specific sections 3.7-3.10 for each Unit Type.

3.6.4 Stress Evaluation

3.6.4.1 For each loading condition considered, the following stresses are to be determined and these are not to exceed the appropriate allowable stresses given in 3.6.5.

a. Stresses due to static loadings only, in calm water conditions, where the static loads include service load such as operational gravity loadings and weight of the unit, with the unit afloat or resting on the sea bed, as applicable.

b. Stresses due to combined loadings, where the applicable static loads in (a) are combined with relevant design environmental loadings, including acceleration and heeling forces.

3.6.4.2 Consideration of local stresses: Local stresses, including those due to circumferential loading on tubular members, are to be added to the primary stresses to determine total stress levels.

3.6.4.3 Combination of stress components: The scantlings are to be determined on the basis of a recognized method which combines, in a rational manner, the individual stress components acting on the various structural elements of the unit. Reference is made to ISO 19904, ISO 19905, NORSOK N-004, EC 3, API RP 2A etc. as the recognized standards which provide the basis for consideration of such combinations.

3.6.4.4 The critical buckling stress of structural elements is to be considered, where appropriate, in relation to the computed stresses.

3.6.4.5 Determination of Bending Stresses:

a. Effective flange area - When computing bending stresses, the effective flange areas are to be determined in accordance with Part 3 of the Main Rules.

b. Eccentric axial loading - Where appropriate, elastic deflections are to be taken into account when determining the effects of eccentricity of axial loading and the resulting bending moments superimposed on the bending moments computed for other types of loadings.

3.6.4.6 Determination of shear stress: When computing shear stresses in structural members, only the effective shear area of the web is to be considered. In this regard, the total depth of the girder may be considered as the web depth.

3.6.4.7 Equivalent stress criteria for plated structure: For plated structures, members may be designed according to the von Mises equivalent stress criterion, where the equivalent stress σ_{eq} is defined as follows:

$$\sigma_{eq} = \sqrt{\sigma_x^2 + \sigma_y^2 - \sigma_x\sigma_y + 3\tau_{xy}^2}$$

σ_x Stress in X direction
σ_y Stress in Y direction
τ_{xy} Shear Stress in X-Y Plane

3.6.4.8 Stress concentration: The effect of notches, stress raisers, and local stress concentrations are to be taken into account in the design of load carrying elements.

3.6.4.9 Analysis and details of structural connections: Unless connections of structural members are specifically detailed as hinged joints, proper consideration is to be given in the structural analysis to the degree of restraint at such connections. Structural connections are to be detailed in such a manner as to ensure full transmission of stresses between members joined, and to minimize stress concentrations. The following details are to be considered, as may be appropriate:

a. Shear web plates, continuous through the joint to transmit tension and compression loads between members by means of shear in the web plate.
b. Flaring or transitioning of the joint, to lower stress levels or to minimize concentrations of stress or both.
c. Thicker joint material, high strength steel, or both, consistent with good weldability, to reduce the effect of high stress levels.
d. Brackets or other supplemental transition members, with scallops and proper end attachment details to minimize high stress concentrations.

3.6.5 Acceptance Criteria

3.6.5.1 General

The scantlings of effective structural elements of the primary frame of the unit, analysed in accordance with 3.6.1, are to be determined on the basis of the allowable stresses specified herein.

3.6.5.2 Individual Stresses

Individual stress components and where applicable, direct combinations of such stresses, are not to exceed the allowable stresses specified in Table 3.6.5.2. For Accidental Limit States, a factor of 0.95 can be considered in lieu of 0.8 for the static + dynamic case.

3.6.5.3 Allowable Stresses in Plate elements used in finite element analysis

3.6.5.3.1 The equivalent stress in plate elements clear of discontinuities is generally not to exceed 0.7 and 0.9 of the yield strength of the material, for the static and static +dynamic loading conditions, respectively. For accidental limit state the equivalent stress in plate elements is not to exceed the yield strength of the material.

3.6.5.3.2 Evaluation of the buckling/ultimate strength failure mode considering axial compressive and shear stresses in plate elements is to be performed using acceptable standards (reference is made to Rules for Bulk Carriers and Oil Tankers, Volume 2, Chapter 8) or non-linear analysis techniques

Table 3.6.5.2: Allowable Stresses

Type of Stress	Static	Static+Dynamic
Tensile	$0.6\sigma_y$	$0.8\sigma_y$
Bending	0.6 x min(σ_y,σ_{cr})	0.8 x min(σ_y,σ_{cr})
Shear	min ($0.4\sigma_y$, $0.6\tau_{cr}$)	min ($0.53\sigma_y$, $0.8\tau_{cr}$)
Compressive	0.6 x min(σ_y,σ_{cr})	0.8 x min(σ_y,σ_{cr})

σ_y: Specified minimum yield stress of the material (N/mm^2)
σ_{cr}, τ_{cr}: critical compressive and shear buckling stress, respectively, [N/mm^2] depending on the dimensions, stiffening, boundary conditions, loading pattern and material of the structural member under consideration.

3.6.5.4 Combined Stresses – Members subject to combined axial load and bending

a) When structural members are subjected to axial compression in combination with compression due to bending, the computed stresses are to comply with the following requirements:

$$\frac{\sigma_a}{F_a} + \frac{\sigma_b}{F_b} < 1; \text{ For } \frac{\sigma_a}{F_a} \leq 0.15$$

$$\frac{\sigma_a}{F_a} + \frac{C_{mo}\sigma_b}{\left(1 - \frac{\sigma_a}{F'_e}\right)F_b} < 1; \text{ For } \frac{\sigma_a}{F_a} > 0.15$$

b) in addition at member ends the following criteria is to be complied:

$$\frac{\sigma_a}{0.6\sigma_y} + \frac{\sigma_b}{F_b} < 1; \text{ For Static Loading}$$

$$\frac{\sigma_a}{0.8\sigma_y} + \frac{\sigma_b}{F_b} < 1; \text{ For Combined Loading}$$

c) When structural members where axial tensile stresses are combined with bending tensile stresses, the following criteria is to be complied:

$$\sigma_a + \sigma_b < 0.6\sigma_y; \text{ For Static Loading}$$

$$\sigma_a + \sigma_b < 0.8\sigma_y; \text{ For Combined Loading}$$

Where:

σ_a: Axial Stress whether compressive or tensile

σ_a: Bending Stress whether compressive or tensile

F_a: Allowable axial stress, which is the minimum of the following:

i) Allowable axial stress in Table 3.6.5.2

ii) Overall buckling stress multiplied with factor of safety as given in 3.6.5.5.

iii) Local buckling stress multiplied with factor of safety for axial stress.

F_b: Allowable bending stress, from table

F'_e: $\sigma_E/1.92$, the limiting Euler buckling stress. This may be increased by not more than 33% for combined loading.

$$\sigma_E = \frac{\pi^2 E}{\left(\frac{kL}{r}\right)^2}$$

E: Modulus of Elasticity of Material

L: Unsupported length of member

r: radius of gyration of member cross section

K: Effective length factor, not to be considered less than 1.0.

C_{mo} Coefficient as follows:

i) For compression members in frames subject to joint translation (sideways)

C_{mo}= 0.85

ii) For restrained compression members in frames braced against joint translation and not subject to transverse loading between their supports, in the plane of bending

$$C_{mo} = min\left(0.6 - 0.4\frac{M_1}{M_2}, 0.4\right)$$

where M_1/M_2 is the ratio of the smaller to larger moments at the ends of that portion of the member unbraced in the plane of bending under consideration. M_1/M_2 is positive when the member is bent in reverse curvature and negative when it is bent in single curvature

iii) For compressive members in frames braced against joint translation in the plane of loading and subject to transverse loading between their supports, the value of C_{mo} may be determined by rational analysis. However, in lieu of such analysis the following values may be used

C_{mo}= 0.85 for members whose ends are restrained

C_{mo}= 1 for members whose ends are unrestrained.

3.6.5.5 Buckling

a) Overall Buckling: For members in compression, the critical buckling stress for the overall column buckling mode is determined as below:

$$\sigma_{cr} = \sigma_E \text{ For } \sigma_E \leq 0.5\sigma_y$$

$$\sigma_{cr} = \sigma_y\left(1 - \frac{\sigma_y}{4\sigma_E}\right) \text{ For } \sigma_E > 0.5\sigma_y$$

The factor of safety η for overall column buckling is to be determined as below:

i) Static loading

$$\eta = 0.52 \text{ For } \sigma_E \leq 0.5\sigma_y$$

$$\eta = \frac{0.6}{\left(1 + 0.15\sqrt{\left({}^{\sigma_y}/_{2\sigma_E}\right)}\right)} \text{For } \sigma_E > 0.5\sigma_y$$

ii) Combined Loading

$$\eta = 0.70 \text{ For } \sigma_E \leq 0.5\sigma_y$$

$$\eta = \frac{0.8}{\left(1 + 0.15\sqrt{\left({}^{\sigma_y}/_{2\sigma_E}\right)}\right)} \text{For } \sigma_E > 0.5$$

b) Local Buckling: Members which are subjected to axial compression or compression due to bending, are to be investigated for local buckling, as appropriate, in addition to overall buckling as specified in a) above.
Unstiffened or ring-stiffened cylindrical shells subjected to axial compression or compression due to bending, and having proportions which satisfy the following criterion, are to be checked for local buckling in addition to the overall buckling.

$$\frac{D}{t} > \frac{E}{9\sigma_y}$$

D: Mean diameter of the cylindrical shell

t: Thickness

3.6.5.6 Plastic analysis: The use of inelastic methods for design considering material and geometric non-linear behavior will be specially considered by IRS. The designer is advised to contact IRS well in advance if such methods are intended to be used.

3.7 Self – Elevating Units

3.7.1 General

3.7.1.1 This section contains specific requirements to be complied by Self – Elevating WTIUs.

3.7.2 Structural Response Assessment

3.7.2.1 The global and local structural response is to be evaluated so as to determine the stresses within each structural component of the unit. A suitable analysis technique is to be selected, for this, reference is made to recognized standards such as ISO 19905. IRS will specially consider other recognized standards or rules for analysis.

3.7.2.2 Analysis report(s) are to be submitted to IRS. The assumptions considered during the assessment, structural modeling and selection of the analysis methods/techniques (e.g. whether static or dynamic, linear/non-linear considering material inelasticity, geometric non-linearities, regular time domain or stochastic analysis, geotechnical non-linear behavior etc.) have to be justified and properly documented in the analysis report.

3.7.2.3 The following conditions are to be considered (as applicable) for the structural response evaluation:

i) Normal operations (Wind Turbine installation) with unit in elevated mode and spud cans/mats on seabed

ii) Operations during arrival and retrieval of the unit to and from the site, including preload operations

iii) Transit conditions

iv) Survival conditions

v) Accident conditions (e.g. ship collision with the unit legs in the elevated condition, dropped object etc. as applicable)

3.7.2.4 Analysis report(s) have to be submitted to IRS. The assumptions considered during the assessment and choice of the method used for modeling/idealization have to be justified and properly documented in the analysis report.

3.7.2.5 Analyses should consider the conditions and criteria specified within Sections 3.7.3 – 3.7.10.

3.7.2.6 Analyses are to establish the structural integrity of the following items but not limited to:

i) Unit's hull primary structure
ii) Structural Foundations and support structures for Cranes, Wind Turbine Components, heavy equipment etc.
iii) Legs
iv) Structure in way of the hull jack houses and the legs.
v) Structural Connections in way of legs with spud can/mat structure
vi) Joints between the leg chords & brace members
vii) Spud cans/footings/mats structures

3.7.3 Air Gap

3.7.3.1 The unit is to be designed for a crest clearance of either 1.2 m or 10% of the combined storm tide, astronomical tide and height of the maximum wave crest above the mean low water level, whichever is less, between the underside of the unit in the elevated position and the crest of the design wave. This crest elevation is to be measured above the level of the combined astronomical and storm tides.

3.7.3.2 The maximum penetration of the footings/mats as applicable considering the different soil conditions in which the unit is to operate is to be accounted for within the air gap calculations.

3.7.4 Seabed conditions

3.7.4.1 Classification will be based upon the designer's assumptions regarding sea bed conditions. These assumptions are to be recorded in the Operating Booklet. It is the responsibility of the operator to ensure that actual conditions do not impose more severe loadings on the unit.

3.7.4.2 Geotechnical data and reports for the seabed sites where the unit is to operate are to be submitted to IRS.

3.7.5 Safety against Overturning

3.7.5.1 Units which are to rest on the sea bed are to have sufficient positive downward gravity loadings on the support footings or mat to withstand the overturning moment due to the combined environmental loads from any direction with the lateral deflection of the legs taken into consideration.

3.7.5.2 The safety against overturning is to be assessed using the most unfavourable direction and combination of environmental, gravity, variable and loads during lifting and installation of wind turbine components in both normal on-site operation and severe storm conditions as follows:

- Normal on-site operation: Units are assumed to have minimum design variable loads and the crane with load in the most unfavourable position
- Survival Condition: Units are assumed to have minimum design variable loads and the crane in the stowed position.
- Accident Conditions: Collision of ship with the Unit's leg structures, Dropped objects etc. in elevated mode (as applicable)

3.7.5.3 Units with individual footings/spudcans are to have righting moments calculated about the most unfavourable axis though the center of one or more footings and are to have a minimum factor of safety of 1.1 for the conditions defined above.

3.7.5.4 Units with mat foundation, are to have righting moments calculated about the most highly stressed edge of the mat and are to have a minimum factor of safety of 1.3 for the conditions defined above.

3.7.6 Preload

3.7.6.1 For units without bottom mats, all legs are to have the capability of being preloaded to the maximum applicable combined gravity plus overturning load. The approved preload procedure is to be included in the Operating Booklet.

3.7.7 Field Transit Moves

3.7.7.1 Field transit moves may only be undertaken when the predicted weather is such that the anticipated motions of the unit will not exceed the design condition. The duration of a field transit move may be for a considerable period of time and should be related to the accuracy of weather forecasting in the area concerned. Such a move should not normally exceed a twelve hour voyage between protected locations, or locations where the unit may be safely elevated; however, during any portion of the move, the unit is not normally to be more than a six hour voyage to a protected location or a location where the unit may be safely elevated. The approved condition is to be included in the Operating Manual.

3.7.8 Structural Considerations

3.7.8.1 The hull is to be considered as a complete structure having sufficient strength to resist all induced stresses while in the elevated position and supported by all legs. All fixed and variable loads are to be distributed, using an accepted method of rational analysis (reference is made to ISO 19905), from the various points of application to the supporting legs. The scantlings of the hull are then to be determined consistent with this load distribution, in accordance with the permissible stresses in Section 3.6.

3.7.8.2 The Unit's hull primary structure scantlings are to be in accordance with Part 3 of Main Rules for plating and structural members forming the external hull shell, tank boundaries main decks etc. Part 3 of Main Rules may be used to determine scantlings for other structural items or other recognized standards (e.g. AISC, NORSOK N-004, EC 3) may be used in lieu.

3.7.8.3 For the elevated position, special attention is to be paid to the distribution of the loads from the supporting points (legs) into the hull structure, taking account also of possible load redistributions/conditions resulting from lack of support at one leg.

3.7.8.4 The conditions valid for towing/ conveyances, for the elevating and lowering procedures and for the operating phases, while standing on the sea floor, shall be clearly indicated in the Operating Manual (see Section 1.4.7).

3.7.9 Legs

3.7.9.1 Legs may be either shell type or truss type. Shell type legs may be designed as either stiffened or unstiffened shells. In addition, individual footing/spud can are to be fitted or legs are to be permanently attached to a bottom mat.

3.7.9.2 The primary scantlings of the legs are to be in accordance with recognized codes and standards (e.g. API RP 2A, Eurocode 3, AISC, NORSOK N-004 (depending upon the type of the leg member, whether tubular/non-tubular). The member connection joints strength is also to be evaluated using the above recognized standards as applicable. Structural analyses using acceptance criteria in Section 3.6 are also to be performed.

3.7.9.3 Legs in the field transit condition - The legs are to have sufficient strength for the bending moment 'M' obtained from the following formula:

$$M = M_1 + 1.2\, M_2 \text{ [N-m]}$$

M_1 = Dynamic bending moment caused by a 6- degree single amplitude of roll or pitch at the natural period of the unit [N-m]

M_2 = Static bending moment due to gravity caused by a 6-degree legs' angle of inclination [N-m].
Special consideration, based on submitted data, will be given to angles of inclination less than 6 degrees when the separation between the bottom of the hull and the top of the mat or the lower tip of the spud can exceeds 15% of the maximum separation.

The legs are to be investigated for any proposed leg arrangement with respect to vertical position during field transit moves, and the approved positions are to be specified in the Operating Booklet. Such investigation is to include strength and stability aspects.

3.7.9.4 Legs in the ocean transit condition – Legs are to be designed for acceleration and gravity moments resulting from the motions in the most severe anticipated environmental transit conditions, together with corresponding wind moments.

Alternatively, legs are to have sufficient strength for the bending moment 'M' obtained from the following formula:

$$M = M_3 + 1.2\, M_4 \text{ [N-m]}$$

M3 = Dynamic bending moment caused by a 15- degree single amplitude of roll or pitch at a 10- second period [N-m]

M_4 = Static bending moment due to gravity caused by a 15-degree legs' angle of inclination [N-m]

For ocean transit conditions, it may be necessary to reinforce or support the legs, or to remove sections of them. The approved condition is to be included in the Operating Booklet.

3.7.9.5 Condition - while lowering to bottom: Legs are to be designed to withstand the dynamic loads which may be encountered by their unsupported length just prior to touching bottom, and also to withstand the shock of touching bottom while the unit is afloat and subject to wave and wind motions.

3.7.9.6 The maximum design motions, bottom conditions and sea state while lowering legs are to be clearly indicated in the Operating Booklet, and the legs are not to be permitted to touch bottom when the site conditions exceed the allowable.

3.7.9.7 The effect of possible scouring action (loss of bottom support) is to be considered. The effect of skirt plates, where provided, is to be given special consideration.

3.7.9.8 Condition while elevating the unit – the legs are to be designed to withstand the loads acting on both, the unit's hull and the legs themselves, during the elevating procedure. The environmental conditions are the same as foreseen for lowering of the legs. The analysis may have to be done for several intermediate positions of the hull.

3.7.9.9 Unit in the elevated position – when computing the stresses in legs, the maximum overturning load on the unit, using the most adverse combination of applicable variable loadings together with the loading as outlined in present chapter, is to be considered. Forces and moments due to lateral frame deflections of the legs are to be taken into account.

3.7.9.10 Retrieval Condition – Consideration is to be given to excessive load on one leg(s) during retrieval due to incomplete extraction of spud can(s) (e.g. excessive penetration of one or more spud can(s) may lead to condition where all spud cans are not simultaneously retrieved from seabed together resulting in unit transferring load to seabed via one or multiple legs during the retrieval operation).

3.7.10 Structure in way of jacking or other elevating arrangements

3.7.10.1 Load carrying members which transmit loads from the legs to the hull are to be designed for the maximum design loads and are to be so arranged that loads transmitted from the legs are properly diffused into the hull structure.

3.7.10.2 The structure surrounding the legs (points of support) shall be designed with particular regard to the introduction of local concentrated forces; main load bearing elements should be continuous in the vertical direction. Regarding the maximal force to be transmitted, preloading of the legs shall be considered during this determination.

3.7.10.3 For loose elements, e.g. bars, rods, bolts, pins, serving for transmission of forces to support the unit, special requirements may be imposed by IRS regarding dimensioning safety factor and testing.

3.7.11 Strength Analysis of Spud cans

3.7.11.1 Scantlings of primary structural members of spud cans are to be determined from the Main Rules. For this purpose, the spud can external boundaries and associated stiffening may be considered as a deep tank bulkhead and the pressures to be considered correspond to the maximum bearing pressures from the soil. Consideration is also to be given if the spud can is freely vented.

3.7.11.2 Strength analysis of Spud can structures (if installed) on the unit is to be submitted to IRS to ensure its' integrity against the loads arising during the Unit's operations in elevated mode.

3.7.11.3 Strength analysis is to be performed using direct calculations with finite element analysis.

3.7.11.4 Extent of structural modeling, boundary conditions and loads can be determined as elaborated in ISO 19905.

3.7.12 Bottom Mats

3.7.12.1 When the bottoms of the legs are attached to a mat, particular attention is to be given to the attachment and the framing and bracing of the mat, in order that the loads transmitted between the legs and the mat are properly distributed. The boundary plating of tanks which are not vented freely to the sea is not to be less in thickness than would be required by the Main Rules for tanks, using a head to the design water level, taking into account the astronomical and storm tides. The mat is to be further investigated while resting on the sea bed with 20% of the bottom bearing area washed away due to scouring. The effects of skirt plates, where provided, will be specially considered. Mats are to be designed to withstand the shock of touching bottom while the unit is afloat and subject to wave motions.

3.7.13 Fatigue Strength

3.7.13.1 Fatigue strength is to be evaluated for all structural details mentioned below to ensure that the fatigue life is not less than 20 years. The number of wave encounters to be considered is not to be less than 10^8.

3.7.13.2 For units which are converted from existing units/ships the residual fatigue life should not be less than 10 years. The above is considering a normal class survey and inspection regime.

3.7.13.3 It is recognized that Units may need to operate on site for prolonged periods and hence may not available for surveys in line with the normal class survey regimes, for these Units the required fatigue life will be specially considered by IRS.

3.7.13.4 The following items are to be checked but not limited to:

i) Spud cans
ii) Spud can connection with legs
iii) Leg members and joints in the splash zone
iv) Legs and hull structural members in way of the jackhouse
v) Foundations of machinery/equipment (e.g. Crane) & Cargo (Wind Turbine Components)

3.7.13.5 Reference is made to ISO 19905 for acceptable techniques of fatigue evaluation. It is recommended to use the hotspot stress approach for fatigue evaluation.

3.7.13.6 It is to be considered during the fatigue strength evaluation that WTIUs would have relatively higher cycles of the hull elevating & lowering on the legs as compared to Units operating as MODUs.

3.8 Column Stabilized Units

3.8.1 General

3.8.1.1 This section contains additional requirements to be complied by Column Stabilized WTIUs.

3.8.1.2 The requirements within this sub-section are applicable to Column Stabilized Units which have configurations as follows:

i) Units with ring pontoons and typically four to eight columns along with upper hull structure

ii) Units with twin pontoons and fitted with braces along with upper hull structure

3.8.1.3 For Column Stabilized Units with different configurations from 3.8.1.2, the requirements of this section will be specially considered by IRS. Additional requirements may be applied by IRS depending upon the configuration.

3.8.2 Structural Response Assessment

3.8.2.1 The global and local structural response is to be evaluated so as to determine the stresses within each structural component of the unit. A suitable analysis technique is to be selected, for this, reference is made to recognized standards such as ISO 19904 or NORSOK N-004. IRS will specially consider other recognized standards or rules for analysis.

3.8.2.2 Analysis report(s) are to be submitted to IRS. The assumptions considered during the assessment, structural modeling and selection of the analysis methods/technique (e.g. whether static or dynamic, linear/non-linear considering material inelasticity, geometric non-linearities, regular time domain or stochastic analysis, geotechnical non-linear behavior etc.) used have to be justified and properly documented in the analysis report.

3.8.2.3 The following conditions are to be considered as applicable for the structural response evaluation:

i) Normal operations (Wind Turbine installation)
ii) Transit conditions
iii) Survival conditions
iv) Accident conditions (accidental flooding, dropped object, collision etc.)

3.8.2.4 Analysis report(s) have to be submitted to IRS. The assumptions considered during the assessment and choice of the method used for modeling/idealization have to be justified and properly documented in the analysis report.

3.8.2.5 Analyses should consider the conditions and the factors of safety provided within Sections 3.8.3 – 3.8.10.

3.8.2.6 Analyses are to establish the structural integrity of the following items but not limited to:

i) Unit's upper hull and lower pontoons/lower hull structure
ii) Columns
iii) Braces (as applicable)
iv) Connections of columns to the upper and lower hulls/lower pontoons
v) Connections of braces (as applicable) to the columns and upper hull
vi) Connections between lower ring pontoons (as applicable)
vii) Structural foundations in way of machinery, equipment, mooring, towing, decks for stowage of wind turbine components etc.
viii) Details in way of moonpools

3.8.3 Air Gap

3.8.3.1 For Unit operating in sea-bed stabilized mode, air Gap is to be maintained as specified in Section 3.7.3.

3.8.3.2 For Units operating in afloat modes, unless deck structures are designed for wave impact, reasonable clearance between the deck structures and the wave crests is to be ensured for all afloat modes of operation, taking into account the predicted motion of the unit relative to the surface of the sea. Calculations, model test results, or prototype experiences are to be submitted for consideration.

3.8.4 Structural

3.8.4.1 Special considerations regarding stresses- For unit of this type, the highest stresses in some members may be associated with less severe environmental conditions than the maximum specified by the owner (designer). Where considered necessary, account is to be taken of the consequent increased possibility of encounter of significant stress levels, by either or both of the following:

a. Suitable reduction of the allowable stress levels for combined loadings given in Section 3.6.
b. Detailed investigation of the fatigue properties in order to evaluate the possibility of high stresses in association with probability of occurrence.
c. Where a column, lower hull or footing is a part of the overall structural frame of a unit, consideration is also to be given to stresses resulting from deflections due to the applicable combined loading.

Particular attention is also to be given to the details of structural design in critical areas such as bracing members, joint connections, etc.

3.8.4.2 For contact with other ships, the unit is to be equipped with sufficient fenders and particular attention is to be given to the reinforcement of shell plating, frames, girders, etc.

3.8.4.3 Local structures in way of fairleads, winches, etc., forming part of the position mooring system, are to be designed to withstand forces equivalent to the breaking strength of the mooring line.

3.8.4.4 Conditions for towing/ conveyances, for ballasting/de-ballasting procedures and mooring operations are to be clearly indicated in the Operating Manual.

3.8.5 Upper Structure (above columns)

3.8.5.1 The scantlings of the upper hull structure are not to be less than those required by the Main Rules in association with the loadings indicated on the deck loading plan. (which are not to be less than the minimum specified in Section 3.6). In addition, when the upper structure is considered to be an effective member of the overall structural frame of the unit, the scantlings are to be sufficient to withstand actual local loadings plus any additional loadings superimposed due to frame action, within the stress limitations given in Section 3.6.

3.8.5.2 When the upper structure is designed to be waterborne in any mode of operation or damaged condition, or to meet stability requirements, it will be subject to special consideration.

3.8.5.3 Special attention is to be paid to the foundations (supporting structure) and fastening of cranes, wind turbine components stowed onboard and similar installations.

3.8.5.4 The upper structure, including the opening parts of the well, etc., is to be good in the continuity of longitudinal strength and transverse strength. Scantlings of structural elements are to be in accordance with Part 3, Chapter 9 of the Main Rules.

3.8.5.5 Where it can be demonstrated that the upper structure is not subject to wave loading or is required in any mode of operation to be watertight or weathertight, there need be no overall consideration of tightness or buoyant load forces.

3.8.5.6 Where the upper structure is designed to be buoyant in any mode of operation or damaged condition or to meet any stability requirement, it will be subject to special consideration.

3.8.5.7 Storage tanks built into or on upper decks are to have scantlings as required for ship's integral tanks.

3.8.6 Columns, Lower Hulls, Footings

3.8.6.1 Main stability columns, lower hulls or footings may be designed as either framed or unframed shells. In either case, framing, ring stiffeners, bulkheads or other suitable diaphragms which are used are to be sufficient to maintain shape and stiffness under all the anticipated loadings in association with established shell analysis methods.

3.8.6.2 Port-lights or windows including those of the non-opening type, or other similar openings, are not to be fitted in columns.

3.8.6.3 Where columns, lower hulls or footings are designed with stiffened plating, the minimum scantlings of plating, framing, girders, etc., may be determined in accordance with the requirements of the Main Rules for ship's integral tanks:

a. Tank spaces : Where the internal space is a tank, the head h is to be taken to a point located at two-thirds of the distance from the top of the tank to the top of the overflow, or to a point 0.91 [m] above the top of the tank, whichever is greater. For tanks intended to carry contents with a specific gravity in excess of 1.05, the head is to be increased by a factor equal to the ratio of the specified gravity to 1.0.
b. Where an internal space is a void compartment, the design head used in association with the above is not to be less than that corresponding to the maximum allowable waterline of the unit in service.
c. Areas subjected to wave immersion: For all areas subject to wave immersion, a minimum head of 6.0 m is to be used.
d. Minimum scantling: In general, the scantlings are not to be less than required for watertight bulkheads in association with a head equivalent to the maximum damaged waterline.

3.8.6.4 Where columns, lower hulls or footings do not incorporate framing members and are designed as shells, either unstiffened or ring stiffened, the minimum scantlings of shell plating and ring stiffeners are to be determined on the basis of established shell analysis methods (e.g. please refer NORSOK N-004) using the appropriate factor of safety and the design heads as given in 3.8.6.3.

3.8.6.5 Additional Structural Requirements

a. Provision for wave and current loadings: Scantlings of columns, lower hulls or footing as determined by 3.8.6.3 and 3.8.6.4 are minimum requirements for hydrostatic pressure loads. Where wave and current forces are superimposed, the local structure of the shell is to be increased in scantlings as necessary, to meet the strength requirements of Section 3.6.
b. Provision for frame action: When the column, lower hull or footing is an effective member of the overall structural frame of the unit, the scantlings are to be sufficient to meet these requirements plus any additional stresses superimposed due to frame action, within the stress limitations of Section 3.6.
c. Consideration for high local loading : Particular consideration is to be given to structural details, reinforcement, etc., in areas subject to high local loadings, or to such loadings that may cause shell distortion; for example
    - bottom bearing loads
    - partially filled tanks
    - continuity through joints
    - wave impacts
d. the effect of scouring action (partial loss of bottom support) is to be considered as follows:
    - for a broad mat type (lower hull) support, 20% of the bottom bearing area is to be considered unsupported.
    - when there are individual footings or pads, any one such support is to be considered unsupported on 50% of its bottom bearing area.
    - other configurations will be specially considered.
    - Where skirt plates are provided their effectiveness in preventing loss of bottom support due to scouring will be specially considered.

3.8.6.6 Bracing Members

a. Stresses in bracing members due to all anticipated loadings are to be determined in accordance with the following requirements in conjunction with the relevant requirements of Section 3.6.
b. Arrangement of braces: Where braces are essential for the structural integrity of the unit, they should be so arranged that they are protected as far as possible against boat impact (collisions) and other forces resulting from normal operations.
c. Loading conditions: Bracing members are to be designed to transmit loadings and to make the structure effective against environmental forces and, when the unit is supported by the seabed, against the possibility of uneven bearing loads. Although designed primarily as brace members of the overall structure under the designated loadings, the bracing must also be investigated, if applicable, for superimposed local bending stresses due to buoyancy, wave and current forces.
d. Effect of wave impact: Where relevant, consideration is to be given to local stresses due to wave impact.
e. Reinforcement of tubular bracing members: When bracing members are of tubular section, ring frames may be required to maintain stiffness and roundness of shape.
f. Watertight bracing members: Underwater bracing members are normally to be made watertight. When bracings are watertight, they are to be suitably designed to prevent collapse from external hydrostatic pressure. They are to be accessible for internal inspection, or else adequate means are to be provided in order to detect leakages at an early stage.

3.8.7 Structural Redundancy

3.8.7.1 When assessing structural redundancy for column stabilized units, the following assumed damage conditions apply:

a. The unit's structure is to be able to withstand the loss of any one slender bracing member without causing overall collapse of the unit's structure.
b. Structural redundancy is to be based on the applicable design load requirements of Section 3.4 except:
    a. When considering environmental loads such as wind force, wave forcing etc. minimum one year return period may be assumed for intended operations
    b. When considering environmental factors, the applied loads are not to be less than 80% of the loads associated with survival condition.
    c. Notwithstanding the kind of stress, the allowable stress at the combined loads condition is to be following formula
    d. When taking into consideration redistribution of forces due to yielding or buckling and overall strength is to be satisfied with (a), the criteria of allowable stress may be exceeded for local stress.

3.8.7.2 The structural arrangement of the upper hull is to be considered with regard to the structural integrity of the unit after the failure of any primary girder.

3.8.8 Fatigue Strength

3.8.8.1 Fatigue strength is to be evaluated for all structural details mentioned below to ensure that the fatigue life is not less than 20 years for newbuildings. The number of wave encounters to be considered is not to be less than 10^8

3.8.8.2 The remaining fatigue life is not to be less than 10 years for Units converted from existing ships/units.

3.8.8.3 The fatigue life specified in 3.8.8.1 apply to Units with normal class survey and inspection regime. It is recognized that Units may need to operate on site for prolonged periods and hence may not available for surveys in line with the normal class survey regimes, for these Units the required fatigue life will be specially considered by IRS.

3.8.8.4 The following items are to be checked but not limited to:
i) Structural details at the columns connection to upper and lower hulls
ii) Structural details at the column connection to the braces as applicable
iii) Ring Pontoon intersections
iv) Connections between primary structural members within the upper hull, lower hull/pontoon and the columns.
v) Stiffener-webframe connections in the upper hull and the lower hull/pontoons.

3.8.8.5 Hotspot stress approach is recommended to be used to evaluate the fatigue life of the connections mentioned in 3.8.8.3 (i) – (iv).

3.8.8.6 Procedures as described in NORSOK N – 004 or ISO 19904 with regard to Column Stabilized Units will be deemed adequate by IRS for performing the fatigue analyses.

3.9 Surface Type

3.9.1 General

3.9.1.1 Compliance is required with provisions within the Main Rules.

3.9.1.2 The deck area in way of large hatches is to be suitably compensated where necessary to maintain the strength of the WTIU.

3.9.1.3 The structure in way of heavy concentrated loads (e.g. wind turbine components, crane etc.) is to be suitably reinforced.

3.9.1.4 Local structure in way of fairleads, winches, etc., forming part of the position mooring system, is to be designed to the breaking strength of the mooring line.

3.10 Surface Type – Self Elevating

3.10.1 General

3.10.1.1 Compliance is required with Sections 3.7 and 3.9 for unit in the elevated mode and afloat mode respectively.

3.11 Welding Workmanship and Inspections

3.11.1 General

3.11.1.1 In general, the welding requirements are to be in accordance with the Main Rules. The following additional requirements also need to be complied with.

3.11.2 Use of Thickness in excess of 50 mm

3.11.2.1 Special precautions, with regard to joint preparation, pre-heat, welding sequence, heat input and interpass temperature, are to be taken for welding thick sections. Ultrasonic inspection to ensure the absence of injurious laminations may be required for material used where through-thickness (Z direction) properties are important. Stress relieving, when specified, is to be carried out using an approved method.

3.11.3 Inspection of Welds

3.11.3.1 All welds are to be subject to visual inspection. Representative nondestructive testing is to be carried out to the satisfaction of the Surveyor. Such testing is to be carried out after all forming and post weld heat treatment. Welds which are inaccessible or difficult to inspect in service may be subjected to increased levels of nondestructive inspection. A plan for nondestructive testing is to be submitted.

3.11.3.2 As a minimum the following welds are to be subjected to 100% nondestructive testing (Radiographic, ultrasonic, magnetic particle, dye-penetrant, or equivalent). In addition to surface nondestructive testing, at least 20% of full penetration welded joints in primary structure and all full penetration welded joints in special application structure are to be subjected to 100% radiographic or ultrasonic inspection. Additional nondestructive testing may be required by the Surveyor.

a) Self-elevating units and Surface Type – Self Elevating Units - Weld joints of lattice type leg structure (including chords, braces, racks, and rack attachments), circumferential joints of cylindrical-type legs, structure in way of leg guides and jack house attachments to deck, and attachments of legs to spud cans or mat.
b) Column stabilized units - Weld attachments of columns to pontoons or lower hulls, braces to column, columns to upper hull, braces to upper hull, brace-to-brace intersections, and in way of any temporary access closures or inserts in main structures.

3.12 Towing Arrangements

3.12.1 General

3.12.1.1 The design and arrangement of towing fittings are to have regard to both normal and emergency conditions.

3.12.1.2 Arrangements, equipment and fittings provided in accordance with Section 3.12.1 are to meet the requirements of Part 3, Chapter 15 of the Main Rules,

3.12.1.3 Each fitting or item of equipment is to be clearly marked with any restrictions associated with its safe operation, taking into account the strength of its attachment to the unit’s structure.

3.13 Stability, Watertight Integrity and Loadline

3.13.1 General

3.13.1.1 For Self-Elevating and Column Stabilized Units, the intact and damage stability, watertight integrity and Loadline are to comply with Chapter 5 of the MODU Rules.

3.13.1.2 For Surface Type Units, the intact stability requirements in accordance with Part 3, Chapter 1 of the Main Rules are to be complied with. For this purpose, the Unit may be considered as a general cargo ship. Additionally for Surface Type – Self Elevating Unit, the Unit is also to comply with the requirements as provided in Chapter 5 of the MODU Rules.

3.13.1.3 Attention is also drawn to requirements of the IMO SPS Code (MSC.266(84) as amended) and requirements by the statutory authorities.

3.13.2 Crane Operations

3.13.2.1 For Surface Type Units, stability of the Unit is also to be assessed for loading conditions when crane is in operation to consider the effect of the relevant lifting forces. For this purpose, it may be assumed that the Unit is stationary (i.e. zero speed).

3.13.2.2 Stability assessment is to be in accordance with the IMO 2008 Intact Stability Code (as amended), Part B, Chapter 2, 2.9.

3.14 Temporary Mooring Equipment and Systems

3.14.1 General

3.14.1.1 Anchors, chain cables, wire ropes and windlass necessary for temporary mooring of the units are to be provided in accordance with the requirements of Part 3, Chapter 15 of Main Rules.

3.14.1.2 Where equipment is provided for keeping position during operations, the same may be accepted in lieu of the equipment specified in 3.14.1.1 provided it can be released in an emergency during any transit condition and its mooring effect can be considered equivalent or more.

3.15 Position Keeping Systems and Equipment

3.15.1 General

3.15.1.1 Position keeping systems and equipment if provided are to be in accordance with Chapter 10, Section 3 of the MODU Rules.

Section 4

Machinery

4.1 General

4.1.1 General

4.1.1.1 The following are applicable to the machinery essential for the safe operation of the WTIU.

4.1.1.2 All propulsion and auxiliary machinery including shafting and propellers, steering arrangements, boilers and other pressure vessels, control systems, jacking systems, pumping and piping systems necessary for the safe operation of the WTIU are to satisfy the requirements specified in this Section. In addition, other applicable requirements for construction and installation in accordance with the Main Rules are also to be complied with. Requirements of the MODU Rules are to be applied where specified in this Section.

4.1.1.3 Alternative design and arrangements proposed in lieu of requirements within this chapter will be specially considered by IRS. IRS *Guidelines for Alternative and Risk based Design Evaluation* may be referred in this regard.

4.2 Machinery Inclinations

4.2.1 Static Conditions

4.2.1.1 All machinery, components and systems essential to the safe operation of a WTIU are to be designed to operate under the following static conditions of inclination:

a) Surface Type Units & Surface-Type Self Elevating Units

From upright and in level trim to an angle of inclination of 15° either way and simultaneously trimmed up to 5° by the bow or stern.

b) Self- Elevating Units

From upright to an angle of inclination of 10° in any direction.

c) Column Stabilized Units

From upright to an angle of inclination of 15° in any direction.

4.2.1.2 IRS may permit or require deviations from these angles, taking into consideration the type, size and service conditions of the WTIU.

4.2.2 Dynamic Conditions

4.2.2.1 For Self- Propelled Units, main propulsion machinery and all auxiliary machinery essential to the propulsion and the safety of the drilling unit are to be capable of operating under the static conditions required by 2.1 and the following dynamic conditions:

a) Surface Type Units & Surface-Type Self Elevating Units: 22.5° rolling and simultaneously pitching 7.5° by bow or stern

b) Self- Elevating Units: 15° in any direction

c) Column Stabilized Units: 22.5° in any direction.

4.2.2.2 IRS may permit or require deviations from these angles, taking into consideration the type, size and service conditions of the WTIU.

4.2.3 Inclinations for Emergency Source of Power

4.2.3.1 The emergency generator and its prime mover and any emergency accumulator battery are to be capable of supplying the power at the following angles of inclination:

a) For Surface Type/ Surface Type-Self Elevating Units 22.5° about the longitudinal axis and/or when inclined 10° about the transverse axis on a surface unit.

b) Self- Elevating Units

15° in any direction on a self-elevating unit.

c) Column Stabilized Units

25° in any direction on a column-stabilized unit

4.3 Jacking Systems for Self Elevating Units

4.3.1 In general, the requirements given in Chapter 12, Section 1.3 of the MODU Rules are to be complied with.

4.4 Machinery for non-propelled WTIUs

4.4.1 In general, the requirements given in Chapter 12, Section 1.4 of the MODU Rules are to be complied with.

4.5 Machinery for self-propelled WTIUs

4.5.1 In general, the requirements given in Chapter 12, Section 1.5 of the MODU Rules are to be complied with.

4.6 Piping Systems

4.6.1 In general, piping systems are to comply with the requirements given in Chapter 12, Section 2 (except 2.1.2 and 2.1.3) of the MODU Rules..

4.7 Ballast Control Systems for Column Stabilized Units

4.7.1 In general, the requirements given in Chapter 12, Section 3 of the MODU Rules, are to be complied with.

4.7.2 A failure modes effects analysis (FMEA) for the ballast control system is to be submitted to IRS.

4.8 Bilge Systems

4.8.1 In general, the requirements given in Chapter 12, Section 4 of the MODU Rules are to be complied with.

4.9 Tank Vents, Overflow and Sounding Pipes

4.9.1 In general, the requirements given in Chapter 12, Section 5 of the MODU Rules are to be complied with.

4.10 Flammable Oils

4.10.1 In general, the requirements given in Chapter 12, Section 6 of the MODU Rules are to be complied with.

4.11 Steam Pipe Systems

4.11.1 In general, the requirements given in Chapter 12, Section 7 of the MODU Rules are to be complied with.

4.12 Air Pressure Systems

4.12.1 In general, the requirements given in Chapter 12, Section 8 of the MODU Rules are to be complied with.

Section 5

Electrical Installations

5.1 General

5.1.1 Scope

5.1.1.1 The following requirements are applicable to electrical equipment essential to the safe operation of the WTIU. Attention is to be given to any requirements of the statutory authorities.

5.1.1.2 In general, Units complying with the requirements for electrical installations provided in the MODU Rules are deemed to have satisfied the requirements of this Section subject to their verification to ensure the essential services as described in 5.1.2.2.

5.1.2 Design & Construction

5.1.2.1 Electrical propelling machinery and associated equipment together with auxiliary services essential for the safety of the WTIU are to be constructed and installed in accordance with the relevant requirements of the IRS Steel Vessel Rules and as specified herein.

5.1.2.2 The following services are considered to be essential:

i) Navigation and special purpose lights, lights for all machinery spaces, control stations, alleyways, stairway and exits
ii) Propulsion equipment
iii) Power generation equipment
iv) Bilge pumps
v) Fire Pumps
vi) Ballast pumps for column stabilized Units
vii) Dynamic Positioning Systems
viii) Jacking systems (for self-elevating Units)
ix) Ventilation for maintaining propulsion
x) Where applicable, ventilation of hazardous areas and those areas maintained at an overpressure to exclude the ingress of dangerous gases.
xi) Any other systems/ equipment, to whom the loss/ failure of power supply whom could pose an immediate threat to the safety of the WTIU.

5.1.2.3 The design and installation of other equipment including that used for Wind Turbine Installation operations is to be such that there is minimal risk of fire due to its failure. It is to, as a minimum, comply with an acceptable specification, standard or code, revised where necessary, for the ambient conditions.

5.1.2.4 Electrical installations are to be such that

.1 all electrical services necessary for maintaining the unit in normal operational and habitable conditions will be assured without recourse to the emergency source of power.

.2 electrical services essential for safety will be assured in case of failure of the main source of electrical power.

.3 electromagnetic compatibility of electrical and electronic equipment is assured; and

.4 the safety of personnel and unit from electrical hazards will be assured

5.1.3 Cathodic Protection

5.1.3.1 Details of impressed-current cathodic protection systems, including installation and locations, are to be submitted for approval, when such systems are installed.

5.1.4 Hazardous Areas

5.1.4.1 In general, presence of areas with explosive atmospheres during operations is not anticipated on WTIU. However, if explosive atmospheres are anticipated during operations, then these areas will be classified as hazardous areas in accordance with Chapter 11 of the MODU Rules.

5.1.4.2 Electrical installations in hazardous areas are to be in accordance with Chapter 13, Section 2 of the MODU Rules.

5.1.5 Alternative Design

5.1.5.1 Alternative design and arrangements proposed in lieu of requirements within this Section will be specially considered by IRS. Reference is made to the IRS *Guidelines for Alternative and Risk based Design Evaluation*.

5.2 Main Source of Electric Power

5.2.1 Non Self-Propelled Units

5.2.1.1 Every unit is to be provided with a main source of electrical power which is to include at least two generating sets.

5.2.1.2 The power of these sets is to be such that it is still possible to ensure the functioning of the services specified in 5.1.2.4, except for power servicing wind turbine installation operations, in the event of any one of these generating sets being stopped.

5.2.1.3 All other relevant requirements of Chapter 13, Section 3.1 of the MODU Rules are also to be complied with.

5.2.2 Self-Propelled Units

5.2.2.1 Unit is to comply with relevant requirements of Chapter 13, Section 3.2 of the MODU Rules.

5.3 Emergency Source of Electric Power

5.3.1 Non Self-Propelled Units

5.3.1.1 Every Unit is to be provided with a self- contained emergency source of Power.

5.3.1.2 Relevant requirements in Chapter 13, Section 4.1 of the MODU Rules are to be complied with.

5.3.2 Self-Propelled Units

5.3.2.1 Unit is to comply with relevant requirements of Chapter 13, Section 4.2 of the MODU Rules.

5.4 Precautions against shock, fire and other hazards of electrical origin

5.4.1 Requirements provided in Chapter 13, Section 5 of the MODU Rulesare to be complied with.

5.5 Alarms and Internal Communication

5.5.1 Requirements provided in Chapter 13, Section 7 of the MODU Rules are to be complied with.

Section 6

Fire Safety

6.1 General

6.1.1 Requirements

6.1.1.1 In general arrangements for fire safety are to be provided in accordance with Part 6 off the Main Rules.

6.1.1.2 The application of 6.1.1.1 is to be as follows:

a) For Units carrying less than 60 persons on board, the relevant requirements of, Part 6 of Main Rules, for cargo ships are to be applied.

b) For Units carrying 60 or more persons on board, the fire safety requirements will be specially considered by IRS. The designer is advised to get in touch with IRS early for such Units.

6.1.1.3 The requirements of the Statutory Authorities of the country in which the WTIU is to be registered are also to be complied with.

6.1.1.4 Attention is also drawn to requirements of the IMO MODU Code (A.1023(26) as amended) and the IMO SPS Code (MSC.266(84) as amended).

6.1.1.5 Units carrying less than 60 persons and which are designed and constructed in accordance with the IRS MODU Rules are deemed to have satisfied the requirements of this chapter.

6.1.1.6 Units complying with the Fire Safety requirements of the IMO SPS Code (MSC.266(84) as amended) are deemed to have satisfied the requirements of this chapter provided they comply with Sections 6.2 & 6.3 (as applicable).

6.1.1.7 Units for which presence of explosive atmospheres is anticipated during their operations are in addition to comply with the relevant requirements of Chapter 14 of the MODU Rules.

6.1.2 Alternative Design

6.1.2.1 Alternative design and arrangements proposed in lieu of requirements within this Section will be specially considered by IRS. Reference is made to the Part 6, Chapter 6 of the Main Rules and the IRS *Guidelines for Alternative and Risk based Design Evaluation*.

6.2 Fire Safety of Helicopter Facilities

6.2.1 Requirements

6.2.1.1 For Units equipped with helicopter facilities, the requirements of Chapter 14, Section 9 of the MODU Rules are to be complied with.

6.3 Carriage of Dangerous Goods

6.3.1 Requirements

6.3.1.1 For Units intending to carry dangerous goods, attention is drawn to Chapter 11, Section 4 of the MODU Rules.

6.3.1.2 Units which carry dangerous goods are to additionally comply with the requirements of Part 6, Chapter 7, Section 2 of the Main Rules.

End of Classification Note