TÜRK LOYDU

Chapter 60 – Offshore Units and Installation – Mobile Offshore Units

January 2024

This latest edition incorporates all rule changes. The latest revisions are shown with a vertical line. The section title is framed if the section is revised completely. Changes after the publication of the rule are written in red colour.

Unless otherwise specified, these Rules apply to ships for which the date of contract for construction as defined in TL- PR 29 is on or after 1st of January 2024. New rules or amendments entering into force after the date of contract for construction are to be applied if required by those rules. See Rule Change Notices on TL website for details.

"General Terms and Conditions" of the respective latest edition will be applicable (see Rules for Classification and Surveys).

If there is a difference between the rules in English and in Turkish, the rule in English is to be considered as valid. This publication is available in print and electronic pdf version. Once downloaded, this document will become UNCONTROLLED. Please check the website below for the valid version.

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Offshore Units and Installations – Mobile Offshore Units

SECTION 1

SCOPE, DEFINITIONS and PROCEDURES

A. Scope, Application

1. Scope

1.1 In this Section the requirements for the different types of mobile offshore units are defined.

This Rules do not cover structural details of industrial items used exclusively in drilling or related operations.

1.2 Types of units

- Units connected to the sea bed by anchoring (mooring)
- Units kept on position by dynamic positioning/ propelling system
- Units connected by legs in jacked up condition

1.3 Materials and Welding for construction of the hull

The materials are to be manufactured and tested in accordance with the TL Rules. Where it is intended to use materials manufactured by different processes or having different properties, their use will be specially considered by **TL**.

The following materials may be used for the main structure/hull:

- Steel, normally
- Concrete, in exceptional cases

Welding is to comply with the **TL** Rules. **TL** is to be satisfied that all welders to be employed in the construction of units to be classed are properly qualified in the type of work proposed and in the proper use of the welding processes and procedures to be followed. The methods and locations for non-destructive testing of welds are to be submitted to the **TL**.

2. Application

2.1 The following types of employment have to be distinguished:

- Drilling/exploration
- Self-elevating drilling units
- Column stabilized drilling units
- Surface drilling units of ship or barge type
- Other types of drilling units
- Production, e.g. oil/gas
- Processing/treatment
- Storage or loading on/off
- Research, measurements
- Construction / pipelaying

2.2 Manning

Only units continuously manned in operation mode are considered.

B. Definitions

1. Mobile offshore unit

A mobile offshore unit is any mobile offshore structure or vessel, whether designed for operation afloat or supported by the sea bed, built in accordance with these Rules and classed by **TL** and includes the entire structure and components covered by these Rules.

2. Drilling unit

A drilling unit is any unit intended for use in offshore drilling operations for the exploration or exploitation of the subsea resources.

2.1 Types of drilling units

Units which are designed as mobile offshore drilling units and which do not fall into the below mentioned categories will be treated on an individual basis and be assigned an appropriate classification designation.

2.1.1 Self-elevating drilling units

Self-elevating drilling units have hulls 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 sea bed.

The legs of such units may penetrate the sea bed, may be fitted with enlarged sections or footings to reduce penetration, or may be attached to a bottom pad or mat.

2.1.2 Column stabilized drilling units

Column stabilized drilling 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 drilling 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 sea bed. Bracing members of tubular or structural sections may be used to connect the columns, lower hulls or footings and to support the upper structure.

Drilling 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.

2.1.3 Surface type drilling units

(a) Ship type (self propelled) drilling units are seagoing ship-shaped units having a displacement- type hull or hulls, of the single, catamaran or trimaran types, which have been designed or converted for drilling operations in the floating condition. Such types have propulsion machinery.

(b) Barge type (non-self-propelled) drilling units are seagoing units having a displacement type hull or hulls, which have been designed or converted for drilling operations in the floating condition. These units have no propulsion machinery.

3. Self-propelled unit

A self-propelled unit is a unit which is designed for unassisted passage. All other units are considered as non-self-propelled.

4. Length L

4.1 Shiptype units

The length **L** is the distance in metres on the summer load waterline from the fore side of the stem to the after side of the rudder post, or the centre of the rudder stock, if there is no rudder post. **L** is not to be less than 96 % and need not be greater than 97 % of the extreme length of the summer load waterline. In units with unusual stern and bow arrangement, the length **L** will be specially considered.

4.2 Other units

The length **L** means 96 % of the total length on a waterline at 85 % of the least moulded depth **H** measured from the top of the keel, or the length from the foreside of the stem to the axis of the rudder stock on that waterline, if that be greater. In units designed with a rake of keel, the waterline on which this length is measured shall be parallel to the designed waterline.

5. Breadth B

The breadth **B** is the greatest moulded breadth of the unit.

6. Depth H

The depth **H** is the vertical distance, at the middle of the length **L**, from the base line to the top of the deck beam at side of the uppermost continuous deck.

In way of effective superstructures the depth is to be measured up to the superstructure deck for determining the unit's scantlings.

Effective superstructures are extending into the range of 0,4 **L** admidship and their length exceeds 0,15 **L**.

7. Draught T

The moulded draught is the vertical distance measured from the moulded base line to the assigned load line.

Certain components of a unit's structure, machinery or equipment may extend below the moulded base line.

8. Block coefficient C_B

The moulded block coefficient $\mathbf{C_B}$ at load draught **T**, based on the length **L** is defined as:

$$C_B = \frac{\text{moulded volume of displacement}\left[m^3\right]\text{at}\,T}{\mathbf{L \cdot B \cdot T}}$$

9. Frame spacing a

The frame spacing **a** will be measured from moulding edge to moulding edge of frames.

10. Water depth

The water depth as used herein is the vertical distance from the sea bed to the mean low water level plus the height of astronomical and storm tides.(See also Chapter 62, Section 1, E)

11. Moulded base line

The moulded baseline is a horizontal line extending through the upper surface of the bottom plating.

12. Lightweight

Lightweight is the displacement of a unit in tonnes without variable deck load, fuel, lubricating oil, ballast water, fresh water and feedwater in tanks, consumable stores, and personnel and their effects. The weight of mediums on board for the fixed fire-fighting systems (e.g. freshwater, CO_2, dry chemical powder, foam concentrate, etc.) shall be included in the lightweight.

13. Weathertight

Means that in any sea conditions water will not penetrate into the unit.

14. Watertight

Means that capability of preventing the passage of water through structure in any direction under the head of water for which the surrounding structure is designed.

15. Downflooding

Means any flooding of the interior or any part of the buoyant structure of a unit through openings which cannot be closed weathertight, watertight or which are required for operations reasons to be left open in all weather conditions, as appropriate for the intact and damage stability criteria.

16. 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. Insofar as the Requirements are concerned, the approved modes of operation of a unit should include the following:

- Operating conditions: Conditions wherein a unit is on location for purposes of drilling or other similar operations, and combined environmental and operational loadings are within the appropriate design limits established for such operations. Unit may be either afloat or supported on the sea bed, as applicable.

- Severe storm conditions: A condition during which a unit may be subjected to the most severe environmental loadings for which the unit is designed. Drilling or similar operations may have been discontinued due to the severity of the environmental loadings. Unit may be either afloat or supported on the sea bed, as applicable.

- Transit conditions: All unit movements from one geographical location to another. (Chapter 59, Section 1, B.5)

17. Further definitions

For further definitions see Chapter 59, Section 1, B.

C. Design Review

1. Extent of review

Examination or verification of the following will be undertaken:

- design documents, such as load assessment and stress analyses (as far as applicable), reports on model tests, design drawings
- practical qualifications of manufacturing firms and personnel
- suitability of the materials used
- erection procedure of the structure on land and at the port
- transportation procedures and jack-up procedure, if applicable

2. Documents for approval

2.1 General

2.1.1 All documents have generally to be submitted to **TL** in Turkish or English language.

2.1.2 The general scope of documents is defined in 2.2 to 2.6, the detailed scope will be defined case by case. **TL** reserve the right to demand additional documentation if that submitted is insufficient for an assessment of the unit or essential parts thereof. This may especially be the case for plants and equipment related to new developments and/or which are not tested on board to a sufficient extent.

2.1.3 Once the documents submitted have been approved by **TL** they are binding on the execution of the work. Subsequent modifications and extensions require the approval of **TL** before becoming effective.

2.2 Plans for the hull and design data

General specifications with an indication of the intended use, design life, location and environment, place(s) and period of construction and the main stages of construction up to final assembly and/or installation at sea.

Plans showing the scantlings, arrangements and details of the principal parts of the hull are to be submitted for approval before construction commences. These drawings have to clearly indicate the scantlings, types and grades of materials, joint details and welding, or other methods of connection. These plans are to include the following, where applicable:

- general arrangement
- specification of the assumed loads
- inboard and outboard profile
- summary of distributions of fixed and variable weights
- plan indicating design loads for all decks
- transverse sections showing scantlings
- longitudinal sections showing scantlings
- decks including helicopter deck and its supporting structure
- framing
- shell plating
- watertight bulkheads and flats

- structural bulkheads and flats
- tank boundaries with location of overflows
- Arrangement plan of watertight compartmentation and Diagrams showing the extent to which the watertight and weathertight integrity is intended to be maintained, including the location, type and dispositionof watertight and weathertight closures.
- Ventilation plan
- Penetration details through bulkheads and decks to accommodate ventilation, piping, electrical, etc.
- Pillars and girders
- Diagonals and struts
- Legs
- structure in way of jacking or other elevating arrangements, supporting the drilling derrick
- Stability columns and intermediate columns
- Hulls, pontoons, footings, pads or mats
- superstructures and deckhouses
- arrangement and details of watertight doors and hatches
- anchor handling arrangements, mooring system, industrial equipment and etc. foundations
- welding details and procedures, pre- and post-treatments
- lines or offsets
- curves of form or equivalent data
- cross curves of stability or equivalent data
- wind heeling moment curves or equivalent data
- capacity plan
- tank sounding tables
- corrosion control arrangements
- methods and locations for non-destructive testing, manufacturer’s quality control methods and test procedures
- where appropriate, general arrangement of equipment including calculations associated with the transfer/installation mode

In addition an arrangement plan of watertight compartments shall be submitted as early in the design stage as possible, for review of damage stability. This drawing is to indicate the watertight bulkheads, decks and flats and all openings therein. Doors, hatches, ventilators, etc. and their means of closure, are to be indicated. Piping and ventilation systems shall be shown in sufficient detail to evaluate their effects on the watertight integrity after incurring damage.

2.3 Plans for machinery and electrical equipment and design data

Plans are to be submitted showing the arrangement and details of:

- general arrangement of machinery installations and equipment
- general arrangement and design details of propulsion system
- auxiliary machinery
- steering gear
- boilers and pressure vessels
- general arrangement and particulars of the electrical installation
- jacking system including description

- bilge and ballast systems

- fire extinguishing systems

- other pumps and piping systems

- working gear as far as it has been agreed to be included in the design review

2.4 Safety aspects

- hazardous areas plan

- arrangement plans of safety devices and equipment, e.g. fire extinguishing plan, escape routes, life-saving appliances,

- structural fire protection

- operating instructions, as far as related to safety

- safety management plans, where applicable

2.5 Calculations

2.5.1 The following data and calculations are to be submitted in conjunction with the scantling plans, as may be applicable:

- structural analysis for relevant loading conditions as agreed with **TL**

- resultant forces and moments from wind, waves, current, mooring and other environmental loading taken into account in the structural analysis

- effect of icing on structural loading, stability and windage area

- stability calculations, both intact and damaged, over the appropriate range of drafts, including the transit conditions

- significant operational loads from drilling derrick and associated equipment, such as riser tensioners industrial items, etc, on supporting structures, and other similar type of significant loadings

- calculations substantiating adequacy of structure to transmit forces between legs and hull through the jacking or other elevating systems

- evaluation of the ability to resist overturning while bearing on the sea bed.

2.5.2 Submitted calculations are to be suitably referenced. Results from relevant model tests or dynamic response calculations may be submitted as alternatives or as substantiation for the required calculations.

2.5.3 The choice of computer programs according to the “State of the Art“ is free. It is recommended to use computer programs which are approved by **TL** in advance as appropriate to solve the actual problems. If the computer programs to be used are not known to **TL**, they may be checked by **TL** through comparative calculations with predefined test examples. Reference applications, already achieved approvals by other institutions and other relevant information shall be provided in advance. A generally valid approval for a computer program is, however, not given by **TL**.

The calculations have to be compiled in a way which allows to identify and check all steps of the calculations with regard to input and output in an easy way.

Handwritten, easily readable documents are acceptable.

Comprehensive quantities of output data shall be presented in graphic form. A written comment to the main conclusions resulting from the calculations has to be provided.

2.6 Further details

The necessary documentation is indicated in further detail in the relevant Chapters and Sections.

2.7 Distribution of documents

The distribution of design documents according to 2.2 – 2.6 will be agreed upon in each individual case, depending on the organization on Owner's, contractor's and/or fabricator’s side, and the mandatory requirements of responsible Administrations.

For the needs of **TL**, general descriptions, calculations and test reports have to be submitted in duplicate, structural plans, detail drawings and building/testing specifications in triplicate, one copy of each being returned to the remitter with the approval or review notation.

3. Operating instructions

3.1 Operating Manual (Booklet)

An Operating Manual or equivalent is to be placed on board of each unit. The booklet shall include the following information, as applicable in the particular case, so as to provide suitable guidance to the operating personnel with regard to safe operation of the unit:

- general description / main characteristics

- pertinent data for each approved mode of operation, including design and variable loading, environmental conditions for the execution of certain operations, e.g. jacking, drilling, etc.

- minimum anticipated atmospheric and sea temperatures

- assumed seabed conditions and their control, scouring, etc.

- admissible draft, or required distance of certain parts from the water surface

- general arrangement showing watertight compartments, closures, vents, allowable deck loading, etc.; if permanent ballast is used, the weight, location and substance used are to be clearly indicated

- hydrostatic curves or equivalent data

- capacity plan showing capacities of tanks, centres of gravity, free surface corrections, etc.

- instructions for operation, including precautions to be taken in adverse weather, changing mode of operations, any inherent limitations of operations, etc.

- plans and description of the ballast system and instructions for ballasting

- hazardous areas plan

- light (ship) unit data on the results of an inclining experiment, etc.

- stability information in the form of maximum KG draught curve, or other suitable parameters based upon compliance with the required intact and stability criteria

- representative examples of loading conditions for each approved mode of operation, together with means for evaluation of other loading conditions

- details of emergency shutdown procedures

- identification of the helicopter used for the design of the helicopter deck and procedure for helicopter operations

- safety checks and maintenance work to be carried through

- emergency procedures and rescue operations

- operating booklet for helicopter operation, including helicopter data on which design is based.

3.2 Construction Portfolio (Booklet)

A set of plan copies 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 involved, is to be placed on board. Any other relevant construction information is to be included in the booklet, including restrictions or prohibitions regarding repairs or modifications.

3.3 The operating instructions will be subject to examination within the design review procedure only insofar as they are related to the specified loads and load cases to be applied, and to other safety matters covered by these Rules.

D. Supervision of Fabrication and Installation

1. General

1.1 Supervision of the fabrication of individual components and of the installation of the hull will generally take the form of inspections by the authorized **TL** Surveyor to the extent considered necessary by **TL** at any given time.

1.2 **TL** branch (inspection) offices will receive, for their supervisory work, previously examined, documents from the Head Office, see C.2.7. Additionally all technical documents connected with the relevant construction project shall be made available to the Surveyors on request.

1.3 **TL** will assess the production facilities and procedures of the yard and other fabricators as to whether they meet the requirements of **TL** Rules. In general, approvals based on such assessments are conditional for acceptance of products subject to testing.

1.4 Materials, components, appliances and installations subject to inspection are to comply with the relevant rule requirements and be presented for inspection and/or construction supervision by **TL** Surveyors, unless otherwise provided as a result of special approvals granted by **TL**.

1.5 It shall be the duty of the fabricator to inform the competent inspection office of the completion of important stages of the construction or of trials and inspections due.

1.6 In order to enable the Surveyor to fulfil his duties, he is to be given free access to the unit and the workshop, where parts requiring approval are fabricated, assembled or tested. For performance of the tests required, the yard or fabricators are to give the Surveyor every assistance by providing the staff and equipment necessary for such tests.

2. Supervision of fabrication

2.1 Aim of supervision

During the phase of fabrication of an unit **TL** will ensure by surveys and inspections that:

- parts for hull and machinery and/or special equipment requiring approval have been constructed in compliance with the approved drawings and particulars

- all tests and trials stipulated by **TL** Rules are performed satisfactorily

- workmanship is in compliance with current engineering standards and/or **TL** Rule requirements

- welded parts are produced by qualified welders having undergone tests

- test Certificates have been presented for components requiring approval (the fabricator will have to ensure that any parts and materials requiring approval will only be delivered and installed, if the appropriate test Certificates have been issued).

- where no individual Certificates are required, typetested appliances and equipment are employed in accordance with rule requirements.

2.2 Marking and attestation of individual components

2.2.1 Insofar as it is necessary to identify materials or components during the fabrication process or possibly also after commissioning, e.g. because of special properties of the material, a permanent mark is to be made by means of a stamp.

2.2.2 The construction supervision, survey and/or final inspection of materials, parts supplied or installation components, corresponding to the relevant specifications and **TL** Rules, will be attested by the Surveyor concerned on special forms, or informally, as agreed in the individual case.

3. Industrial equipment

Regarding working gear and special equipment, supervision of construction and testing will be agreed upon from case to case.

E. Testing and Commissioning

1. Program

An overall test or commissioning program including the complete, combined function of the unit as well as partial tests of the different systems is to be established. The detailed requirements for the overall function and the functioning of the different systems are defined in the following Chapters and Sections. The test program is to be approved by **TL**.

2. Tests at fabricators

As far as practicable, machinery and equipment will be subjected to operational trials on the fabricator's test bed to the scope specified in the Construction Rules. This applies also to engines produced in large series. Where the machinery, equipment or electrical installations are novel in design or have not yet sufficiently proved their efficiency under actual service conditions on board ships or units, **TL** may require performance of a trial under particularly severe conditions.

Upon completion of work, compartments, decks, bulkheads, etc. are to be tested as specified in the following Chapters and Sections.

3. Sea trials

Upon completion of the unit and/or the system/ equipment to be classed, all structure/hull, machinery and electrical installations will be subjected to operational trials in the presence of the **TL** Surveyor, prior to and during the sea trial. This will comprise, e. g.:

- tightness, operational and load tests of tanks, covers, shell ports, ramps, etc.

- operational and/or load tests of the machinery and installations (propulsion plant, electrical installations, steering gear, anchor equipment, etc.) of importance for safe operation

During a final survey, checks will be made to ensure that any deficiencies found, for instance during the sea trial, have been eliminated.

4. Report

A test or commissioning report has to be established by the fabricator or Owner and to be agreed with the **TL** Surveyor.

5. Corrective actions

If the tests according to the established test program, see 1., are partially or totally not satisfactory to the **TL** Surveyor, corrective actions have to be provided by the fabricator or Owner and the relevant part of the tests repeated until a satisfactory result has been reached.

SECTION 2

SELF- ELEVATING UNITS

A. General

1. Definition

Self-elevating units have hulls 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 sea bed. Equipment and supplies may be transported on the unit, or may be added to the unit in its elevated position. The legs of such units may penetrate the sea bed, may be fitted with enlarged sections or footings (spud cans) to reduce penetration, or may be attached to a bottom pad or mat. Selfelevating units are also known as Jack-up units. See example Figure 2.1.

The Class Notation **SELF ELEVATING UNIT** will be assigned for this type, see Chapter 59, Section 2, C.2.3.

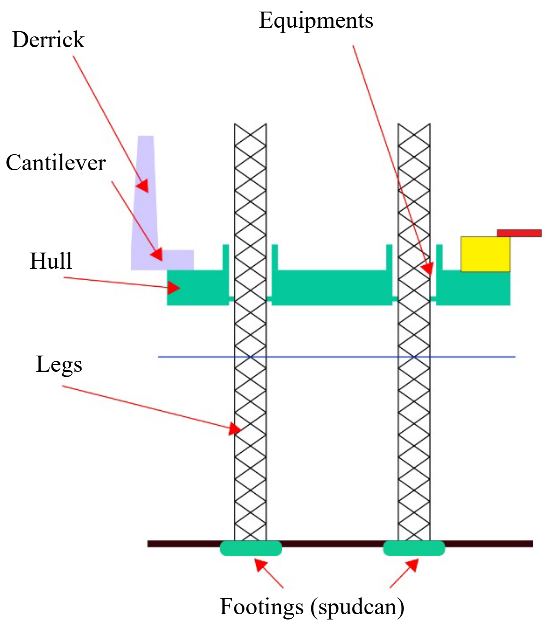

Figure 2.1 Example of a self elevating unit

2. International Standards

SNAME Technical and Research Bulletin 5-5A: “Guidelines for Site Specific Assessment of Mobile Jack-up Units published” by the Society of Naval Architects and Marine Engineers

ISO 19901-1: “Petroleum and natural gas industries - Specific requirements for offshore structures - Part 1: Metocean design and operating conditions”

API RP 2A-WSD: “Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms - Working Stress Design”

ISO 19905-1: “Petroleum and natural gas industries - Site-specific assessment of mobile offshore units - Part 1: Jack-ups”.

3. Scope

3.1 This Section covers those specific design criteria and features of self-elevating mobile offshore units which are not dealt with in the special Sections as referred to in the following.

3.2 Subdivision and watertight integrity

Subdivision and watertight integrity are dealt with in Section 7, Regarding stability see C.

3.3 Machinery and electrical installations

Machinery and electrical installations shall be designed according to Chapters 4 and 5, respectively, as far as applicable. For the jacking installation, see Chapter 63, Section 9 and Chapter 64, Section 12, I.

3.4 Auxiliary installations and equipment

Special (auxiliary) installations and equipment are to be designed according to the specific Sections as far as applicable. See also Chapter 59, Section 1, D.2.

3.5 Lifting appliances

For the interaction of lifting appliances with the unit, its foundations, etc. Chapter 62, Section 8.

The requirements for offshore cranes and other lifting appliances themselves are defined in the **TL** Rules, Chaper 50, Rules for the Construction and Survey of Lifting Appliances.

3.6 Towing and elevating

Conditions for towing, for the elevating and lowering procedures and for operating phases while standing on the sea floor, shall be clearly indicated in the Operating Manual, compare Section 1, C.3.1.

3.7 Drilling

Drilling derricks shall be designed according to recognized codes/standards and/or applicable national regulations. The rated capacity for each reeving shall be included in the Operating Manual.

Permanently installed piping systems for drilling operations are to comply with recognised standard or code.

These Rules do not include requirements for the drilling of subsea wells or procedures for their control. Such drilling operations are subject to control by the coastal state.

B. Structure

1. General

1.1 The buoyant main structure (hull) of a selfelevating unit shall be designed to resist the loads and stresses arising in the floating condition and while elevated. Chapter 62, Sections 1 to 4 apply.

1.2 Design Conditions

The following design conditions shall be accounted for the unit:

- transportation (transit) condition
- Installation condition
- Operating (in place) condition
- Survival condition
- Retrieval condition

All of the above loading conditions shall be detailed in the Operating Manual.

Transportation (transit) condition: The movement of a unit from one geographical location to another.

Survival condition: Refer to the conditions in which a unit is on location exposed to extreme storm environmental loadings for which the unit is designed. Daily operations (e.g. drilling) may have been terminated where the unit is placed on the seabed.

Installation condition: Refer to a condition in which a unit is lowering the legs and elevating the hull.

Retrieval condition: Refer to conditions in which a unit is lowering the hull and elevating the legs.

Operating (in place) condition: Refer to a condition in which a unit is on site for daily operations (e.g. drilling), and relevant environmental and operational loadings are within the design limits defined in Operating Manual. The unit is placed on the seabed.

1.3 Air Gap

1.3.1 The air gap is defined as the minimum clearance between the underside of the unit in the elevated position and the calculated crest of the design wave with adequate allowance for safety.

1.3.2 The unit is to be designed for a 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 hull 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. See also Chapter 62, Section 2, B.4.11.

Negative air gap is when the wave hits the deck while positive air gap is when there is a gap between deck structure and top of wave.

Evaluation of sufficient air gap shall include consideration of all affected structural elements including lifeboat platforms, riser balconies, overhanging deck modules etc.

The air gap shall be computed with the maximum wave height having a return period of 100 years.
TL may accept a smaller distance if wave impact forces on the deck are accounted for in the strength and overturning calculation.

Distance between the hull structure and wave shall be satisfied in floating transit condition for appurtenances such as crane pedestal, drill floor, helideck, etc.

TL may require a higher air gap or a higher crest clearance, on a case-by-case basis.

1.4 Classification or Certification will be based upon the designer's assumptions regarding the sea bed conditions. These assumptions shall be recorded in the Operating Manual. It is the responsibility of the Operator to ensure that actual conditions do not impose more severe loading on the unit.

1.5 Structural Categorization

Categorization of structural members for self-elevating units are defined in Chapter 62, Section 4.

1.6 Welding category

A welding shall be classified in the same category as the structural category of the element in which welding is carried out. When a weld connecting two items classified in different structural categories, the welding shall be classified in the category of the higher classed element.

A particular care shall be given to the welding on a permanent backing element is not permitted for the special structural category and required to approval for the other categories, especially related to fatigue and corrosion concerns.

1.7 Fatigue analysis

The fatigue damage shall be computed with the combined effects of global and local structural response. The fatigue analysis should focus on members that are essential to the overall structural integrity of the unit.

The areas are prone to fatigue may be covered but not limited to:

- Leg members and connections in the upper and lower guides

- Leg to hull fixation system

- Leg members and connections in the splash zone

- Leg members and connections in the lower part of the footings (spudcan)

- Footing to leg intersection.

Note: *A particular care should be given to the leg in the splash zone, submerged parts legs and footings.*

2. Hull

2.1 Structural elements such as the outer shell, decks, bulkheads, girders, stringers and leghouses shall be dimensioned with relevant global and local responses for each structural element according to the principles outlined in Chapter 62, Section 3. **TL** Rules, Chapter 1 – Hull Structures may be used as a basis where applicable, e.g. dimensioning of tank boundaries.

2.2 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, by an accepted method of rational analysis, 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, but are not to be less than those required by the Rules defined in 2.1. Scantlings of units having other than rectangular hull configurations will be subject to special consideration

2.3 Deckhouses located near the boundary of the unit shall be designed to resist the possible impact of sea wash during conveyance.

Deckhouses are to have sufficient strength for their size, function and location and are to be constructed to approved plans. Their general scantlings are to be as indicated in the Rules according to 2. Where they are close to the side shell of the unit, their scantlings may be required to conform to the requirements for bulkheads of unprotected deckhouse fronts

2.4 Special attention is to be paid to the foundations and fastening of drilling derrick(s) and cranes, also with regard to transit conditions.

Corrosion protection shall be installed throughout the duration of the operation.

3. Structure in way of jacking

3.1 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 arranged that loads transmitted from the legs are properly distributed into the hull structure

3.2 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 resulting from lack of support at one leg.

The structure surrounding the legs (points of support) shall be designed with particular regard to the introduction of local concentrated forces; main loadbearing elements should be continuous in the vertical direction.

Regarding the maximal force to be transmitted, preloading of the legs shall be considered, see 4.5 below.

3.3 For loose elements, e.g. bars, rods, bolts, pins, serving for transmission of forces to support the unit, special requirements may be imposed regarding dimensioning (safety factors) and testing.

4. Legs

4.1 Leg types

Legs may be either shell type or truss type. Shell type legs may be designed as either stiffened or unstiffened shells. According to the sea bed conditions envisaged, individual spudcans (footings) may be installed or legs may be permanently secured to a bottom mat.

Truss (lattice) type legs are usually made of tubular elements. A particular care shall be given to the tubular intersections which are highly stressed areas exposed to fatigue.

Eccentricities are in general to be minimized and accounted for design.

The bracing system of truss type legs shall be designed to ensure structural redundancy.

Truss (lattice) legs shall be verified against buckling and punching shear strength of the nodes in accordance with the requirements given by **TL** Chapter 62, Section 3, G.

4.2 Lower end

Where footings or mats are not fitted, proper consideration shall be given to the leg penetration of the sea bed and the corresponding end fixity of the legs. Depending on the mat and type of connection, a rotational restraint of the leg may exist also in this case.

4.3 Leghouse (Jackhouse) support strength

A particular care shall be given to

- Means for the leg support,
- Jackhouses,
- Supporting structure of the jackhouse to the hull
- Main loading transfer girders between the jackhouses.

4.4 Dimensioning

4.4.1 The legs of self-elevating units shall be designed to resist the forces and bending moments resulting from the following operational conditions. The safety factors according to loading condition 2 according to Chapter 62, Section 3, C. and D. apply. Fatigue may have to be specially considered, particularly for legs of truss type. For fatigue criteria, see Chapter 62, Section 3, H.

Various positions of the hull structural supports along the legs shall be taken into account when estimating the forces and moments in the legs.

The bottom impact forces that occur during installation and retrieval shall be adequately accounted for in the design.

A particular attention shall be given to the loads transferred from the legs and the seabed reaction in the elevated condition. High stress concentrations at the intersection between spudcan and leg shall be avoided as much as possible.

4.4.2 Ocean transit condition

The present section takes into account requirements for wet transit (ocean transit). In case of dry transit that requirements on a heavy lift vessel shall be covered by the MWS (Marine Warranty Survey) under the marine operation scope.

Legs shall be designed for acceleration and gravity moments resulting from the motions in the most severe anticipated environmental transit conditions, together with corresponding wind moments. Calculation or model test methods, acceptable to **TL**, may be used. Alternatively, legs may be designed for a bending moment resulting from a 15° single amplitude of roll or pitch at a 10 second period, plus 120 % of the gravity moment caused by the legs' angle of inclination (minimum design criteria).

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 Manual.

The structural strength of the hull, legs and footings during operation and survival conditions shall comply with the ULS, FLS and ALS as stated in **TL** Chapter 62, Section 3, B..

The hull strength (for yield and buckling check) shall be evaluated in accordance with the maximum longitudinal tension and compression stresses caused by relevant load conditions in deck and bottom plates.

The response of the actual leg and hull connection system shall properly be represented in the appropriate global and local analyses.

For further guidance with regards to modelling leg and hull interaction, refer to SNAME 5-5A.

4.4.3 Field transit condition

Legs are to be designed for a bending moment resulting from a 6° single amplitude of roll or pitch at the natural period of the unit, plus 120 % of the gravity moment caused by the legs' angle of inclination.

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 Manual.

Such investigation should include strength and stability aspects.

4.4.4 Condition while lowering legs

Legs are to be designed to withstand the dynamic loads which may be encountered along 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 motions caused by waves.

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

4.4.5 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 (4.6.4).

The analysis may have to be done for several intermediate positions of the hull.

4.4.6 Elevated (working) condition

When computing leg stresses, the maximum overturning load on the unit, using the most adverse combination of applicable variable loadings together with the loadings as outlined in Chapter 62, Section 2, is to be considered. Forces and moments due to lateral frame deflections of the legs are to be taken into account. (Consideration is to be given to the possibility of wave induced vibration).

Eccentricity of support or partial restraint of the lower leg ends may have to be considered (e.g. for spud can design), depending on the soil conditions. The analysis will usually have to be carried through for several water depths and corresponding site and environmental conditions.

4.4.7 Accidental condition

The loads and resulting damage as a result of accidental circumstances are as follows:

- Collision
- Dropped objects
- Fire and explosion
- Flooding during transportation (transit)

shall be taken into account to avoid loss of floatability during transportation, on-bottom instability in elevated operation and extreme storm conditions.

Collision event by a supply ship with a leg of a self-elevating unit shall be taken into account for all elements that may be struck by a side, bow, or stern impact.

A collision event will normally cause local damage of the leg. Furthermore, global strength and overturning stability of the unit shall also be verified. The damaged chord, brace and joints may be assumed to be ineffective for checking of residual strength of the unit subject to collision event.

An accidental event with one broken brace for truss legs in the most loaded area of the leg structure shall be examined to determine the redundancy of the brace system.

Critical locations for dropped objects event shall be established based on the actual route of potential dropped objects (e.g. crane).

A dropped object impact against a chord or brace shall result in entire failure of the element or its intersections. These designated locations should be assumed as an ineffective for the verifying of the residual strength subject to the dropped object impact.

The structure that is exposed to a fire shall have adequate structural strength before evacuation has taken place.

Supporting structure of blast (explosion) walls and the transmission of the blast loads into main loading bearing elements shall be assessed when applicable.

Structural effects due to heeling of the unit subject to damage flooding during the transportation (transit) condition shall be considered in the strength evaluation. The unit shall be established in accordance with environmental condition with 1-year return period subject to damage flooding.

4.5 Spudcans and bottom mat

4.5.1 If the sea bed conditions are characterized by very soft mud and silt, the lower ends of the legs are to be 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 are properly distributed.

4.5.2 The envelope plating of tanks which are not vented freely to the sea is not to be less in thickness than would be required by the rules for tanks, using a head to the design water level taking into account the astronomical and storm tides.

4.5.3 The effects of scouring on the bottom bearing surface should be considered. The effects of skirt plates, where provided, have to be especially considered.

4.5.4 Mats are to be designed to withstand the loads encountered during lowering including the shock of touching bottom while the unit is afloat and subject to wave motions.

4.5.5 Provisions for ballasting and de-ballasting the mat have to be installed. These may be pipelines running down each leg into the mat to vent off trapped air during ballasting or to induce air for displacing the water and thus de-ballasting the mat. These pipelines may also be used to blow air under the bottom of the mat with the aim of facilitating the lifting of the mat from the bottom of the sea.

Appropriate reinforcements shall normally be installed inside the spudcans.

The pressure distribution to be used upon the spudcans or the bottom mat shall be submitted to **TL** review and approval.

The pressure distribution shall be accounted for the nature and response of the soil.

A three-dimensional finite element model is required for the strength assessment of the spudcan and bottom mat scantling.

The extension of the model shall be agreed upon the **TL**.

4.5.6 Appropriate reinforcements shall normally be installed inside the spudcans. The pressure distribution to be used upon the spudcans or the bottom mat shall be submitted to **TL** for review and approval. The pressure distribution shall be accounted for the nature and response of the soil. A three-dimensional finite element model is required for the strength assessment of the spudcan and bottom mat scantling. The extension of the model shall be agreed upon the **TL**.

4.6 Preload capability

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 pre-load procedure shall be included in the Operating Manual.

Regarding the preloading capability of the elevating machinery, see Chapter 63, Section 9.

5. Global structural models

The global stiffness and structural response of the unit shall be represented by a global model. In general, the global model should account the following but not limited to;

- Longitudinal and transverse bulkheads, web frames and decks for the deck structure
- Leg truss or shell and attached stiffeners
- Jackhouse (leghouse)
- Leg to hull interface
- Spudcan main plate and attached stiffeners

Note: *For further guidance with regards to modelling procedures, refer to SNAME 5.*

6. Local structural models

An appropriate number of local structural models should be generated to assess behavior of the structure to variations in local loadings. The models should be properly detailed such that obtained results are reliably achieved.

The local models should be analyzed in the ULS assessment as follows but not limited to;

- Stiffened plates exposed to tank pressures or heavy deck area loads
- Jackhouse supporting structure to hull
- Hull and leg connections
- Riser balcony structure
- Drill floor and pipe racks supporting structure
- Helideck supporting structure
- Crane pedestal supporting structure
- Spudcan, or mat

To calculate the transfer of leg axial forces, bending moments, and shear forces between the upper and lower guide structures and the jacking and fixation system, a comprehensive finite element model should be used. The analysis modelling should incorporate a comprehensive model of the leg in the hull interface area, the upper and lower guides, jacking and locking (fixation) system, and the jackhouse structure.

Note: *For further guidance with regards to modelling procedures, refer to SNAME 5-5A.*

7. Elevating Systems

7.1 Machinery

7.1.1 Jacking mechanisms is to be:

- Arranged so that a single failure of any component does not cause an uncontrolled descent of the unit;
- Designed and constructed for the maximum lowering and lifting loads of the unit as specified in the unit's operation manual
- Able to withstand the forces imposed on the unit from the maximum environmental criteria for the unit; and
- Constructed such that the elevation of the leg relative to the unit can be safely maintained in case of loss of power (e.g., electric, hydraulic, or pneumatic power).

7.2 Control, communication and alarms

7.2.1 The elevating system is to be operable from a central jacking control station.

7.2.2 The jacking control station should have the following:

- Audible and visual alarms for jacking system overload and out-of-level. Units whose jacking systems are subject to rack phase differential should also have audible and visual alarms for rack phase differential; and
- Instrumentation to indicate:
    - the inclination of the unit on two horizontal perpendicular axes;
    - power consumption or other indicators for lifting or lowering the legs, as applicable; and
    - brake release status.

7.2.3 A communication system is to be provided between the central jacking control and a location at each leg.

C. Stability

1. General

The general requirements for stability are defined in Section 7. Additional aspects are given in the following.

2. Overturning Stability

2.1 The unit, when resting on the sea bed, is to have sufficient downward gravity loading on the support footings or mats to withstand the overturning moment of the combined environmental forces from any direction, for each design loading condition. The dynamic amplification of the combined wave and current loading influence is also to be accounted for the overturning stability. The overturning safety, defined as the sum of the restoring moments divided by the sum of the overturning moments, should not be less than:

- 1,5 for loading condition 2
- 1,3 for loading condition 3

according to Chapter 62, Section 3, C.

2.2 It is assumed that noticeable inclinations of the unit will not occur or will be corrected immediately, and that the effects of any dangerous changes of the sea bed will be kept under control. Corresponding instructions shall be contained in the Operating Manual.

SECTION 3

COLUMN STABILIZED UNITS

A. General

1. Definition

Column stabilized units depend upon the buoyancy of widely spaced columns for floatation 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 to an upper structure supporting e.g. drilling equipment or accommodation quarters. 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 sea bed. Bracing members of tubular or structural sections may be used to connect the columns, lower hulls or footings, and to support the upper structure.

A semi-submersible unit is designed to be used in the floating mode, with the column water plane area providing stability in operating and storm conditions.

Twin pontoon designs have in general two lower hulls, each supporting several vertical columns. The columns are supporting the upper deck. The number of columns ranges from 4 to 8. Diagonal and horizontal bracings can be used to reinforce the structure. See example Figure 3.1.

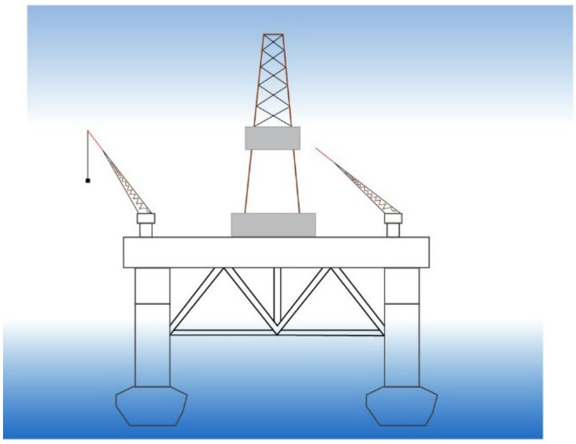

Figure 3.1 Example of a Column stabilized unit – twin pontoon

Ring pontoon designs have typically one continuous lower hull supporting several vertical columns. Pontoons and nodes make up the lower hull. The upper deck is supported by the columns. The number of columns ranges from 4 to 8. See example Figure 3.2.

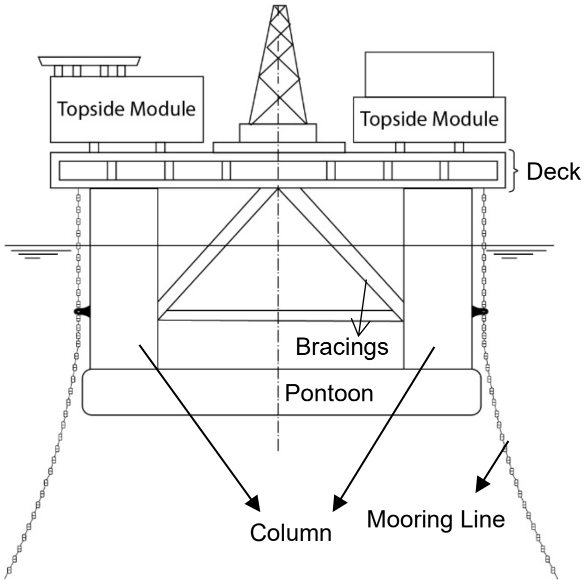

Figure 3.2 Example of a Column stabilized unit – ring pontoon

Operations may be carried out in the floating condition, in which condition the unit is described as a Semi-Submersible Unit, or when the unit is supported by the sea bed, in which condition the unit is described as a Submersible Unit. A Semi-Submersible Unit may be designed to operate either floating or supported by the sea bed, provided each type of operation has been found to be satisfactory and suitable.

Column-stabilised unit can be moored using either a passive mooring system, such as anchor lines, or an active mooring system, such as thrusters, or a combination of the two systems.

A column-stabilised unit can be built to operate in a variety of modes such as transit, operational, and survival. The modes of operation for limiting design criteria shall be clearly identified and documented.

The Class Notation **COLUMN STABILIZED UNIT** will be assigned for this type, compare Chapter 59, Section 2, C.2.3.

2. International recognized standards

The following recognized international standards may be considered when applicable on a case by case basis:

IMO MODU Code for the Construction and Equipment of Mobile Offshore Drilling Units, published by the International Maritime Organization.

API 2A WSD means the standard published by American Petroleum Institute "Recommended Practice for Planning, Designing, and Constructing Fixed Offshore Platforms - Working Stress Design" - latest edition.

API 2U: Bulletin on Stability Design of Cylindrical Shells - latest edition

API 2V: Design of Flat Plate Structures - latest edition

AISC 360-05: Specifications for Structural Steel buildings - latest edition.

3. Scope

3.1 This Section covers those specific design criteria and features of column stabilized mobile offshore units which are not dealt with in other Sections, as referred to in the following.

3.2 Subdivision and watertight integrity

Subdivision and watertight integrity are dealt with in Section 7. Regarding stability see C.

3.3 Machinery and electrical installations

Machinery and electrical installations shall be designed according to Chapters 63 and 64, respectively, as far as applicable. For ballast and bilge pumping arrangements see Chapter 63, Section 13e, H. and I. and Chapter 64, Section 12, J.

Propulsion installations, designed for conveyances under own power or for towage assistance, and/or for positioning, shall also be designed according to Chapters 63 and 64 and according to the **TL** Rules, Chapters 4 and 5, as applicable.

3.4 Positional mooring equipment

Mooring equipment supporting structure such as fairleads and winches, chain stoppers, towing brackets etc. shall be designed related to the loads and acceptance criteria specified in **TL** Chapter 62, Section 3.

Mooring equipment for position keeping at the working location is defined in Section 8, C.

3.5 Dynamic position keeping

Dynamic position keeping at the working location means maintaining a desired position within the normal excursions of the control system and under defined environmental conditions. The required position tolerances during drilling operations have to be defined by the Owner/Operator.

The complete dynamic positioning system requires the following sub-systems:

- Power system
- Thruster system
- Control system

Thrusters used as sole means of position keeping shall provide a level of safety equivalent to that provided for mooring arrangements to the satisfaction of **TL.**

The Class Notations **DK 1** to **DK 3** will be assigned if the unit is equipped with such a system, compare Chapter 59, Section 2, C.2.7.

Further details are defined in the Chapter 63, Section 6, E.

3.6 Auxiliary installations and equipment

Special (auxiliary) installations and equipment are to be designed according to the specific Sections as far as applicable. See also Chapter 59, Section 1, D.2.

3.7 Lifting appliances

For the interaction of lifting appliances with the unit, their foundations, etc. see Chapter 62, Section 8. Each elevator cabin in a column shall provide for an emergency exit with an escape ladder in the hoistway.

The requirements for offshore cranes and other lifting appliances themselves are defined in the **TL** Rules, Chapter 50 – Rules for the Construction and Survey of Lifting Appliances.

3.8 Towing and ballasting

Conditions for towing, for ballasting and deballasting procedures and for mooring operations shall be clearly indicated in the Operating Manual, compare Section 1, C.3.1.

3.9 Drilling

Drilling derricks shall be designed according to recognized codes/standards (e.g. IMO MODU Code for the Construction and Equipment of Mobile Offshore Drilling Units, published by the International Maritime Organization) and/or applicable national regulations. The rated capacity for each reeving shall be included in the Operating Manual.

Permanently installed piping systems for drilling operations are to comply with an recognised standard or code.

These Rules do not include requirements for the drilling of subsea wells or procedures for their control. Such drilling operations are subject to control by the coastal state.

B. Structure

1. General

1.1 Structural design shall be based on the principles described in Chapter 62, Sections 1 to 4, see also 1.5. Particular attention should be given to structural details in critical areas such as connections of bracing members, where high local loads are acting, see also 3.7 and Chapter 62, Section 3, B. and Section 4, B. – D.

1.2 Structural categorization

Categorization of structural members for column-stabilised units are defined in Chapter 62, Section 4.

1.3 For the dimensioning of ship-like structural members such as decks, bulkheads, deck houses, girders and pillars, the **TL** Rules, Chapter 1 – Hull be used as a design basis.

1.4 Wave clearance (Air gap)

Adequate air gap assessment for conditions specified in 1.4.1 and 1.4.2 is to cover consideration of all affected structural elements such as lifeboat platforms, riser balconies, overhanging deck modules etc.

1.4.1 Afloat condition

Unless deck structures are designed for wave impact, to the satisfaction of **TL,** reasonable clearance between the deck structures and the wave crests is to be ensured for afloat modes of operation, taking into account the predicted motion of the unit relative to the surface of the sea. Positive air gap should generally be achieved for waves with a 10^{-2} annual probability of exceedance in the ULS condition. Calculations, model test results or reports on past operating experience with similar configurations showing that adequate provision is made to maintain this clearance are to be submitted.

1.4.2 On-bottom condition

The unit is to be designed for a 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 hull 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. See also Chapter 62, Section 2, B.4.10.

1.5 Stress and motion analysis

1.5.1 As the design of column stabilized units is governed by both, structural and motion behaviour, calculations will have to be presented for approval covering both aspects. The investigation shall be carried out for a sufficient number of draughts and environmental conditions in order to determine the most severe cases of stressing and the associated motions, and vice versa.

Model tests may serve as additional basis for design.

1.5.2 For units of this type, the highest stresses may be associated with less severe environmental conditions than the maximum specified by the Owner/designer.

Where considered necessary by **TL,** account shall be taken of the consequent increased possibility of encounter of significant stress levels, by either or both of the following:

- suitable reduction of the allowable stress levels for combined loading defined in Chapter 62, Section 3, D.
- detailed investigation of fatigue properties

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

1.6 Load cases for structural assessment

The load cases for hull structural evaluation shall be described at a minimum to maximize the following loading effects:

- Split force between pontoons (in particular for twin pontoons type)
- Torsional moments about horizontal axes
- Longitudinal shear forces between the pontoons
- Longitudinal acceleration of deck mass
- Transverse acceleration of deck mass
- Vertical acceleration of deck mass
- Vertical wave bending moments of the pontoons
- Column shear force
- Column bending moment

1.7 Structural redundancy

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

1.7.1.1 The unit's structure shall be able to withstand the loss of any slender bracing member without causing overall collapse of the unit's structure.

1.7.1.2 Structural redundancy will be based on the applicable requirements of Chapter 62, Section 2 to 4, except:

- maximum calculated stresses in the structure remaining after the loss of a slender bracing member are to be in accordance with Chapter 62, Section 3, D. These criteria may be exceeded for local areas, provided redistribution of forces due to yielding or buckling is taken into consideration.
- When considering environmental factors, a one year return period may be assumed for intended areas of operations, see Chapter 62, Sections 2.

1.7.2 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.

2. Upper structure

2.1 The scantlings of the upper structure are not to be less than those required by the Rules mentioned above, in association with the loading indicated on the deck loading plan (these loadings are not to be less than the minima specified in Chapter 62, Section 2, D.4). 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 loading plus any additional loading superimposed due to frame action, within the stress limitations given in Chapter 62, Section 3, D.

2.2 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.

2.3 Tanks

See Section 7, G.2.

2.4 Deckhouses fitted to the upper structure are to be designed in accordance with the Rules defined in 1.2, with due consideration given to their location and to the environmental conditions in which the unit will operate

2.5 Local structures in way of fairleads, winches, etc., forming part of the positional mooring system, shall be designed to the breaking strength of the mooring line

2.6 Special attention is to be paid to the foundations (supporting structure) and fastening of drilling derrick(s), cranes (see also Chapter 62, Section 8) and similar installations.

3. Columns, lower hulls and footings

3.1 Main stability columns lower hull or footings may be designed as either framed or unframed shells. In either case, framing, ring stiffeners, bulkheads or other suitable elements used are to be sufficient to maintain shape and stiffness under all the anticipated loading.

3.2 Where columns, lower hulls or footings are designed with stiffened plating, framing, girders, etc., may be determined in accordance with the requirements for tanks (see Section 7, G). Where an internal space is a void compartment, the design head used is not to be less than that corresponding to the maximum allowable waterline of the unit in service. In general, the scantlings are not to be less than required for watertight bulkheads in association with a head equivalent to the maximum waterline in damaged condition; for all areas subject to wave immersion, a minimum head of 6,0 m shall be used.

3.3 Where columns, lower hulls or footings 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 using the appropriate safety factors and the design heads as given in 3.2, see also Chapter 62, Section 3, G.4.

3.4 Openings in columns, like portlights or windows, including those of the non-opening type, or other similar openings are not to be fitted in columns.

Regarding openings in external and internal walls, bulkheads, etc. see also Section 7, G.

3.5 Scantlings of columns, lower hulls or footings as determined according to 3.2 and 3.3 are minimum requirements for hydrostatic pressure loads. Where wave and current forces, or bottom contact pressure in case of units resting on the sea bed are superimposed, the local structure of the shell is to be increased in scantlings as necessary, to meet the strength requirements mentioned in 1.1 above. Scantlings in tanks are to be determined for both, full and empty conditions.

Internal structure of columns in way of braces shall be capable to withstand the axial strength of the brace.

A particular care shall be provided to the structural design of columns in way of connections with deck box structure to ensure that loadings are redistributed smoothly.

3.6 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 the requirements of this section plus any additional stress superimposed due to frame action, within the stress limitations of Chapter 62, Section 3, D.

3.7 Particular consideration is to be given to structural details, reinforcements, etc., in areas subject to high local loading, or to such loading that may cause shell distortion, for example:

- Sloshing in partially filled tanks

- Local strength against external damage

- Continuity through joints;

- Wave impacts

- Bottom bearing loads, where applicable.

3.8 Consideration shall be given to objects falling down from the platform onto the lower hull or footing. The size of objects and the potential area where objects may fall down has to be determined under special consideration of crane operations. From there the following angles of fall direction may be assumed:

- in air, unit floating: 10°

- in air, unit supported on seabed: 5°

- in water: 15 °

The endangered main structural elements of the lower hull determined in this way have to be reinforced to withstand the impact energy of fallen objects.

3.9 When a unit is designed for operations while supported by the seabed, the footings shall be designed to withstand the shock of bottom contact due to wave action on the hull. Such units shall also be evaluated for the effects of possible scouring action (loss of bottom support). The effect of skirt plates, where provided, shall be given special consideration.

4. Bracing members

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 Chapter 62.

4.1 Arrangement of braces

The following considerations shall be applied to bracing systems:

- Brace structural arrangements shall be checked with relevant combinations of global and local loads

- In addition to individual brace element redundancy, structural redundancy of slender bracing systems shall generally incorporate brace node redundancy, i.e. all braces entering the node.

- Brace end connections such as brace and column intersections, shall typically be designed such that the brace element itself will fail before the end connection.

- Underwater braces shall be watertight and have a leakage detection system.

- The effect of slamming load on braces shall be accounted for (e.g. in transportation condition).

Where braces are essential for the structural integrity of the unit, see 1.5, they should be so arranged that they are protected as far as possible against boat impact (collisions) and other forces resulting from normal operations.

4.2 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.

4.3 Where relevant, consideration is to be given to local stresses due to wave impact. ~~3~~

4.4 When bracing members are of tubular section, ring frames may be required to maintain stiffness and roundness of shape. The necessary yielding and buckling investigation have to consider axial stresses and stresses caused by hydrostatic pressure, where applicable, see Chapter 62, Section 3, G.4.

Local effects such as induced by residual stresses and weld surface defects shall be considered through the joint classification as specified by **TL** Chapter 62, Section 3.

4.5 Where braces are designed to be buoyant, they shall be designed to prevent collapse from hydrostatic pressure. They shall be accessible for internal inspection, or else adequate means should be provided in order to detect leakage at an early stage.

5. Global strength capacity

Gross scantlings may be used in the assessment of hull strength provided that an intact corrosion protection system in place and well maintained throughout the unit's service life.

Ultimate strength capacity check shall be carried out for entire structural elements contributing to the global and local strength of the unit. The structures shall be checked with the followings but are not limited to;

- Bulkheads, frameworks and decks in the deck box structure
- Connections between braces and the deck structure
- Connections between columns to the deck structure
- Girders in the deck box structure
- Outer shell of pontoons
- Longitudinal and transverse bulkheads, girders and decks in pontoons
- Connections between pontoon, columns and braces
- Brace to brace connections
- Outer shell of columns
- Decks, stringers and bulkheads forming columns

6. Local model

Pressure loadings and other relevant local loads shall be considered when designing pontoons and columns in all applicable design loading conditions specified in **TL** Chapter 62, Section 3, C.

A special attention shall be given to structural details in areas exposed to high local loadings caused by wave slamming, partially filled tanks, or potential external damage.

Local comprehensive finite element analysis of critical intersections such as pontoon and pontoon, pontoon and column, column and deck and brace should be accounted for.

The following areas shall be examined using fine mesh models when the three-dimensional model is established on coarse mesh models:

- Deck box structure
- Pontoon structure
- Column structure
- Connection of pontoon with column
- Connection of column with deck
- Horizontal and diagonal bracings
- Brace to brace connection (e.g. K joint)
- Crane supporting structure
- Mooring supporting structure
- Topside module stools or supports
- Risers supporting structure, when applicable

When the **TL** deems it essential, other areas may be needed to be assessed using fine mesh models, depending on the structural arrangement and loading conditions of the unit, as well as the results of the coarse mesh analysis.

7. Local reinforcements

It is necessary to give adequate reinforcements in the structural foundations of items such as:

- The fairleads, chain stoppers, winches, towing, mooring and anchoring equipment
- The machineries
- The drilling equipment, crane pedestal support, helideck support, etc.

Adequate strength shall be provided in above areas to withstand the loads created in all the conditions of operation, and avoid vibration that may lead to structural damage.

8. Fatigue Design

Fatigue capacity assessment shall be carried out to document sufficient strength against fatigue damage failure throughout unit's design life.

Fatigue analyses shall be carried out in accordance with **TL** Chapter 62, Section 3, H or international recognized methods to the satisfaction of the **TL**.

The design of main structural elements shall be considered the design life of the unit and for all of its conditions of operation. The design life of the structure shall be specified and It is normally to be taken not less than 20 years. The design life of the structure shall be defined in the design criteria.

Additional fatigue design factor shall be accounted for the structural members in non-inspectable areas or areas where repair within the targeted lifetime is not possible or practical.

8.1 Structural details to be checked for fatigue analysis

Structural details for fatigue damage analysis shall be chosen on a case-by-case basis, at the satisfaction of the **TL**. The following items are typically covered, but not limited to:

- Stiffeners attached to bulkheads and primary supporting elements
- Dnd brackets
- Fanges of primary members in way of brackets
- Pontoon to column connections
- Deck box to column connections
- Brace to brace connections
- Tubular joints (e.g. K joint)
- Topside module stool connections on decks
- Moonpool corners, when applicable
- Riser supporting structure
- Supporting structures of mooring equipments
- Supporting structure of riser tensioning systems, when applicable
- Crane pedestals and supporting structure
- Anode attachments

Initial imperfections such as fabrication induced residual stresses and initial distortions shall affect the fatigue strength capacity. This should be normally accounted for by joint classifications, provided however that standard quality control procedures are sufficiently followed up.

9. Accidental limit design

The column stabilized unit shall be evaluated using relevant accidental events in addition to the design loading conditions as described in **TL** Chapter 62.

The following accidental events are in general accounted for the evaluation of hull and deck:

- Collision with supply ship
- Dropped objects during transit and operations

- Fire and explosion

- Unintended flooding

A collision event between a supply ship and a column of a column-stabilised unit shall be accounted for all members of the unit which may be subjected to side, bow or stern impact. The vertical extent of the collision extent shall be in accordance with the depth and draught of the supply ship and the relative motion between the unit and supply ship.

A collision event will normally lead to local damage of the column. However, for a unit with slender columns, the global strength shall be also analyzed.

A collision event against a brace will normally lead to complete failure of the brace and its joints (e.g. K-joints). These items shall be assumed as an ineffective for checking of the residual strength of the unit subject to collision event.

A dropped object event on a brace will normally lead to complete failure of the brace or its joints (e.g. K-joints). These parts are assumed as an ineffective for checking of the residual strength of the unit subject to dropped object impact.

The main load bearing structure that is exposed to a fire and explosion event shall not lose the structural capacity. For further requirements considering accidental limit state events involving fire and explosion refer to **TL** Chapter 62, Section 3, C or international recognized standard acceptable to **TL**.

1. For units designed to be supported by the seabed the clearance in Section 2, B.1.3.2 is to be maintained.

C. Stability

1. General

The general requirements for stability are defined in Section 7. Additional aspects are given in the following.

2. Stability of units resting on the sea bed

Units designed to rest on the sea bed are to have sufficient downward gravity loading on the support footings or lower hull to withstand the overturning moment of the combined environmental forces from anydirection, for each applicable design loading condition.

The overturning safety factor, defined as the sum of the restoring moments divided by the sum of the overturning moments, should not be less than:

- 1,5 for loading condition 1

- 1,3 for loading condition 2

according to Chapter 62, Section 3, C.

SECTION 4

SURFACE DRILLING UNITS

A. General

This rule applies to the hull and topside of ship-shaped drilling and well servicing units (e.g. stimulation and well intervention vessels) fabricated in steel for both restricted and non-restricted operations.

Flag and Coastal State requirements are not addressed under the scope of these Rules.

A compliance with IMO MODU Code may be needed by Operator (Owner), Flag State and Coastal State. **TL** reserves the right to refer to the requirements of the IMO MODU Code, when considered necessary.

1. Definitions

Hull:

Refers to hull structure, marine systems, living quarters and any other equipment located inside the hull.

Topsides:

Refers to the facilities located above hull used for process, utilities and other related functions. Note that FSOs do not have topside modules.

Appurtenances:

Offshore ships' specific members including their supporting structures that protrude from the hull and are not generally present on commercial ships, such as risers, boat-landings, mooring support structures, topside module stools, riser protectors, flare tower foundations, etc.

FSO (floating storage and offloading vessel):

A vessel used for oil storage with facilities for transfer to a shuttle tanker The units are typically made up of a hull with a turret or spread mooring system. The unit is designed to store crude oil. The unit can be relocated, however it is usually kept in the same area for a long period of time (no production facilities).

FPSO (floating production, storage and offloading vessel):

A vessel used for oil production and storage, including offloading facilities to a shuttle tanker The vessel is designed to store crude oil. Normally, the vessel is moored to the seabed, with producing facilities on the main deck. The vessel can be relocated, however it is usually kept in the same area for a long period of time.

A FPSO shall be regarded as a single facility with several functions. For its design, an integrated approach is essential, particularly for the assessment of operational and safety considerations. All systems are as follows:

- Fire protection and fire-fighting
- Instrument, Control and Safety System
- Safety and escape
- Electrical
- Mechanical handling
- Piping
- Marine operations

The FPSO, its station-keeping systems such as mooring system, yokes, turrets, the product transfer systems such as side by side or tandem offloading and the CALM buoys, SPM etc. shall be under scope of the Class. For the FPSO, the scope of Classification shall cover the following items:

- The hull and living quarters
- The safety and lifesaving systems
- The cargo handling systems and in particular the offloading system such as hawsers, hoses and ancillary equipment
- The utilities systems of the hull
- The Lifting appliances such as cranes and other devices
- The structure integrating the station-keeping system such as turret, chain stoppers, etc.

- Hull onboard towing equipment.
- The methanol loading and storage system
- The station-keeping system.
- The hull integrated supports of topsides

In general, process systems (topsides), export lines, flowlines, and risers do not require classification unless required by the Operator / Owner.

FDPSO (floating drilling, production, storage and offloading vessel):

A vessel that is used for oil drilling, storage, and production, with the ability to offload to a shuttle tanker The vessel is equipped to store crude oil.

FLNG (LNG floating production and storage vessel):

A vessel equipped with oil and gas production and storage facilities. The vessel is usually permanently moored. Because of the unit's complexity, a more thorough safety assessment is usually performed. The shuttle tanker is typically outfitted with systems for quickly disconnecting mooring lines between the shuttle tanker and the oil and gas producing and storage unit.

Turret:

A structure that connects the unit to the combined riser- and mooring-systems, allowing the unit to rotate freely (weather vane) without twisting the risers and mooring lines. Corresponds to a turret's structural, mooring, and riser support components.

Temporary mooring:

Anchoring in sheltered waters or harbors subject to mild environmental loads.

Ship type drilling units:

Ship type drilling units are seagoing ship-shaped units having a displacement-type hull or hulls, of the single, catamaran or trimaran types, which have been designed or converted for drilling operations in the floating condition. Such types have propulsion machinery.

A ship type drilling unit is utilized in the exploration and/or exploitation of oil and gas. The unit is normally fitted with a dynamic positioning system with several thrusters (dynamic positioning systems-DP) and operates in the same area for a limited duration of time. The unit complies with the standard class survey schedule.

The following are some characteristics of a drilling vessel:

- Worldwide transportation (transit) as conventional ships
- Short transportation time
- Large storage and payload capacity
- Motions similar to conventional ships and drilling operations are limited by ship motions
- Can operate in deep and ultra-deep waters

The Class Notation **DRILLING VESSEL** will be assigned for this type, compare Chapter 59, Section 2, C.2.3.

Well stimulation vessel or well intervention vessel:

A unit is capable of executing subsea well wire-line intervention (without the need of a riser) and/or subsea coiled tubing. The unit is usually operating on the same area for a limited duration of time and is normally fitted with dynamic positioning system with several thrusters. The unit complies with the standard class survey schedule.

Barge type drilling units:

Barge type drilling units are seagoing units having a displacement type hull or hulls, which have been designed or converted for drilling operations in the floating condition. These units have no propulsion machinery.

The Class Notations **PONTOON EQUIPPED FOR DRILLING** will be assigned for this type, compare Chapter 59, Section 2, C.2.3 and C.2.9.

Other types of surface drilling units:

Units which are designed as mobile offshore drilling units and which do not fall into the categories above will be treated on an individual basis and be assigned an appropriate Classification designation.

1.1 Unit's areas categorization

TL may categorize structural members of the units included by this standard as follows:

- members of the "ship part," which are structural members constituting the ship hull and subject to the Ship Rules' requirements, including the moonpool structure

- members of the "offshore part", which are structural members welded to the hull structure giving an interface between the hull and equipment installations onboard the drilling vessel.

The "offshore part" shall also include structural members strengthening the hull to withstand loads caused by topsides equipment installations.

***Note: TL** may change the boundary limits between "ship part" and "offshore part" as a consequence of engineering judgment based on knowledge of the loading path and corresponding stress level.*

1.1.1 Requirements for "ship part"

Structural members of the "ship part" shall meet the requirements of the **TL** Ship Rules, unless otherwise specified in these Rules in the event of a discrepancy between the Ship Rules and these Rules; the more stringent requirement will apply.

1.1.2 Requirements for "offshore part"

Structural members of the "offshore part" shall meet the requirements of the **TL** Offshore Rules (Chapters 59 -64).

The following are some examples of members that belong to the "offshore part":

- Derrick foundation on hull

- Turret supporting structure on hull

- Crane pedestal and its foundations

- Pipe rack foundations

- Substructure of laydown areas

- Helideck supporting structure

- Winches drawworks) foundation on hull

- Flare boom foundations

- Passing mooring foundations on hull, when applicable

- Handling cranes for BOP, ROV, etc pedestal and foundation on hull

1.2 Turret and moonpool structure

The opening of the moonpool should be arranged to minimize additional stress caused by global stress concentration. Excessive yielding and buckling in the structure surrounding the moonpool shall be checked.

A finite element analysis shall be employed to calculate the mooring and turret interface to the hull structure, taking into account all relevant loads. Loads from mooring lines, external sea pressure, internal tank filling, and hull girder loads shall be taken into account.

Yielding and buckling checks shall be performed with acceptance criteria given in **TL** Rules, Chapter 62.

***Note:** The influence of global hull girder loads is relatively minor when the turret structure is located in the vessel's bow section. The hull girder loads may be eliminated if the effect of hull girder contribution can be documented, such as through a wave load analysis, to have no effect on the turret support structure.*

2. Scope

2.1 This Section covers those specific design criteria and features of surface drilling units which are not dealt with in other Sections, as referred to in the following.

2.2 Subdivision and watertight integrity

Subdivision and watertight integrity of surface drilling units are dealt with in Section 7. Regarding stability see C.

2.3 Machinery and electrical installations

Machinery and electrical installations shall be designed according to Chapter 63 and 64 respectively, as applicable.

2.4 Positional mooring equipment

An arrangement drawing for the mooring system has to be submitted. Mooring forces and permissible mooring directions are to be defined.

In the drawings for the hull structure the foundations for the mooring winches and the fairleads have to be shown. As maximum mooring forces the breaking strength of the mooring cables defined in the mooring arrangement has to be assumed.

Mooring equipment for position keeping at the working location is defined in Section 8, C.

2.5 Dynamic position keeping

Dynamic position keeping at the drilling location means maintaining a desired position within the normal excursions of the control system and under defined environmental conditions. The required position tolerances during drilling operations have to be defined by the Owner/Operator.

The complete dynamic positioning system requires the following sub-systems:

- Power system
- Thruster system
- Control system

Thrusters used as sole means of position keeping shall provide a level of safety equivalent to that provided for mooring arrangements to the satisfaction of **TL.**

The Class Notations **DK 1** to **DK 3** will be assigned if the unit is equipped with such a system, compare Chapter 59, Section 2, C.2.7.

Further details are defined in the **TL** Rules, Chapter 22, Dynamic Positioning Systems.

2.6 Lifting appliances

Drawings showing the location and support of foundations for cranes and davits have to be submitted. The forces to the hull structure have to be defined.

For the interaction of lifting appliances with the unit, their foundations, etc. see Chapter 62, Section 8.

The requirements for offshore cranes and other lifting appliances themselves are defined in the **TL** Rules, Chapter 50 – Rules for the Construction and Survey of Lifting Appliances.

2.7 Towing

If the unit is towed by tugs, a general arrangement drawing of the towing system has to be submitted. Towing forces and permissible towing directions are to be defined.

In the drawings of the hull structure the measures to transfer the towing forces into the hull have to be shown. As maximum towing forces the breaking strength of the towing ropes or cables defined in the towing arrangement has to be assumed.

Conditions for towing shall be clearly indicated in the Operating Manual, compare Section 1, C.3.1.

B. Structure

1. General

Scantlings of the hull structure are to meet the **TL** Rules, Chapter 1 – Hull. For barge types according to A.1.2 especially Section 33 – Barges and Pontoons has to be observed.

Special consideration however is to be given to items which may require some deviation or additions to these Rules.

1.1 Ship type drilling units

1.1.1 Scantlings of the hull structure are to meet the above mentioned Rules. Special consideration is, however, to be given to items which may require some deviation or additions to the Rules, in particular the items indicated in 1.1.2 – 1.1.5.

1.1.2 The required strength of the unit is to be maintained in way of the drilling well, and particular attention is to be paid to the transition of fore and aft members so as to maintain continuity of the longitudinal material. In addition, the plating of the well is to be suitably stiffened to prevent damage due to foreign objects which may become trapped in the well while the unit is under way.

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

1.1.4 The structure in way of heavy concentrated loads resulting from the drilling derrick, pipe rack, set back, drilling mud storage, etc., is to be suitably reinforced.

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

1.2 Barge type drilling units

1.2.1 Scantlings of the hull structure are to meet the above mentioned Rules. Special consideration, where applicable, is to be given to items listed in 1.1.

1.3 Design methods

The two applicable design methods are given as follows:

- Working Stress Design (WSD)
- Load and Resistance Factor Design (LRFD).

The design method for the project shall be specified and implemented. It is not acceptable to combine different design methods during the design. Both methods shall apply to the hull and topside structure.

1.4 Structural Categorization

Categorization of structural members for surface drilling units are defined in Chapter 62, Section 4 and Chapter 1 Hull, Section 3 as applicable.

1.5 Design principles

The limiting operating condition which the unit is intended to operate shall be specified and used as a basis for the design operating conditions. The condition shall be specified with:

The limiting operating condition under which the unit is designed to operate shall be specified and utilized as the basis for the design operating conditions. The condition shall be described such as:

- Significant wave height
- Zero crossing period
- Wind speed

The design principles for transit, operating and survival conditions shall be provided in Operating Manual.

The Operator/Owner shall establish the limiting operational parameters for loading conditions covering typical on-site operations in terms of pitch, roll, and heave amplitudes.

1.6 Design conditions

All applicable design conditions shall be taken into account as follows;

- Transportation (transit) condition
- Operating condition
- Survival condition
- Accidental condition

A drilling unit is typically designed for worldwide operation, although it can also be configured to operate in specific locations. A production unit is usually built to operate in a specific location.

1.6.1 Transportation (transit) condition

Unrestricted transportation is described as transporting the unit from one geographical location to another, and is addressed by the TL Offshore Rules Chapter 62.

However, the units that are expected to stay at one specific location for most of the design life may be accounted under restricted transportation.

TL Ship Rules may be used to compute design accelerations for topside module structures and topside module interfaces to the hull. Design accelerations may also be derived through direct calculations as an alternative approach.

1.6.2 Operating conditions

Operating condition refers to a maximum operational criteria for the environmental loads at which the unit need to standby the operation, and typically stop the drilling activity. Operation criteria is primarily applicable for drilling units.

The operating condition shall take into account for the combination of wave and wind effects.

Limiting design data for each operation mode shall be defined in the structural design brief and in the Operating Manual.

1.6.3 Survival condition (ULS)

The survival condition refers to the “ultimate limit state (ULS)” condition and is the extreme storm environmental loads the unit may be subjected to.

The survival condition shall take into account for the combination of wave and wind effects.

A unit operating in locations subject to extreme storm conditions such as typhoons, hurricanes, etc and intend to leave the location and look for sheltered waters, the survival condition may be accounted for as an accidental condition. Furthermore, the unit shall be designed in accordance with the 100-year storm condition.

1.6.4 Accidental condition (ALS)

An accidental condition refers to unintended event which in combination with other conditions result in an accidental outcome such as collision, dropped object, fire, explosion, and working failure, etc.

1.7 Loads

1.7.1 Static Loads

The still water loads are made up of both permanent and variable functional loads.

Permanent functional loads applicable for offshore vessels are:

- Mass of the steel of the vessel including permanently fitted topside modules and equipment, such as accommodation, helideck, flare tower, drilling equipment, offshore cranes and production equipment.

- Mass of position mooring lines and risers.

Typical variable functional loads are:

- Hydrostatic pressures
- Ballast water
- Fuel oil
- Crude oil
- General Cargo
- Mud, brine and drill water
.
- Consumables
- Personnel
- Mooring forces

- Riser tension.

Note: *Variations in operating mass distributions (including tank-filling conditions) shall be properly accounted for in the structural design.*

1.7.2 Still water hull girder loads

For transit and operational conditions separately, all applicable still water load conditions shall be described, and allowable limit curves for hull girder bending moments and shear forces shall be defined.

The allowable limits for hull girder still water bending moments and hull girder still water shear forces shall be specified at each transverse bulkhead point and included in the loading manual. Stillwater sagging and hogging moments, as well as positive and negative stillwater shear forces, shall have separate limitations.

1.7.3 Wave induced loads

The wave loads shall be calculated for the specific environment where the unit shall be operated.
Wave induced responses shall be determined as follows;

- Vessel motions
- Accelerations
- Vertical wave bending moment
- Horizontal wave bending moment
- Torsional moments when relevant
- External sea pressure
- Axial forces

1.7.4 Wind loads

Topside structures prone to significant wind exposure, such as flare towers, derricks, and modules, shall be designed to account for wind loads. The inertia loads from the waves shall be combined with the mean wind speed over 1 minute period at the actual position above sea level.

Note that additional Vortex Shedding analyses are required for slender members, such as members in a flare tower structure.

1.7.5 Green sea loading

Green sea-exposed structural elements shall be designed to sustain the induced loads. Green sea loads are accounted for as local loads. When lacking more exact information, model test shall be employed.

2. Drilling well (moonpool)

A moonpool is a vertical structure that extends of a ship from deck to bottom level, that provide access to the sea and allowing for the safe and efficient deployment of equipment for drilling and subsea operations.

3D Finite Element analysis shall be employed to calculate the stress distribution in the areas such as moonpool openings, where global and local stress concentrations exist and shall be used to evaluate yielding, buckling and fatigue check.

In general, the minimum required longitudinal strength of the unit shall be maintained in way of the moonpool opening that generates potential reinforcements in comparison to the full part aft and forward of the moonpool opening. A proper transition of aft and forward structural elements shall be designed to ensure longitudinal material continuity. See example Fig 4.1.

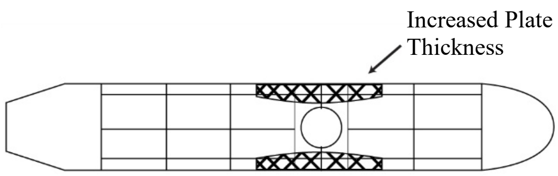

Figure 4.1 Example of an increased deck and bottom plating through moonpool corners.

Moonpool corners on deck, bottom and inner bottom are highly stress concentration areas, shall typically be strengthen with corner plates using insert plates and/or soft bracket types. See example Fig 4.2.

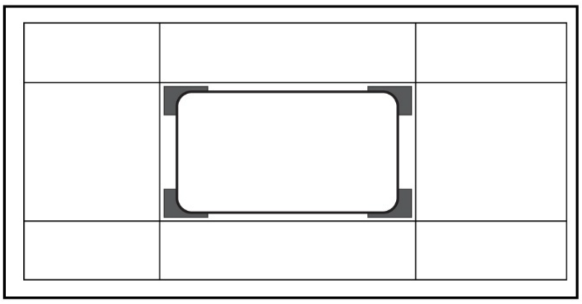

Figure 4.2 Example of a deck and bottom plating through moonpool corners.

The moonpool region shall be modeled for finite element analysis, with an appropriate extent modeling size taken into account.

As a general rule, sea pressures acting on moonpool bulkheads shall be computed as side shell sea pressures in accordance with the Ship Rules.

TL may accept pressures on moonpool bulkheads derived from direct calculations or model testing if relevant documentation on the calculations or test technique is submitted for approval.

Moonpool walls shall be adequately strengthen to avoid damage from a potential collision with an object trapped in the moonpool.

The dynamic loadings caused by collision event should be assessed accordingly, considering the mass, angle and shape of the dropped object, in addition to the vessel motion accelerations.

2.1 The required strength of the unit shall be maintained in way of the drilling well and particular attention shall be given to the transition between fore-and-aft members so as to maintain continuity of the longitudinal material. Stress concentrations have to avoided by a favourable structural detailed design. In addition, the plating of the well is to be suitably stiffened to prevent damage due to foreign objects which may become trapped in the well when the unit is in transit.

2.2 The drilling well is to be surrounded by cofferdams. Such cofferdams may temporarily be used also as tanks for liquids related to drilling operations, if they can be easily emptied for inspection.

3. Deck area

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

3.2 The structure in way of heavy concentrated loads resulting from the drilling derrick, pipe rack, set back, drilling mud storage, etc., is to be suitably reinforced.

3.3 The local structure in way of elements of the position mooring system and of the towing system, if applicable, has to be reinforced accordingly.

4. Hull structural strength

The hull girder strength and it’s structural members shall meet with the requirements as given in **TL** Ship Rules.

All structural members typically subject to local loads in both transit and in place (operation) conditions shall meet with the technical requirements in **TL** Offshore Rules Chapter 62.

The longitudinal strength requirements in transportation (transit) condition, and in survival condition in benign environment waters shall be evaluated in accordance the specific project technical requirements.

The longitudinal strength shall be assessed for the actual site specific loads in harsh environment waters. Relevant environmental loads derived from direct calculations shall be accounted for.

The yielding and buckling capacity checks of the main longitudinal members on the hull girder ultimate strength shall be carried out.

Scope of direct strength calculations shall be addressed with followings, but not limited to;

Hull strength:

- 3D cargo hold analysis
- optional: full ship analysis when relevant

Local analysis:

- Opening on main deck, bottom, and inner bottom (e.g. moonpool corners)
- Toe of girder bracket at typical transverse bulkhead
- Toe and heel of horizontal stringer in way of transverse bulkhead
- Topside module supporting structure
- Crane pedestal and supporting structure
- Drill floor and supporting structure
- Foundations for heavy equipments such as BOP, Xmas, mud pumps, etc.

4.1 Hull section scantlings assessment

Based on geometry, given scantlings and described loads that the local Rule requirements for plates and profiles shall be calculated in accordance with the **TL** Ship Rules.

Global section modulus (i.e. deck, bottom structure) and moment of inertia shall be checked for compliance with the **TL** Rule requirements.

A particular attention shall be paid to the support of the corrugated bulkhead to the tank top (i.e. mud tanks)

Shadow areas of large openings that bending efficiency considered 0% should be taken into account section scantling calculations.

Typically cross sections should be checked accordingly and relevant examples might be given as follows but not limited to;

- Through moonpool
- Through brine tank and reserve mud tank aft end moon pool
- Through riser hold
- Through mud tank and pump room
- Tthrough MDO tanks, etc.

4.2 Transverse Strength

The transverse girder system and its elements shall be checked by means of finite element analysis and shall meet the requirement in accordance with material yielding and buckling capacity specified in the **TL** Ship Rules.

The structural design brief should include the determination of the design loading conditions, which should take into account the unit's structural arrangements.

Design loading conditions that emerge offshore for maintenance and inspection purposes shall be accounted for.

4.3 Local supports

The foundations and supporting structures of hull equipment and machinery shall be checked and are given as follows, but not limited to;

- Helideck supporting structure and substructure
- Thrusters supporting structures
- Rudders, nozzle and steering gears
- Davits and supporting structures of launching appliances such as life boat, raft, etc.
- Foundations and supporting structures of temporary mooring equipment such as chain stoppers, windlasses or winches, bollards, chocks, etc.

See example Fig 4.3.

4.4 Local stress analysis

The scantlings of the main girder system such as transverse frames, longitudinal girders, and horizontal stringers, as well as the girders on the transverse bulkhead, shall be evaluated. The impact of topside modules on hull structure, especially the drilling derrick, shall be accounted for.

The loads can be imposed by pressure in tanks, deck loads and equipments by mean of mass points. The mass represented topside structure may be connected to foot prints by bar elements.

The extension of the finite element model shall be agreed by the **TL**.

Fine mesh FE analysis or equivalent methods shall be used to identify local stress distribution in local locations, which is difficult to perform using coarse mesh.

Local stress assessments shall be performed in parts of the hull where the part ship finite element models used for the main girder system's strength do not adequately describe the local response, such as the toe of the girder bracket.

4.5 Strength assessment of topside module structure

A 3D structural analysis shall be used to evaluate the global strength of a topside module. The model shall contain primary supporting members such as deckhouse shell structures, internal bulkheads, pillars between decks, derrick, drill floor and substructure, and the primary member in trusswork structures. See example Figure 4.4.

The hull deformation shall be taken into account for design when the longitudinal deformations of the hull at the module and hull intersections to affect the stresses in the primary elements of the module due to hull girder bending moment.

Buckling of beams, columns and frames may be checked in accordance with **TL** Chapter 62 or other recognized standards as e.g. AISC, and API.

The buckling check of plated structures may be checked in accordance with **TL** Chapter 62.

Tubular members may be checked in accordance with TL Chapter 62 or API RP 2A.

Fatigue of topside module structures shall be documented according to the principles and requirements given in accordance with TL Chapter 62.

4.6 Topside to hull interface structure

This section provides the requirements for the hull strength supporting structure of topside interface foundations and support of heavy equipment.

The structural strength of the topside module supporting structures and associated foundations shall be verified using finite element analyses.

The appropriate model extent shall be in accordance with the requirements to calculate the stress distribution from:

- Hull girder bending moments and shear forces

- Lateral pressures in tanks and sea pressure, where applicable

- Local loads from equipments

Topside module structures such as drillfloor substructure and main supporting foundations for equipments, which shall have major impact of the hull girder stiffness, shall be included in the hull girder finite element modelling.

Hull girder loads corresponding to sagging and hogging conditions shall be taken into account when applicable.
The allowable still water bending moment and shear force figures specified and approved by **TL** in the Loading Manual shall be referenced.

The yielding and buckling strength checks shall comply with the requirements specified in **TL** Chapter 62 considering design procedure, load combinations and the modelling mesh size.

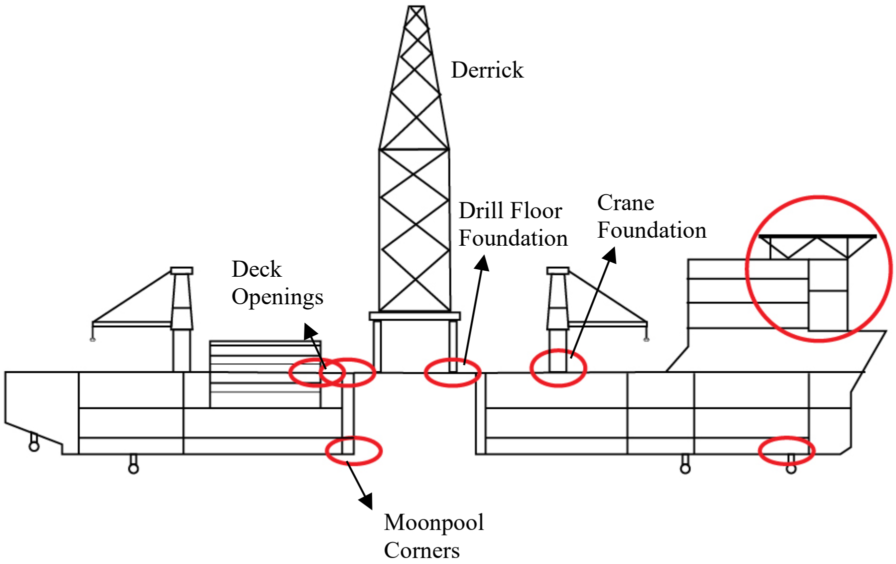

Figure 4.3 Example of the foundations and supporting structures of drill ship hull to be checked

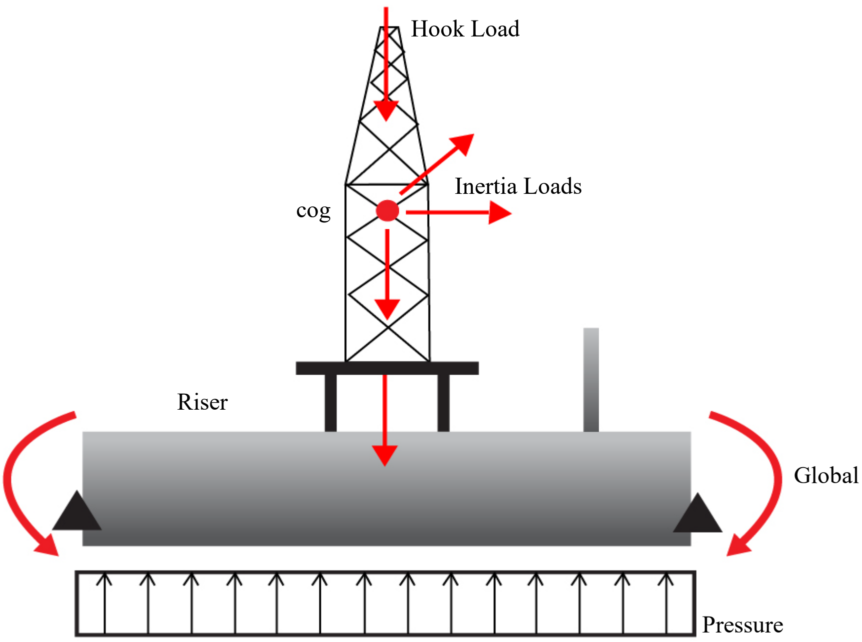

Figure 4.4 Example of the application of loads and boundary conditions on drill ships

4.7 Fatigue principles and methodology

The section provides the requirements for fatigue capacity evaluation of structural details in the unit. The evaluations shall consider for all major loadings that contribute to the fatigue damage.

The fatigue life assessment of the topside module supporting structure shall be checked and documented in accordance with the principles and requirements given in TL Chapter 62.

In determining fatigue life, stress concentration factors from fabrication imperfections that exceed the values specified in the S-N curves shall be taken into account.

Typical global loads shall be accounted for are:

- wave bending moments and shear forces
- horizontal and vertical hull deflections
- wave induced accelerations (e.g. inertia loads).

Typical local load effects shall be accounted for are:

- external sea pressure
- internal tank pressure
- vortex shedding
- variation of filling level in cargo tanks (e.g. low cycle).

A relevant correlation between various responses such as global wave bending, external and internal dynamic pressure and corresponding vessel accelerations shall be taken into account in the fatigue life calculation.

Low cycle fatigue shall be accounted for due to variable loads in drilling working operations.

The accumulated fatigue damage from both transit and operating conditions shall be computed based on the unit's operational parameters. The appropriate fraction of time in each condition, as well as the wave headings, shall be accounted for.

Gross scantling may be used in the fatigue life analysis as long as an intact protection scheme is in place.

4.7.1 Structural details to be checked

Fatigue critical details in the hull and topside module supporting structures shall be checked to demonstrate the adequate fatigue strength.

The structural items shall be checked as follows, but not limited to;

- openings on hull deck, bottom and inner bottom structure including deck penetrations.
- longitudinal stiffener end connections to transverse web frame and bulkhead.
- shell plate connection to longitudinal stiffener and transverse frames with special consideration in the splash zone.
- Toe and heel of horizontal stringer in way of transverse bulkhead.
- Hopper knuckles and other relevant discontinuities
- moonpool area corners including bracket connections, when applicable.
- topside module stool and supporting structures
- crane pedestal foundation and supporting structures
- hull connections to derrick and drill floor substructure
- helideck supports on hull deck
- attachments, foundations, supports etc. on hull deck

Note: *Additional details than above listed may be required in accordance with the complexity of the hull structure and topside interface design and fabrication details upon the* ***TL*** *request.*

4.8 Accidental conditions

Safety assessment shall be based on the principles for relevant accidental scenarios. The layout and arrangement of topside facilities and equipment shall be designed to minimize the negative consequences of accidental scenarios.

The accidental scenarios shall be validated in accordance with the dropped objects, fires, explosions, collision, unintended flooding, and loss of heading control.

Non-linear finite element analysis should be applied for the structural strength capacity assessment. All applicable failure modes such as strain rate, local buckling and joint overloading shall be verified. Local overloading of the structural capacity may be accepted if redistribution of loads is possible.

Dropped objects in crane lifts or other lifting-related working operations shall be examined. A dropped object shall not cause a critical failure such as a fire or an explosion, or damage to the unit's process equipment or safety system.

All safety-critical equipment shall be protected from dropping objects, and the protective structure shall be able to withstand the impact energy specified.

The structure that is exposed to a fire shall keep adequate structural strength prior to evacuation has taken place.

Structural design considering for large plate field rupture induced by explosion actions should be avoided as far as feasible due to the uncertainties of the actions and the outcomes of the rupture.

Supporting structure of blast (explosion) walls and the transfer of the explosion action into main structural elements shall be assessed when applicable. Efficiency of connections and the possible consequences from explosion shall be accounted for.

The hull structural design versus unintended flooding shall be in accordance with the deepest equilibrium waterline in damaged condition derived from damage stability assessments.

Collision event with a typical supply ship is normally not affecting the structural integrity as long as the unit complies with stability requirements specified by international or national regulators.

The impact of losing heading control shall be assessed for the units that are normally operated with heading control via thruster assistance.

The loss of heading control condition shall be taken into account in the hull, and topside module structural design.

4.9 Loading tool (instrument)

The loading tool (instrument) used to monitor the still water bending moments and shear forces, as well as the unit's stability, shall meet the criteria given in the **TL** Ship Rules.

The maximum allowable still water bending moments and shear forces approved in the loading manual shall be followed up.

4.10 Corrosion control for hull and topside structure

The hull and topside structures shall be corrosion protected in accordance with **TL** Offshore Rules Chapter 62.

Steel surfaces in topside structures, with the exception of tanks, shall be protected by a suitable coating procedure that has been validated in marine environments.

Fresh water tanks shall have a sufficient coating system. Coating systems used in potable water tanks shall be subject to special requirements.

4.11 Principles of inspection

The extent of non-destructive testing performed during hull fabrication shall be in accordance with the requirements as given in TL Chapter 62.

C. Stability

Stability according to the requirements defined in Section 7 has to be investigated for the three occurring modes of operation:

- Drilling operation under defined environmental conditions
- Severe storm conditions
- Transit conditions between different drilling locations

D. Drilling Facilities

1. Scope

These Rules do not include requirements for the drilling of subsea wells or procedures for their control. Such drilling operations are subject to control by the coastal state.

2. Drawings to be submitted

The planned interaction of the drilling systems with hull has to be clearly documented, e.g. by:

- Drawings showing the arrangement of the drilling derrick including weights and moments
- Drawings showing the pipe storage and handling
- Drawings showing mud tanks, cement silos, etc.

3. Operating manual

The rated capacity for each reeving shall be included in the Operating Manual.

4. Drilling equipment

4.1 Drilling derricks shall be designed according to recognized codes/standards and/or applicable National Regulations.

Permanently installed piping systems for drilling operations are to comply with a recognised standard or code.

4.2 Requirements for drilling systems are contained in Chapter 63, Section 11.

E. Safety Aspects

1. Hazardous areas

The general classification in hazardous and nonhazardous areas is contained in Chapter 63, Section 2, whereas the area classification requirements to be observed for drilling are defined in Chapter 63, Section 11, B.2.

The requirements for explosion protection of electrical equipment in hazardous areas are defined in Chapter 64, Section 13.

2. Fire protection

The requirements for structural fire protection and means of escape are defined in Chapter 63, Section 10, B.

3. Fire detection and extinguishing

The requirements for fire detection and alarm systems are defined in Chapter 63, Section 10, J. The requirements for fire extinguishing systems and equipment are summarized in Chapter 63, Section 10, C. – I.

4. Life-saving appliances

The number, size and arrangement of life-saving appliances for the complete crew shall follow the requirements defined in Section 9 of this Chapter.

SECTION 5

PIPELAYING UNITS

A. General

1. Definition

As pipelaying vessels are to be understood:

1.1 Pipelaying vessels

Pipelaying vessels are seagoing ship-shaped units having a displacement-type hull or hulls, of the single or catamaran types, which have been designed or converted for pipe laying. Such types have propulsion machinery and a dynamic positioning system or positional mooring equipment.

The Class Notation **PIPE-LAYING VESSEL** will be assigned for this type, compare Chapter 59, Section 2, C.2.3.

1.2 Pipelaying barges

Pipelaying barges are seagoing units having a displacement type hull or a semi-submersible configuration, which have been designed or converted for pipe laying. These units have no propulsion machinery, but may have positional mooring equipment, adequate tug assistance or dynamic positioning.

The Class Notations **PONTOON EQUIPPED FOR PIPELAYING** will be assigned for this type, compare Chapter 59, Section 2, C.2.3 and C.2.9.

2. Scope

2.1 This Section covers those specific design criteria and features of pipelaying units which are not dealt with in other Sections, as referred to in the following.

2.2 Machinery and electrical installations

Machinery and electrical installations shall be designed according to Chapter 63 and 64 respectively, as applicable.

2.3 Lifting appliances

2.3.1 Drawings showing the location and support of foundations for cranes and davits have to be submitted. The forces to the hull structure have to be defined.

Rules for the interaction of lifting appliances with the unit, their foundations, etc. are defined in Chapter 62, Section 8.

2.3.2 If the lifting appliances shall be included into the Certification or Classification by **TL**, the requirements for offshore cranes and other lifting appliances are defined in the **TL** Rules, Chapter 50 – Rules for the Construction and Survey of Lifting Appliances.

3. Safety aspects

3.1 Hazardous areas

The general classification in hazardous and nonhazardous areas is contained in Chapter 63, Section 2.

The requirements for explosion protection of electrical equipment in hazardous areas are defined in Chapter 64, Section 13.

3.2 Fire protection

The requirements for structural fire protection and means of escape are defined in Chapter 63, Section 10, B.

3.3 Fire detection and extinguishing

The requirements for fire detection and alarm systems are defined in Chapter 63, Section 10, J. The requirements for fire extinguishing systems and equipment are summarized in Chapter 63, Section 10, C. – I.

3.4 Life-saving appliances

The number, size and arrangement of life-saving appliances for the complete crew shall follow the requirements defined in Section 9 of this Chapter.

B. Movement and Position Keeping

1. Possibilities

For the movement and position keeping of the unit during pipelaying the following possibilities may be established:

- Positional mooring with cables and anchors
- Dynamic positioning by a greater number of thrusters on the unit
- Combination of mooring and dynamic positioning

2. Dynamic analysis of the pipelaying system

A dynamic analysis is to be submitted to **TL,** which is to consider:

- Arrangement of positional mooring system considering elasticity of cables, if applicable
- Function of dynamic positioning system, if applicable
- Influence of the laid pipe and forces at the tensioners
- Influence of seastate, wind and current conditions, see Chapter 62, Section 1.

3. Positional mooring equipment

3.1 If the Class Notation "**EQUIPPED WITH POSITION MOORING SYSTEM**" will be assigned, such a system consisting of:

- Heavy anchors belonging to the unit and regularly changed in position by anchor handling tugs
- Safe stowage of the anchors on the unit and appliances to hand them over to the tugs
- Anchor cables as wire ropes or chain cables from the anchors to fairleads and winches on the unit including accessories like shackles,
- Quick release devices, wire rope terminations, etc.
- A winch or windlass for each anchor cable including tension control and measuring of cable length paid out
- Central control of all winches to keep position and allow forward movement of the unit on the planned track has to be provided, see also Chapter 59, Section 2, C.2.9.

3.2 An arrangement drawing for the mooring system is to be submitted. Mooring forces and permissible mooring directions are to be defined. An example for a mooring system with 10 anchors is shown in Figure 5.1 and Figure 5.2 for the two phases of starting of the operation and after a travel of abt. 600 m.

3.3 In the drawings for the hull structure, the foundations for the mooring winches and the fairleads are to be shown. The acting forces on the foundations are to be calculated for 100 % of the nominal breaking load of the mooring cables. For the supporting structure under this equipment 100 % of the minimum yield stress R_{eH} is to be observed as acceptance criterion in the calculation.

3.4 The mooring equipment for position keeping on the pipeline track is defined in Section 8, C.

4. Dynamic position keeping

4.1 Dynamic position keeping at the pipelaying route means maintaining a desired position within the normal allowance of the control system and under defined environmental conditions. The required position tolerances during pipelaying operations have to be defined by the Owner/Operator.

Thrusters used as sole means of position keeping shall provide a level of safety equivalent to that provided for mooring arrangements to the satisfaction of **TL.**

4.2 The complete dynamic positioning system requires the following sub-systems:

- Power system

- Thruster system

- Control system

4.3 The Class Notations **DK 1** to **DK 3** will be assigned if the systems complies with the requirements of the **TL** Rules, Chapter 22 – Dynamic Positioning Systems, see also Chapter 59, Section 2, C.2.7.

5. Combination of positional mooring systems with dynamic positioning

5.1 A combination of the positional mooring system according to 3. with a dynamic positioning system according to 4. May also be established, if it is of advantage for a special task.

5.2 It must be secured that all elements of the combined system are operated from one control station overlooking the unit and the mooring area.

5.3 The detailed requirements for such a combination will be defined case by case.

6. Towing

6.1 If the unit is towed by tugs, a general arrangement drawing of the towing system is to be submitted. Towing forces and permissible towing directions are to be defined.

6.2 Towing arrangements and procedures shall be such as to reduce to a minimum any danger to personel during towing operations. The design and arrangement of towing fittings shall have regard to both normal and emergency conditions.

6.3 In the drawings of the hull structure the measures to transfer the towing forces into the hull have to be shown. As towing forces, 100 % of the nominal breaking load of the towing lines is to be considered.

For the supporting structure under this equipment 100 % of the minimum yield stress R_{eH} is to observed as acceptance criterion in the calculation.

7. Operating manual

For the positioning and towing systems, the following aspects are to be included in the Operating Manual, compare Section 1, C.3.1:

- Principal functioning and co-operation of the different elements of the system

- Procedure for the start of pipelaying

- Procedure for normal pipelaying operation with advancing unit

- Stopping or finishing the pipelaying operation with disconnecting and abandoning of the pipeline

- Towing conditions

- Procedures in the event of failure of the systems

- Emergency measures

8. Sea trials

8.1 A schedule for the proposed tests of the positioning and towing systems are to be submitted for approval to **TL** Head Office in due time before the sea trials.

8.2 All procedures defined in the Operating Manual are to be tested as far as practicable in the sea trials.

8.3 The trials are to be executed in presence of a **TL** Surveyor who will sign a detailed trials protocol to be prepared by the builder, if the tests are successful. The duplicate of this protocol is to be sent to **TL** Head Office for final approval.

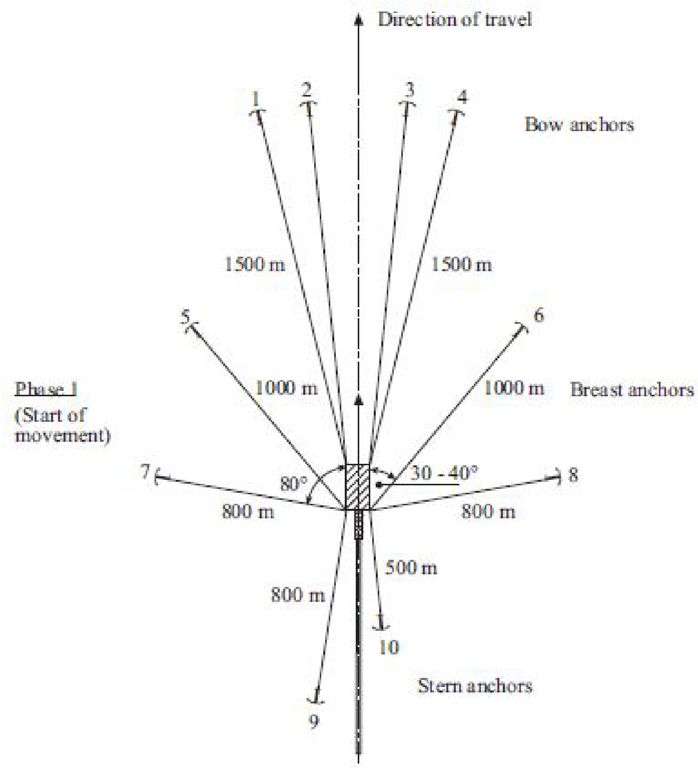

Fig. 5.1 Example for a typical position mooring system in abt. 100 m water depth (starting phase)

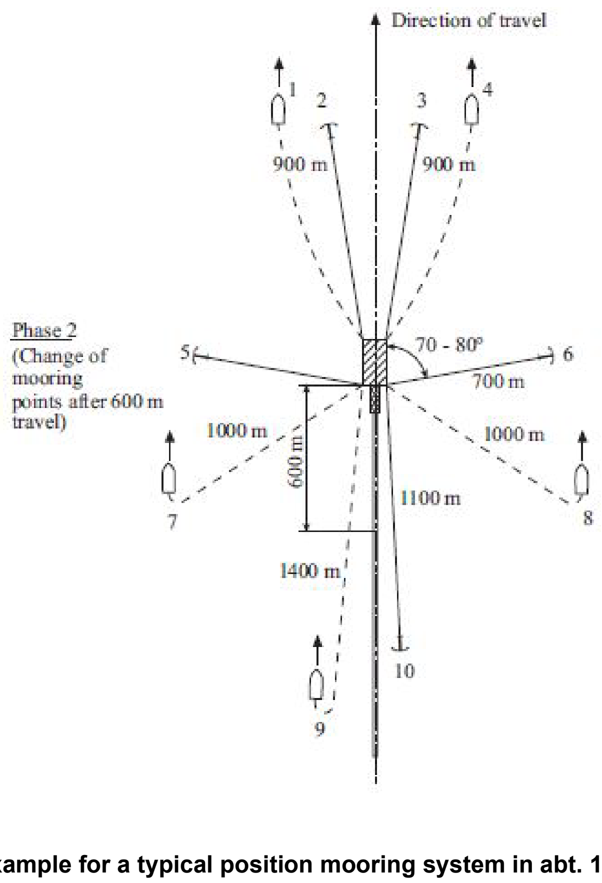

Fig. 5.2 Example for a typical position mooring system in abt. 100 m water depth (after 600 m travel)

C. Structure

1. General design

Scantlings of the hull structure are to meet the **TL** Rules, Chapter 1 – Hull. For barge types according to A.1.2 especially Section 33 – Barges and Pontoons is to be observed.

Special consideration however is to be given to items which may require some deviation or additions to these Rules, in particular the items defined in the following.

2. Loads

The loads established in the dynamic analysis of the pipelaying system according to B.2. are to be considered.

3. Special aspects for the hull structure

The following requirements, which are characteristic for pipelaying, are to be considered for the design of the hull structure, e.g.:

- Slot in the rear part of the main deck to lead the pipe with the necessary bending radius to the stinger
- Transmission of the forces from the stinger to the stern of the unit and of the forces from the A-frame for holding the stinger back and adjusting the inclination of it to the main deck
- Transmission of the pipeline forces pulling the (two) tensioners horizontally to the stern into the midship section of the hull
- Considerable mooring forces from different directions at stern and bow
- Various loads from the pipelaying facility as described in E.

D. Watertight Integrity and Stability

1. Watertight integrity

For subdivision into watertight compartments see Section 7, E.

2. Stability

2.1 Load cases

The following load cases have to be considered:

2.1.1 Standard load cases

- Normal pipelaying operation up to defined environmental limit conditions
- Severe storm and seaway conditions with pipe disconnected and abandoned at the seabed

2.1.2 Special load cases

- Ocean towage for long distances without or with stinger, if applicable
- Field towage for short distances with stinger
- Inspection or repair of existing pipelines by lifting up a part of the pipeline from the seabed to the units side
- Influences from crane operation and positional mooring are to be considered

2.1.3 Other load cases

Depending on the type of pipelaying unit and the method of operation other load cases may be considered case by case.

2.2 Stability criteria

2.2.1 Intact stability

Concerning stability criteria International Code on Intact

Stability, MSC 267(85) as amended shall be applied **(1).**

Special considerations shall be given to an unusual arrangement of units, which also may lead to additional stability criteria.

2.2.2 Damage stability

The criteria of the Code of Safety for Special Purpose Ships acc. to IMO Res. MSC.266(84) as amended and of the Code for the Construction and Equipment of Mobile Offshore Drilling Units (MODU Code) as amended shall be used as far as applicable.

E. Pipelaying Facility

1. Scope

In general the facility directly used for pipe storage, fabrication of the pipe connections, pipe fixing and delivering/recovering to/from the sea bed are not subject to Classification or Certification by **TL.** But the characteristics of the facilities, which influence:

- Overall design of the unit
- Overall safety of the unit
- Weights and forces on all foundations
- Floating and stability behaviour, etc.

will be considered by **TL**. Therefore **TL** has to be fully informed by the documents defined in 2.

(1) *In addition, the criteria of the Code of Safety for Special Purpose Ships acc. to IMO MSC.266(84) as amended and of the Code for the Construction and Equipment of Mobile Offshore Drilling Units (MODU Code) as amended shall be used as far as applicable.*

2. Documents to be submitted

A complete set of documentation to define the influenceson the unit is to be submitted by the builder/Operator of the facility, consisting of e.g.:

- General arrangement of the pipelaying facility and description of the main functions, definition of the environmental conditions up to which the facility is able to operate
- Facilities for lifting the pipes from the supply vessels to the storage area and pipe transport on the unit defining all created moments and forces
- Plans showing the arrangement of the pipe storage/racks, the maximum weights and the intended foundations on the upper deck
- Plans defining the foundation forces of the facility for pipe connections
- Plans showing the arrangement of the pipe tensioners and the maximum tension forces
- Plans showing the support arrangement on the pipe ramp and the maximum forces to be experienced
- Plans showing the integration of the stinger at thestern of the hull and definition of the forces to be transferred into the hull, if applicable
- Plans showing the stinger including length variation, if applicable and its floating support, if applicable
- Plans showing the A-frame for variation of the stinger inclination, if applicable
- **TL** reserve the right to ask for any other documentation necessary to define the interaction of the facility with the unit.

3. Operating Manual

The Operating Manual of the unit, compare Section 1, C.3.1, shall include all safety aspects created by the facility and is also to be submitted to **TL**. This manual shall include e.g.:

- Functions of the pipelaying facility including repair of existing pipelines, if applicable
- Influence of pipelaying on unit operation
- Special hazards to the unit
- Emergency measures if a failure happens in the pipelaying facility, etc.

SECTION 6

WELL STIMULATION UNITS

A. General

1. Definition

Well stimulation vessels or units are self-propelled ship-type vessels equipped for intervention at subsea wells with the aim to improve the operational well performance.

The Class Notations **WELL STIMULATION VESSEL** or **WELL STIMULATION UNIT** will be assigned for this type, compare Chapter 59, Section 2, C.2.3.

2. Stimulation service

The service of well stimulation vessels/units may be distinguished in:

- stimulation of subsea wells using various operating procedures

- stimulation of subsea wells including handling and storage of well fluids

3. Scope

In this Section the overall and special aspects for this type of vessel/unit are summarized and references are given to the different Chapters and Sections of the Rules where the detailed requirements are defined.

B. Special Safety Aspects

1. Area classification

For all types of vessels/units hazardous and nonhazardous areas are to be investigated and a complete area classification has to be performed, as far as needed. For the relevant criteria of such a classification see Chapter 63 – Machinery Installations, Section 2.

2. Fire protection

Special attention shall be given to fire protection and measures for fire fighting. Relevant methods are summarized in Chapter 63 – Machinery Installations, Section 10.

3. Emergency shut down

For all vessels/units an emergency shut down and quick well disengagement concept has to be developed distinguishing different shutdown levels according to the used procedures of well stimulation. The requirements for relevant safety systems are defined in Chapter 63 – Machinery Installations, Section 16.

4. Evacuation

If the stimulation procedures fail and the crew will be in extreme danger the equipment for a quick and smooth evacuation shall be available. The references to the requirements for such equipment are provided in Section 9.

5. Documentation

All safety aspects are to be clearly defined in written form, such as a Safety Management Plan, and shall be included in the Operating Manual of the vessel/unit, compare Section 1, C.3.1.

C. Position Keeping

1. As the well stimulation vessel/unit is to stay near or above the well within a very restricted location allowance, the position keeping will be a major prerequisite.

2. Position keeping may be established by the following methods:

- positional mooring with anchors, cables and mooring winches according to Section 8 and Chapter 63, Section 8, C.

- dynamic positioning with propulsion systems according to Chapter 63, Section 6, E. For this type of vessel/unit the requirements for Class Notation **DK 2** are recommended.

D. Well Stimulation Equipment

1. The foundations for such equipment are to be integrated into the structure of the vessel/unit considering extreme loads likely to occur during the stimulation process.

2. Well stimulation equipment is in general not subject to Classification by **TL.** Nevertheless this equipment shall be designed and built according to recognized regulations and safety standards.

3. Especially equipment to be installed in hazardous areas shall meet the necessary safety standards. For electrical installations reference may given to Chapter 64 – Electrical Installations, Section 13.

SECTION 7

SUBDIVISION, STABILITY and LOAD LINE

A. General Remarks, Scope

1. This Section refers to the subdivision, stability and load line requirements for mobile offshore units and covers, essentially, the relevant regulations of the IMO "Code for the Construction and Equipment of Mobile Offshore Drilling Units (MODU Code)", as amended.

2. Any additional National Regulations is to be observed, where applicable.

3. Regarding the effects of (maximum) angles of inclination on machinery installations see Chapter 63, Section 1, C. and Chapter 64, Section 1, E.

4. All units are to have positive stability in calm water equilibrium position, for the full range of draughts when in all modes of operation afloat, and for temporary positions when raising or lowering. In addition, all units are to meet the stability requirements set forth herein for all applicable conditions.

B. Righting and Heeling Lever Curves

1. Curves of righting levers and of wind heeling levers similar to Figure 7.1 with supporting calculations shall be prepared covering the full range of operating draughts including those in transit conditions, taking into account the maximum deck cargo and equipment in the most unfavourable position applicable.

The righting lever curves and wind heeling lever curves shall be related to the most critical axes. Account shall be taken of the free surface of liquids in tanks.

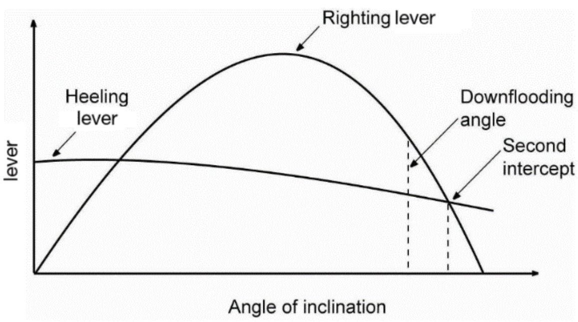

Figure 7.1 Righting and heeling lever curves

2. Where equipment is of such a nature that it can be lowered and stowed, additional wind heeling lever curves may be required; such data shall clearly indicate the position of such equipment. Provisions regarding the lowering and effective stowage of such equipment should be included in the operating manual.

3. The wind heeling moment is to be calculated at several angles of inclination for each mode of operation. The calculations are to be performed in a manner to reflect the range of stability about the most critical axis. The lever for the heeling force is to be taken vertically from the centre of lateral resistance or, if available, the centre of hydrodynamic pressure, of the underwater body to the centre of pressure of the areas subject to wind loading. In calculating wind heeling moments for ship-shaped hulls, the curve may be assumed to vary as the cosine function of the vessel's heel.

The curves of wind heeling levers shall be drawn for wind forces calculated by the following formula:

$$F = 0{,}5 \cdot C_S \cdot C_H \cdot \rho \cdot v^2 \cdot A \quad [N]$$

F = wind force [N]

C_S = shape coefficient depending on the shape of the structural member exposed to the wind, see Table 7.1 [–]

C_H = height coefficient depending on the height above sea level of the structural member exposed to wind, see Table 7.2 [–]

ρ = the air mass density (1.222 kg/m^3)

v = wind velocity [m/s]

A = projected area of all exposed surfaces in either the upright or the heeled condition [m²].

***Note :** All units are to be consistent.*

Shapes or combinations of shapes which do not readily fall into the specified categories will be subject to special consideration by the **TL**.

In calculating the wind forces, the following procedures are recommended:

(a) In the case of units with columns, the projected areas of all columns should be included; i.e. no shielding allowance should be taken.

(b) The block projected area of a clustering of deckhouses may be used in lieu of calculating each individual area. The shape coefficient may be assumed to be 1,1.

(c) Isolated houses, structural shapes, cranes, etc., should be calculated individually, using the appropriate shape coefficient.

(d) In calculating the projected areas to the vertical plane, the area of surfaces exposed to wind due to heel or trim, such as under-deck surfaces, etc., should be included using the appropriate shape factor. Open truss work commonly used for derrick towers, booms and certain types of masts may be approximated by taking 30% of the projected block area of each side, e.g. 60% of the projected block area of one side for double-sided truss work.

4. Wind forces are to be considered from any direction relative to the unit and the value of the wind velocity is to be as follows:

4.1 In general a minimum wind velocity of 36 m/s (70 knots) for offshore service shall be used for normal operating conditions and a minimum wind velocity of 51,5 m/s (100 knots) shall be used for the severe storm conditions in a reasonable period of time (See C, 2.). Loading conditions 2 and 3, respectively see Chapter 62, Section 3, C.

4.2 Where a unit is to be limited in operation to sheltered locations (protected inland waters such as lakes, bays, swamps, rivers, etc.) consideration is be given to a reduced wind velocity of not less than 25,8 m/s (50 knots) for normal operating conditions.

Table 7.1 Values of coefficient C_S

Shape	**C_S**
Spherical	0,4
Cylindrical	0,5
Large flat surface (hull, deckhouse, smooth under deck areas)	1,0
Drilling derrick	1,25
Wires	1,2
Exposed beams and girders under deck	1,3
Small parts	1,4
Isolated shapes (cranes, beams, etc.)	1,5
Clustered deckhouses or similar structures	1,1

Table 7.2 Values of coefficient C_H

Height above sea level [m]	**C_H (1)**
0 - 15,3	1,00
15,3 - 30,5	1,10
30,5 - 46,0	1,20
46,0 - 61,0	1,30
61,0 - 76,0	1,37
76,0 - 91,5	1,43
91,5 - 106,5	1,48
106,5 - 122,0	1,52
122,0 - 137,0	1,56
137,0 - 152,5	1,60
152,5 - 167,5	1,63
167,5 - 183,0	1,67
183,0 - 198,0	1,70
198,0 - 213,5	1,72
213,5 - 228,5	1,75
228,5 - 244,0	1,77
244,0 - 259,0	1,79
Above 259	1,80
(1) *The higher value of C_H has to be used.*	

4.3 In all cases, the limiting wind velocities are to be specified and instructions should be included in the Operating Manual for changing the mode of operation by redistribution of the variable load and equipment, by changing draughts, or both. Particulars of the applicable service restrictions should be recorded in the Operating Manual.

4.4 For the purpose of calculation it is to be assumed that the unit is floating free of mooring restraints. However, the possible detrimental effects of mooring restraints are to be considered.

5. In calculating the wind heeling moments the lever of the wind overturning force shall be taken vertically from the centre of pressure of all surfaces exposed to the wind to the centre of lateral resistance of the underwater body of the unit. The unit shall be assumed floating free of mooring restraint.

6. The wind heeling levers shall be calculated for a sufficient number of heel angles to define the curve. For ship shaped hulls the curve may be assumed to vary as the cosine function of unit heel.

7. Wind heeling moments derived from wind tunnel tests on a representative model of the unit may be considered as to the method given in 3. to 6. Such heeling moment determination shall include lift and drag effects at various applicable heel angles.

C. Intact Stability Criteria

1. Standard criteria

1.1 All units are to have sufficient stability (righting ability) to withstand the overturning effect of the force produced by a sustained wind from any horizontal direction, in accordance with the stability criteria for all afloat modes of operation. see also Figure 7.1.

1.2 For surface (ship-like) and self-elevating units the area under the righting lever curve to the second intercept or downflooding angle, whichever is less, shall be not less than 40 % in excess of the area under the wind heeling lever curve to the same limiting angle.

1.3 For column stabilized units the area under the righting lever curve to the angle of downflooding shall be not less than 30 % in excess of the area under the wind heeling lever curve to the same limiting angle.

1.4 The righting lever curve shall be positive over the entire range of angles from upright to the second intercept.

2. Severe storm condition

Each unit shall be capable of sustaining a severe storm condition in a period of time consistent with meteorological conditions. The procedures recommended and the approximate length of time required, considering both operating conditions and transit conditions, shall be contained in the Operating Manual. It shall be possible to achieve the severe storm condition without the removal or relocating of solid consumables or other variable loads. However, on application and with agreement of **TL** and Administration**,** loading a unit past the point at which solid consumables would have to be removed or relocated to go to severe storm condition may be permitted under the following conditions, provided the allowable KG requirement is not exceeded:

- in a geographic location where weather conditions annually or seasonally do not become sufficiently severe to require a unit to go to severe storm condition, or

- where a unit is required to support extra deck-load for a short period of time that is well within the bounds of a favourable weather forecast

The geographic locations, weather conditions and loading conditions when this is permitted shall be identified in the Operating Manual.

3. Alternative stability criteria

Alternative stability criteria may be accepted by the Administration provided an equivalent level of safety is maintained, and if they are demonstrated to afford adequate positive initial stability. The acceptability of such criteria will be determined considering at least the following and taking into account, as appropriate:

- Environmental conditions representing realistic winds (including gusts) and waves appropriate for world wide service in various modes of operation.

- Investigate dynamic response of the unit. The analysis shall include the results of wind tunnel tests, wave tank model tests, and non-linear simulation, where appropriate. Any wind and wave spectra used shall cover sufficient frequency ranges to ensure that critical motion responses are identified.

- Potential for downflooding, taking into account dynamic responses and wave profile;

- Susceptibility to capsizing considering the unit's restoration energy and the static inclination due to the mean wind speed and the maximum dynamic response.

- An adequate safety margin to account for uncertainties.

- Damage assumptions at least equivalent to the requirements contained in Sections F.2, F.3 and F.1;

- For column stabilized units one compartment flooding assumptions at least equivalent to the requirement contained in F2.2

D. Inclining Test

1. An inclining test shall be carried out with the first unit of a design, when as near to completion as possible, to determine accurately the light ship data (weight and position of centre of gravity). An inclining test procedure is to be submitted to the **TL** for review prior to the test, which is to be witnessed by a Surveyor of the **TL**.

2. For successive units which are identical by design, the light ship data of the first unit of the series may be accepted by the Administration in lieu of an inclining test, provided the difference in light ship displacement or position of centre of gravity due to weight changes and minor differences in machinery, outfitting or equipment, confirmed by the results of a deadweight survey, are less than 1 % of the values of the light ship displacement and principal horizontal dimensions as determined for the first of the series.

Particular care shall be given to the detailed weight calculation and comparison with the original unit of a series of column stabilized semi-submersibles as these, even though identical by design, are recognized as being unlikely to attain an acceptable similarity of weight or centre of gravity to warrant a waiver of the inclining test.

3. The results of the inclining test, or deadweight survey and inclining experiment adjusted for weight differences, shall be reviewed by the TL prior to inclusion in the Operating Manual.

4. A record of all changes to machinery, structure, outfitting and equipment that affect the light ship data, shall be maintained in the Operating Manual, or a light ship data alterations log, and be taken into account in daily operations.

5. For column stabilized units:

5.1 A lightweight survey or inclining test shall be conducted at the first renewal survey. If a lightweight survey is conducted and it indicates a change from the calculated light ship displacement in excess of 1% of the operating displacement, an inclining test shall be conducted, or the difference in weight shall be placed in an indisputably conservative vertical centre of gravity and approved by the Administration.

5.2 If the survey or test at the first renewal survey demonstrated that the unit was maintaining an effective weight control programme, and at succeeding renewal surveys this is confirmed by the records under 4, light ship displacement may be verified in operation by comparison of the calculated and observed draught. Where the difference between the expected displacement and the actual displacement based upon draught readings exceed 1% of the operating displacement, a lightweight survey shall be completed in accordance with 5.1.

6. The inclining test or deadweight survey shall be carried out in the presence of a **TL** Surveyor.

E. Subdivision and Damage Stability

All units are to have sufficient stability to withstand the flooding from the sea of any single compartment or any combination of compartments consistent with the damage assumption set out in subsection F for operating and transit modes of operation.

1. Surface and self-elevating units

1.1 The unit shall have sufficient freeboard and be subdivided by means of watertight decks and bulkheads to provide sufficient buoyancy and stability to withstand:

1.1.1 In general, the flooding of any one compartment in any operating or transit condition consistent with the damage assumptions set out in subsection F; and

1.1.2 for a self-elevating unit, the flooding of any single compartment while meeting the following criterion (see Figure 7.2):

$RoS \geq 7^o + (1.5\theta_s)$

where:

$RoS \geq 10^o$

RoS = range of stability, in degrees
= $\theta_m - \theta_s$

where:

θ_m = maximum angle of positive stability, in degrees

θ_s = static angle of inclination after damage, in degrees

The range of stability is determined without reference to the angle of downflooding.

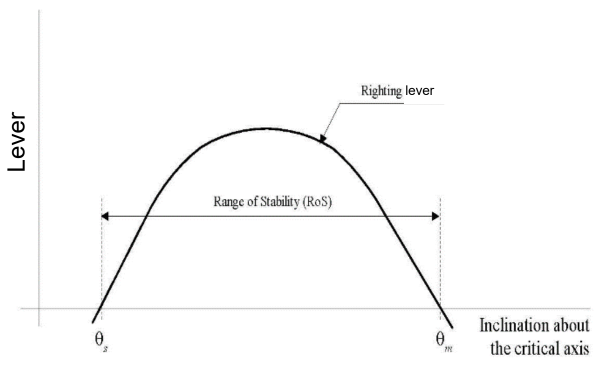

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Figure 7.2 Residual stability for self-elevating units

1.2 The unit shall have sufficient reserve stability in a damaged condition to withstand the wind heeling moment based on a wind velocity of 25.8 m/s (50 knots) superimposed from any direction. In this condition the final waterline, after flooding, shall be below the lower edge of any downflooding opening

1.3 Self elevating and surface type units are to have sufficient stability, such that the final waterline is located below the lower edge of any opening that does not meet the watertight integrity requirements of subsection G.

2. Column stabilized units

2.1 The unit shall have sufficient freeboard and be subdivided by means of watertight decks and bulkheads to provide sufficient buoyancy and stability to withstand a wind heeling moment induced by a wind of velocity of 25,8 m/s (50 knots) imposed from any direction in any operating or transit condition, taking the following considerations into account:

- The angle of inclination after the damage set out in F.3. shall not be greater than 17°.

- Any opening below the final waterline shall be made watertight, and openings within 4 m above the final waterline shall be made weathertight.

- The righting lever curve after damage as set out above shall have, from the first intercept to the lesser of the extent of weathertight integrity required above and the second intercept, a range of at least 7°. Within this range the righting lever curve shall reach a value of at least twice the wind heeling lever curve, both being measured at the same angle **(1)**, see Fig. 7.3.

(1) *Refer to "An example of alternative stability criteria for a range of positive stability after damage or flooding for column-stabilized semisubmersible units", adopted by IMO by resolution A.651(16).*

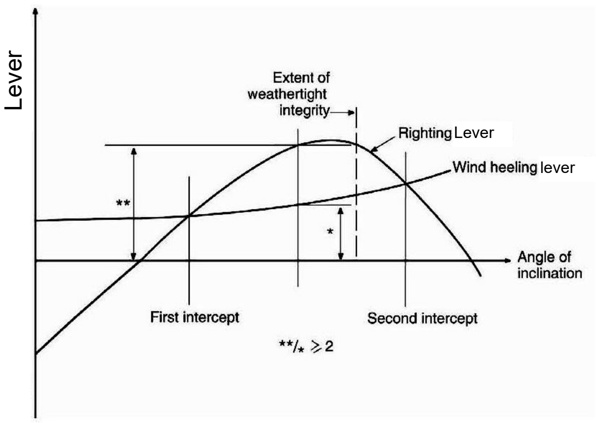

Fig. 7.3 Righting and heeling lever curves for damage stability

2.2 Column stabilized units are to have sufficient stability to withstand, in any operating or transit condition with the assumption of no wind, the flooding of any single watertight compartment located wholly or partially below the waterline in question, which is a pump room, a room containing machinery with a salt water cooling system or a compartment adjacent to the sea.

Taking the following considerations into account:

- The angle of inclination after flooding shall not be greater than 25°.

- Any opening below the final waterline shall be made watertight.

- A range of positive stability **(1)** shall be proven, beyond the calculated angle of inclination in these conditions, of at least 7°.

3. All types of units

3.1 The requirements of items 1 and 2 shall be determined by calculations which take into consideration the proportions and design characteristics of the unit and the arrangements and configuration of the damaged compartments. In making these calculations, it shall be assumed that the unit is in the worst anticipated service condition as regards stability and is floating free of mooring restraints.

3.2 For all types of units, the ability to reduce heeling angles by pumping out or ballasting compartments, or by application of mooring forces etc., shall not be considered as justifying any relaxation or alleviating of these provisions. For the purpose of calculation, it is to be assumed that the unit is floating free of mooring restraints. However, possible detrimental effects of mooring restraints are to be considered.

3.3 Alternative subdivision and damage stability criteria may be considered for approval by the Administration provided an equivalent level of safety is maintained. In determining the acceptability of such criteria, the Administration should consider at least the following and take into account:

- extent of damage as set out in subsection F;
- on column-stabilized units, the flooding of any one compartment as set out in 2.2,
- the provision of an adequate margin against capsizing.

F. Extent of Damage

1. Surface units

1.1 In assessing the damage stability of surface units, the following extent of damage shall be assumed between effective watertight bulkheads:

- horizontal penetration: 1,5 m

- vertical extent: bottom shell upwards without limit.

1.2 The distance between effective watertight bulkheads or their nearest stepped portions, which are positioned within the assumed extent of horizontal penetration, shall be not less than 3 m. Where there is a lesser distance one or more of the adjacent bulkheads shall be disregarded.

1.3 Where damage of a lesser extent than given in 1.1 results in a more severe final equilibrium condition, such lesser extent shall be assumed.

1.4 All piping, ventilation systems, trunks, etc., within the extent of damage referred to in 1.1 shall be assumed to be damaged. Positive means of closure shall be provided at watertight boundaries to preclude the progressive flooding of other spaces which are intended to be intact. In addition, the compartments bounded by the bottom shell are to be considered flooded individually.

2. Self-elevating units

2.1 In assessing the damage stability of self-elevating units, the following extent of damage shall be assumed between effective watertight bulkheads:

- horizontal penetration: 1,5 m
- vertical extent: from the base line upwards without limit

Where a mat is fitted, the above extent of damage should be applied to both the platform and the mat but not simultaneously, unless deemed necessary by the Administration due to their close proximity to each other. Assumed damage penetration simultaneous to both the mat and the upper hull need only be considered when the lightest draught allows any part of the mat to fall within 1,5 m vertically of the waterline, and the difference in horizontal dimension of the upper hull and mat is less than 1,5 m in any area under consideration.

2.2 The distance between effective watertight bulkheads or their nearest stepped portions, which are positioned within the assumed extent of horizontal penetration, shall be not less than 3 m. Where there is a lesser distance one or more of the adjacent bulkheads shall be disregarded.

2.3 Where damage of a lesser extent than given in 2.1 results in a more severe condition, such lesser extent shall be assumed.

2.4 All piping, ventilation, systems, trunks, etc. within the extent of damage referred to in 2.1 shall be assumed to be damaged.

2.5 Positive means of closure shall be provided at watertight boundaries to preclude the progressive flooding of other spaces which are intended to be intact. In addition, the compartments adjacent to the bottom shell are also to be considered flooded individually.

2.6 The recessed ends and sides of the drilling slot need not be subject to horizontal penetration if warning signs be posted on each side of the vessel stating that no boats be allowed inside the drilling slot. Instructions to this effect should be included in the Operating Manual.

3. Column stabilized units

3.1 In assessing the damage stability of column stabilized units, the following extent of damage shall be assumed.

3.2 Only those columns, underwater hulls and braces on the periphery of the unit shall be assumed to be damaged, and the damage shall be assumed in the exposed portions of the columns, underwater hulls and braces.

3.3 Columns and braces shall be assumed to be flooded by damage having a vertical extent 3,0 m of occurring at any level between 5 m above and 3 m below the draughts specified in the Operating Manual. Where a watertight flat is located within this region, the damage should be assumed to have occurred in both compartments above and below the watertight flat in question. Lesser distances above or below the draughts may be applied to the satisfaction of the Administration, taking into account the actual operating conditions. However, the extent of required damage region should be at least 1,5 m above and below the draughts specified in the Operating Manual.

3.4 No vertical bulkhead shall be assumed to be damaged, except where bulkheads are spaced closer than a distance of one eighth of the column's perimeter at the draught under consideration, measured at the periphery, in which case one or more of the bulkheads shall be disregarded.

3.5 Horizontal penetration of damage shall be assumed to be 1,5 m.

3.6 Underwater hulls or footings shall be assumed to be damaged while the unit is operating in a transit condition, in the same manner as indicated in 3.2, 3.3, 3.5 and having regard to their shape, either 3.4 or between effective watertight bulkheads.

3.7 If damage of a lesser extent results in a more severe damage equilibrium condition, such a lesser extent shall be assumed.

3.8 All piping, ventilation systems, trunks, etc., within the extent of damage shall be assumed to be damaged.

3.9 Positive means of closure shall be provided at watertight boundaries to preclude the progressive flooding of other spaces which are intended to be intact.

G. Watertight Integrity

1. Watertight boundaries

1.1 All units are to be provided with watertight bulkheads as may be required by the Rules (see Chapter 1, Section 11). In all cases, the plans submitted are to clearly indicate the location and extent of the bulkheads. In the case of column stabilized drilling units, the scantlings of the watertight flats and bulkheads are to be made effective to that point necessary to meet the requirements of damage stability and are to be indicated on the appropriate plans.

1.2 All surface type units are to be fitted with a collision bulkhead as may be required (see Chapter 1, Section 11). Sluice valves, cocks, manholes, watertight doors, etc., are not to be fitted in the collision bulkhead. Elsewhere, watertight bulkheads are to be fitted as necessary to provide transverse strength and subdivision.

2. Tank boundaries

2.1 Tanks for fresh water or fuel oil, or any other tanks which are not intended to be kept entirely filled in service, are to have divisions or deep swashes as may be required to minimize the dynamic stress on the structure. Tight divisions and boundary bulkheads of all tanks are to be constructed in accordance with the Rules. The arrangement of all tanks, together with their intended service and the height of the overflow pipes, is to be clearly indicated on the plans submitted for approval. Consideration is to be given to the specific gravity of the liquid in the tank.

2.2 Tanks are to be tested in accordance with the Rules (See Chapter 1, Section 3, E).

3. Boundary penetrations

3.1 The number of openings in watertight subdivisions should be kept to a minimum compatible with the design and safe operation of the unit. Where watertight boundaries are required for damage stability, they are to be made watertight throughout, including piping, ventilation, shafting, electrical penetrations, etc. For compliance with the requirements of damage stability (see E), where individual lines, ducts or piping systems serve more than one compartment or are within the extent of damage, satisfactory arrangements are to be provided to preclude the possibility of progressive flooding through the system to other spaces, in the event of damage.

3.2 Piping systems and ventilation ducts designed to watertight standards of the type mentioned in 3.1 are to be provided with valves in each compartment served. These valves are to be capable of being remotely operated from the weather deck, pump room or other normally manned space. Valve position indicators are to be provided at the remote control stations.

3.3 Non-watertight ventilation ducts as mentioned in 3.1 are to be provided with watertight valves at the subdivision boundaries and the valves are to be capable of being operated from a remote location, with position indicators on the weatherdeck, or in a normally manned space. For self-elevating units, ventilating systems which are not used during the transit operations may be secured by alternative methods, subject to special consideration.

3.4 Watertight doors shall be designed to withstand water pressure to a head up to the bulkhead deck or freeboard deck respectively. A prototype pressure test shall be conducted for each type and size of door to be installed on the unit at a test pressure corresponding to at least the head required for the intended location. The prototype test shall be carried out before the door is fitted. The installation method and procedure for fitting the door on board should correspond to that of the prototype test. When fitted on board, each door shall be checked for proper seating between the bulkhead, the frame and the door. Large doors or hatches of a design and size that would make pressure testing impracticable may be exempted from the prototype pressure test, provided that it is demonstrated by calculations that the doors or hatches maintain watertightness at the design pressure, with a proper margin of resistance. After installation, every such door, hatch or ramp shall be tested by means of a hose test or equivalent.

4. Closures

4.1 General

External closing appliances are to be as prescribed by applicable load line requirements. Special consideration will be given to openings in the upper deck of column stabilized units.

4.2 General requirements related to watertight integrity

4.2.1 External openings, such as air pipes (regardless of closing appliances), ventilators, ventilation intakes and outlets, nonwatertight hatches and weathertight doors, which are used during operation of the unit while afloat, are not to submerge when the unit is inclined to the first intercept of the righting moment and wind heeling moment curves in any intact or damaged condition. Openings, such as side scuttles of the non-opening type, manholes and small hatches, which are fitted with appliances to ensure watertight integrity, may be submerged **(2)**. Such openings are not to be regarded as emergency exits. Where flooding of chain lockers or other buoyant volumes may occur, the openings to these spaces should be considered as downflooding points.

4.2.2 External openings fitted with appliances to ensure watertight integrity, which are kept permanently closed while afloat, are to comply with the requirements of 4.2.4.

4.2.3 Internal openings fitted with appliances to ensure watertight integrity, are to comply with the following:

(i) Doors and hatch covers which are used during the operation of the unit while afloat should be remotely controlled from the central ballast control station and should also be operable locally from each side. Open/shut indicators should be provided at the control station. In addition, remotely operated doors provided to ensure the watertight integrity of internal openings which are used while at sea are to be sliding watertight doors with audible alarm. The power, control and indicators are to be operable in the event of main power failure. Particular attention is to be paid to minimizing the effect of control system failure. Each power-operated sliding watertight door shall be provided with an individual handoperated mechanism. It shall be possible to open and close the door by hand at the door itself from both sides.

(ii) Doors or hatch covers in self-elevating units, or doors placed above the deepest load line draft in column-stabilized and surface units, which are normally closed while the unit is afloat may be of the quick acting type and should be provided with an alarm system (e.g., light signals) showing personnel both locally and at the central ballast control station whether the doors or hatch covers in question are open or closed. A notice should be affixed to each such door or hatch cover stating that it is not to be left open while the unit is afloat.

(iii) The closing appliances are to have strength, packing and means for securing which are sufficient to maintain watertightness under the design water pressure of the watertight boundary under consideration.

(iv) Remotely operated doors shall meet SOLAS regulation II-1/13-1.

4.2.4 Internal openings, including openings providing access for inspection, fitted with appliances to ensure watertight integrity, which are to be kept permanently closed while afloat, are to comply with the following:

(2) *Such openings are not allowed to be fitted in the column of stabilized units (See Section 3, B, 3.).*

(i) A signboard to the effect that the opening is always to be kept closed while afloat is to be fitted on the closing appliance in question.

(ii) Opening and closing of such closure devices should be noted in the unit's logbook, or equivalent.

(iii) Manholes fitted with bolted covers need not be dealt with as under (i).

(iv) The closing appliances are to have strength, packing and means for securing which are sufficient to maintain watertightness under the design water pressure of the watertight boundary under consideration.

4.3 General requirements related to weathertight integrity

4.3.1 Any opening, such as an air pipe, ventilator, ventilation intake or outlet, non-watertight sidescuttle, small hatch, door, etc., having its lower edge submerged below a waterline associated with the zones indicate in (i) or (ii) below, is to be fitted with a weathertight closing appliance to ensure the weathertight integrity, when:

(i) a unit is inclined to the range between the first intercept of the right moment curve and the wind heeling moment curve and the angle necessary to comply with the requirements of C.1 during the intact condition of the unit while afloat; and

(ii) a column stabilized unit is inclined to the range:

a) necessary to comply with the requirements of E, 2.1 and with a zone measured 4.0 m perpendicularly above the final damaged waterline per E, 2.1 referred to Figure 7.4, and

b) necessary to comply with the requirements of E, 2.2.

4.3.2 External openings fitted with appliances to ensure weathertight integrity, which are kept permanently closed while afloat, are to comply with the requirements of 4.2.4 (i) and (ii).

4.3.3 External openings fitted with appliances to ensure weathertight integrity, which are secured while afloat are to comply with the requirements of 4.2.3 (i) and (ii).

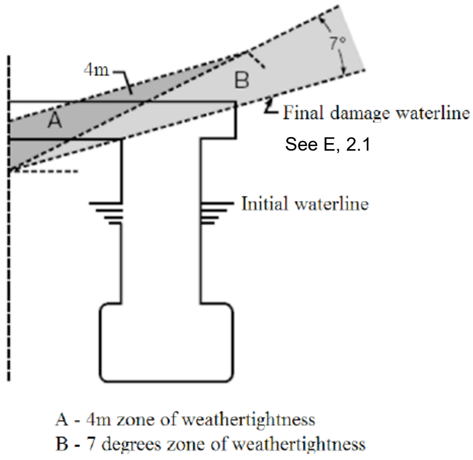

Figure 7.4. Minimum weathertight integrity requirements for column stabilized units

H. Load Line

1. General requirements

1.1 The requirements of the 1966/88 Load Line Convention, including those relating to certification, as amended shall in principle apply to all units and certificates shall be issued as appropriate. The minimum freeboard of units which cannot be computed by the normal methods laid down by that Convention shall be determined on the basis of meeting the applicable intact stability, damage stability and structural requirements for transit conditions and drilling operations while afloat. The freeboard shall not be less than that computed from the Convention where applicable.

All other units are to have load line marks which designate the maximum permissible draught when the unit is in the afloat condition. Such markings are to be placed at suitable visible locations on the structure, to the satisfaction of the **TL**. These marks, where practicable, are to be visible to the person in charge of mooring, lowering or otherwise operating the unit. The permissible draughts are to be established on the basis of meeting the applicable stability and structural requirements as set forth herein for afloat modes of operation, with such seasonal allowances as may be determined. In no case is the draught to exceed that permitted by the International Convention on Load Lines, where applicable. A load line, where assigned, is not applicable to bottom-supported units when resting on the sea bed, or when lowering to or raising from such position.

1.2 The requirements of the 1966/88 Load Line Convention with respect to weathertightness and water tightness of decks, superstructures, deckhouses, doors, hatchway covers, other openings, ventilators, air pipes, scuppers, inlets and discharges, etc., shall be taken as a basis for all units in the afloat condition.

1.3 In general, heights of hatch and ventilator coamings, air pipes, door sills, etc., in exposed positions and their means of closing shall be determined by consideration of of the provisions regarding both intact and damage stability requirements.

1.4 All downflooding openings which may become submerged, before the angle of inclination at which the required area under the intact righting arm curve is achieved, shall be fitted with weathertight closing appliances.

All downflooding openings the lower edge of which is submerged when the unit is inclined to the first intercept between the righting moment and wind heeling moment curves in any intact or damaged condition should be fitted with a suitable watertight closing appliance, such as closely spaced bolted covers.

1.5 With regard to damage stability, the requirements in E.2.1 (2nd item), E.2.2 and G.4.1 shall apply.

1.6 Administrations should give special consideration to the position of openings which cannot be closed in emergencies, such as air intakes for emergency generators, having regard to the intact righting arm curves and the final waterline after assumed damage.

1.7 Special consideration shall be given to small hatches with an opening area of 2,5 m² or less at the exposed deck over the forward 0,25 **L** on seagoing units of length 80 m or more, that are contracted on or after 1st January 2004, where the height of the exposed deck in way of the hatch is less than 0,1 **L** or 22 m above the summer load waterline, whichever is the lesser. For design details see **TL** Rules, Chapter 1 – Hull, Section 15, B.

1.8 Special consideration shall be given to air pipes, ventilator pipes and their closing devices at the exposed deck over the forward 0,25 **L** on seagoing units of length 80 m or more, that are contracted on or after 1st January 2004, where the height of the exposed deck in way of the pipes is less than 0,1 **L** or 22 m above the summer load waterline, whichever is the lesser. For design details see **TL** Rules, Chapter 1 – Hull, Section 16, D and E.

2. Surface units

2.1 Load lines shall be assigned to surface units as calculated under the terms of the 1966 Load Line Convention and shall be subject to all the conditions of assignment of that Convention.

2.2 Where it is necessary to assign a greater than minimum freeboard to meet intact or damage stability requirements, or due to any other restriction, imposed by the Administration, regulation 6(6) of the 1988 LL Protocol should apply. When such a freeboard is assigned,seasonal marks above the centre of the ring shall not be marked, and any seasonal marks below the centre of the ring shall be marked. If a unit is assigned a greater than minimum freeboard at the request of the owner, regulation 6(6) need not apply.

2.3 Where moonpools are arranged within the hull in open communication with the sea, the volume of the moonpool shall not be included in the calculation of any hydrostatic properties. An addition shall be made to the geometric freeboard, if the moonpool has a larger cross-sectional area above the water line at 0,85 **H** than below, corresponding to the lost buoyancy (**H** = depth). This addition for the excess portion above 0,85 **H** shall be made as prescribed for well/recesses below. If an enclosed superstructure contains part of the moonpool, deduction shall be made for the effective length of the superstructure.

Where open wells/recesses are arranged in the freeboard deck, a correction equal to the volume of the well/recess up to the freeboard deck divided by the waterplane area at 0,85 **H** shall be made to the freeboard obtained after all other corrections except bow height correction have been made. Free surface effects of the flooded well/recess shall be taken into account in stability calculations.

2.4 The procedure described in 2.3 shall also apply in cases of small notches or relatively narrow cut-outs at the stern of the unit.

2.5 Narrow wing extensions at the stern of the unit shall be considered as appendages and excluded for the determination of length **L** and for the calculation of freeboards. The Administration should determine the effect of such wing extensions with regard to the provisions relating to the strength of unit based upon length (*L*).

3. Self-elevating units

3.1 Load lines shall be assigned to self-elevating units as calculated under the terms of the 1966 Load Line Convention taking into account 2.2 to 2.5. When floating or when in transit from one operational area to another, units shall be subject to all the conditions of assignment of that Convention unless specifically excepted, e.g. from Reg. 39 (minimum bow height).

However, these units shall not be subject to the term of that Convention while they are supported by the seabed or are in the process of lowering or raising their legs.

For the consideration of moonpools see 2.3.

3.2 The minimum freeboard of units which due to their configuration cannot be computed by the normal methods laid down by the 1966 Load Line Convention shall be determined on the basis of meeting applicable intact stability, damage stability and structural requirements in the afloat condition.

3.3 Where it is necessary to assign a greater than minimum freeboard to meet intact or damage stability provisions or on account of any other restriction imposed by the Administration, regulation 6(6) of the 1988 LL Protocol should apply. When such a freeboard is assigned, seasonal marks above the centre of the ring should not be marked and any seasonal marks below the centre of the ring should be marked. If a unit is assigned a greater than minimum freeboard at the request of the owner, regulation 6(6) need not apply.

3.4 Where moonpools are arranged within the hull in open communication with the sea, the volume of the moonpool should not be included in the calculation of any hydrostatic properties. If the moonpool has a larger cross-sectional area above the waterline at 85% of the depth for freeboard than below, an addition should be made to the geometric freeboard corresponding to the lost buoyancy. This addition for the excess portion above the waterline at 85% of the depth for freeboard should be made as prescribed below for wells or recesses. If an enclosed superstructure contains part of the moonpool, deduction should be made for the effective length of the superstructure.

Where open wells or recesses are arranged in the freeboard deck, a correction equal to the volume of the well or recess to the freeboard deck divided by the waterplane area at 85% of the depth for freeboard should be made to the freeboard obtained after all other corrections, except bow height correction, have been made. Free surface effects of the flooded well or recess should be taken into account in stability calculations.

3.5 The procedure described in paragraph 3.7.15 should apply in cases of small notches or relatively narrow cut-outs at the stern of the unit.

3.6 Narrow wing extensions at the stern of the unit should be considered as appendages and excluded for the determination of length (*L*) and for the calculation of freeboards. The Administration should determine the effect of such wing extensions with regard to the requirements of the 1988 LL Protocol for the strength of unit based upon length (*L*).

3.7 Some self-elevating units utilize a large mat or similar supporting structure which contributes to the buoyancy when the unit is floating. In such cases the mat or similar supporting structure shall be ignored in the calculation of freeboard. The mat or similar supporting structure shall, however, always be taken into account in the evaluation of the stability of the unit when floating since its vertical position relative to the upper hull may be critical. See also Section 2 – Self Elevating Units.

4. Column stabilized units

4.1 The hull form of this type of unit makes the calculation of geometric freeboard in accordance with the provisions of Chapter III of the 1966 Load Line Convention impracticable. Therefore the minimum freeboard of each column stabilized unit shall be determined by meeting the applicable requirements for

- the strength of unit's structure

- minimum clearance between passing wave crests and deck structure, see Section 3, B.1.3.

- intact and damage stability requirements

4.2 The minimum freeboard shall be marked in appropriate locations on the structure.

4.3 The enclosed deck structure of each column stabilized unit shall be made weathertight.

4.4 Windows, sidescuttles and portlights, including those of the non-opening type, or other similar openings shall not be located below the deck structure of column stabilized units.

4.5 Administrations should give special consideration to the position of openings which cannot be closed in emergencies, such as air intakes for emergency generators, having regard to the intact righting arm curves and the final waterline after assumed damage.

5. Pipelaying units

For the special requirements for watertight integrity and stability of pipe laying units see Section 5, D.

SECTION 8

MOORING EQUIPMENT

A. General

1. Definitions

1.1 Permanent mooring

A permanent installation, as specified by the Offshore Rules and/or Standards, is one that operates on a single site for at least 5 years.

The mooring system of a permanent installation unit is specified as a permanent mooring system.

Disconnectable permanent mooring:

A disconnectable permanent installation unit is one that can disconnect from its mooring and riser systems in extreme environmental or emergency conditions.

The mooring system of a disconnectable permanent installation unit is specified as a disconnectable permanent mooring system.

When the installation unit is disconnected, the mooring system remains at location.

1.2 Temporary mooring equipment

Temporary mooring equipment in the context of this Section is the mooring equipment consisting of anchors, cables, winches etc. intended to be used while the mobile offshore unit is not in a working condition but during voyages and location moves, and for anchoring within harbours or in sheltered areas. The equipment is to be designed to hold a unit in position when exposed to moderate environmental loads.

1.3 Positional mooring equipment

Positional mooring equipment in the context of this Section is a system for position keeping on the working location. The system is intended to keep the unit in position, i.e. maintaining the prescribed limits of movement during the work envisaged and preventing the unit or other floating bodies from drifting under all anticipated sea and weather conditions.

1.4 Mobile mooring

A mobile mooring refers to a mobile unit's mooring system. The unit is neither a permanent installation nor a permanent installation that can be disconnected.

A mobile unit's mooring system is referred to as a mobile mooring system because it is designed to stay at a specific site for less than 5 years. Mobile mooring systems can be dismantled and reinstalled. See Fig. 8.1 for station keeping – mooring systems.

1.5 Unit moored at a jetty

A unit moored at a jetty is a specific type of permanent or disconnectable permanent installation unit.

The mooring system of a unit moored at a jetty is specified as a permanent or disconnectable permanent mooring system.

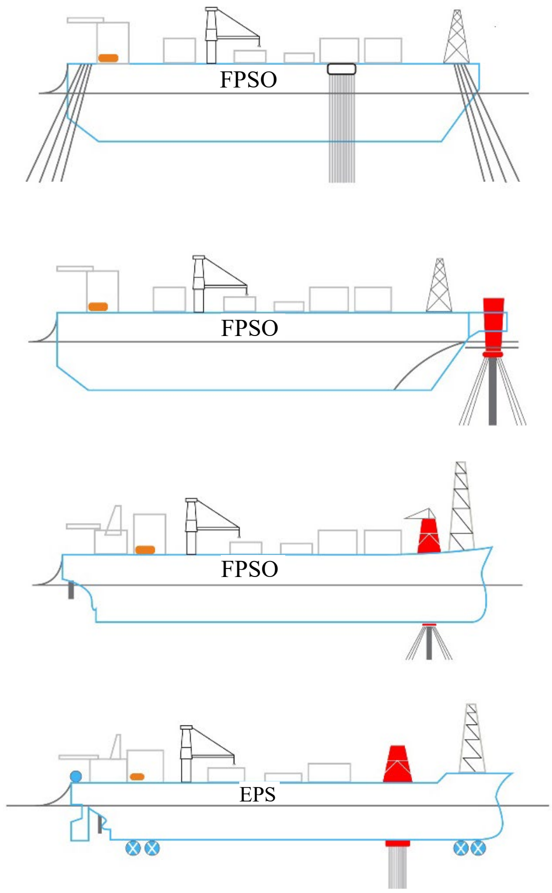

Figure 8.1 Example of station keeping – mooring systems

1.6 Hawser

A hawser is a mooring line connecting an offloading unit to a buoy or a mooring line between two offshore installation units.

2. International Recognized Standards

API RP 2A Recommended Practice for Planning, Designing and Construction of Fixed Offshore Platforms

API RP 2SK Recommended Practice for Design and Analysis of Station-keeping Systems for Floating Structures,

API RP 2SM Recommended Practice for Design, Analysis, and Testing of Synthetic Fibre Ropes in Offshore Applications

ISO 1704 Shipbuilding – Stud-link anchor chains

ISO 19901-1 Petroleum and natural gas industries - Specific requirements for offshore structures - Part 1: Meteocean design and operating considerations

ISO 19901-7 Petroleum and natural gas industries - Specific requirements for offshore structures - Part 7 Station keeping systems for floating offshore structures and mobile

NORSOK M-001 Material selection

NORSOK N-003 Actions and Action Effects

OCIMF Mooring Equpment Guidelines (MEG4)

3. Scope

3.1 As a condition of Class and for assigning the Class Notation **+** , the unit is to be provided with temporary mooring equipment complying with the provisions of B. Deviations from this general requirement will be stated in the Class Certificate.

3.2 Positional mooring equipment, usually provided for ship type and column stabilized units, is to comply with the provisions of C. An appropriate Notation may be affixed to the Character of Classification, see C.1.2.

3.3 When separate temporary mooring equipment is not fitted, consideration will be given to accepting the positional mooring equipment as equivalent to the rule requirements for temporary mooring equipment, if the provisions of B. are complied with.

3.4 Where positioning of the unit on the working location is achieved by a dynamic positioning system, the Notation **DK** will be affixed to the Character of Class, see C.7. In that case separate temporary mooring equipment according to B. will be required.

4. Operating manual

The operating manual covers the operational characteristics and capabilities of the mooring system in accordance with the **TL** Offshore Rules (Chapters 59 - 64) and the IMO MODU Code.

The design life of mooring lines shall be defined in the operating manual. The reference site assessment shall be provided in the operating manual.

5. Documents to be submitted

Plans showing the arrangement and complete details of the anchoring system, including anchors, shackles, anchor lines consisting of chain, wire or rope, together with details of fairleads, windlasses, winches and any other components of the anchoring system and their foundations are to be submitted to **TL.**

B. Temporary Mooring Equipment

1. General

1.1 Temporary mooring equipment fitted in accordance with the provisions of this Section is to be designed for quick and safe operation in all foreseeable service conditions and for holding the unit at anchor.

Note:

1. *Temporary mooring equipment is, therefore not intended to hold a unit off fully exposed coasts in rough weather or to stop a unit which is moving or drifting. In this condition, the loads on the mooring equipment increase to such* *a degree that its components may be damaged or lost owing to the high energy forces generated, particularly for large units.*

2. In good holding ground the temporary mooring equipment required by this Section is intended to hold a unit in conditions such as to avoid dragging of the anchor. In poor holding ground, the holding power of the anchors will be significantly reduced.

1.2 The temporary mooring equipment shall consist of anchors, chain cables, windlass or winches, chain stoppers, chain lockers (if chains are fitted) and wire ropes. The equipment of anchors and chain cables is to be determined from Chapter 1, Hull, Table 17.1.

1.3 The anchors are to be effectively stowed and secured to prevent any movement at sea. If the anchors are stowed at the shell, the shell plating is to be increased in thickness and the framing may have to be strengthened.

1.4 The arrangements are to be such as to provide an easy lead of chain cable/wire rope from the anchor to the windlass/winch and to ensure that the anchor can be dropped by its own weight without assistance.

1.5 Dimensioning

1.5.1 For the supporting structure under windlasses, chain stoppers, fairleads, sheaves and any other items of equipment subjected to loads from the anchor cables as determined in accordance with the provisions of 1.5.2 or 1.5.3, the following permissible stresses are to be observed:

- axial, bending stress : $\sigma_b \leq 0,8 \cdot R_{eH}$
- shear stress : $\tau \leq 0,5 \cdot R_{eH}$
- equivalent stress : $\sigma_{eq} = \sqrt{\sigma_b^2 + 3 \cdot \tau^2} \leq R_{eH}$

1.5.2 Where chain cables are led through hawse pipes, the acting forces are to be taken as 80 % or 45 % of the rated breaking load of the chain cable, i.e.

- for chain stoppers : 80 %
- for windlasses : 80 % where no chain stoppers are fitted
- for windlasses : 45 % where chain stoppers are fitted

1.5.3 Where hawse pipes are not installed and the chain cables are guided by fairleads and sheaves, the acting forces are to be taken as 100 % or 50 % of the rated braking load of the chain cable, i.e.

- for fairleads and sheaves: 100 %
- for chain stoppers : 100 %
- for windlasses : 100 % where no chain stoppers are fitted
- for windlasses : 50 % where chain stoppers are fitted

2. Equipment numeral

Equipment numeral is to be calculated according to Chapter 1, Section 17, B.

3. Anchors

3.1 General

Type/design, materials, manufacture and testing of anchors used for position mooring shall comply with the Chapter 1, Hull, Section 17, C.

Two rule power anchors according to Chapter 1, Hull, Table 17.1 are to be connected to their chain cables and positioned on board ready for use. It is to be ensured that each anchor can be stowed in the hawse and hawse pipe in such a way that it remains firmly secured in seagoing conditions.

Anchors used as positional anchors in accordance with C., which must be specially laid the right way up or which require flukes and profile to be adjusted to meet sea bed conditions, will not normally be approved for temporary mooring purposes.

4. Mooring chain cables and accessories

4.1 The chain cable diameters given in Chapter 1, Hull, Table 17.1 apply to chains complying with the requirements of the **TL** Rules, Chapter 2, Section 10, where

- Grade K1 (ordinary quality)
- Grade K2 (special quality)
- Grade K3 (extra special quality)

are defined.

4.2 Grade K1 chain cable should not be used for offshore applications. Where the installation of offshore quality mooring chains is intended, the provisions of C.4. apply.

4.3 Grade K2 and K3 chain cables must be post production quenched and tempered and shall be purchased only from recognized manufacturers.

4.4 Chain cables or wire ropes, if fitted, are to be made of materials and tested in accordance with the **TL** Rules mentioned under 4.1.

4.5 Where the total mass of anchors is divided into three or four anchors, see 3.1, the chain cable diameter and lengths are to be determined from Chapter 1, Hull, Table 17.1 for the mass of the anchor actually fitted. The chain cable length is to be determined by dividing the tabular length by two and then multiplying by the number of anchors actually fitted, unless specified otherwise by the Owner/Operator.

The mass and geometry of stud link chain cables are to be in compliance with the requirements in Chapter 2, Rules for Material, Section 10.

4.6 Accessories

4.6.1 Anchor shackles shall be of an approved type and the material(s) shall conform to the **TL** Rules mentioned under 4.1. Kenter-type shackles are recommended.

4.6.2 A forerunner with swivel is to be fitted between anchor and chain cable. In lieu of a forerunner with swivel, an approved swivel shackle may be fitted. However, swivel shackles are not to be connected directly to the anchor shank unless specially approved.

4.6.3 Where a spare anchor is fitted, see 3.1, a sufficient number of suitable spare shackles is to be kept on board to facilitate fitting of the spare anchor at any time.

4.7 Attachment of cable ends

4.7.1 The inboard ends of the chain cables are to be secured to the structures by a fastening able to withstand a force not less than 15% BL nor more than 30% BL (BL= breaking load of the chain cable).

4.7.2 The fastening is to be provided with a mean suitable to permit, in case of emergency, an easy slipping of the chain cables to sea, operable from an accessible position outside the chain locker.

4.8 Wire ropes

For wire ropes fitted in lieu of chain cables, see Chapter 1, Section 17, D.

4.9 Proof and Breaking Loads of Stud Link Chain Cables

For design and/or standard breaking loads BL and proof load PL of stud link chain cables, see Chapter 1, Section 17, D.

5. Chain locker

For capacity and arrangement of anchor chain locker see Chapter 1, Section 17, E.1.

5.1 Special requirements to minimize the ingress of water

For special requirements to minimize the ingress of water, see Chapter 1, Section 17 E.2.

5.2 Securing of Stowed Anchors

For securing of stowed anchors, see Chapter 1, Section 17, E.5.

C. Position Keeping Systems and Components

1. General

1.1 All units, except self-elevating units and submersible units, should be provided with position keeping systems designed to maintain the floating unit on station in all design conditions valid for its intended area(s) of operation.

1.2 Units provided with position keeping systems equipment in accordance with C. will be eligible to the special optional Class Notation "**EQUIPPED WITH POSITION MOORING SYSTEM**" added to the Character of Classification in accordance with the **TL** Rules, see Chapter 59, Section 2, C.2.9.

1.3 Units provided with thrusters serving (also) for position keeping will be eligible for the special Notations **DK1** to **DK3**, see 7.

2. Anchoring systems

2.1 Approval documents

2.1.1 Plans showing the arrangement and complete details of the anchoring system, including anchors, shackles, anchor line consisting of chain, wireor rope, together with details of fairleads, windlasses, winches, and any other components of the anchoring system and their foundations are to be submitted to **TL** for approval.

2.1.2 An analysis of the anchoring arrangements expected to be utilized during the unit's operation is to be submitted to **TL**. Among items to be addressed are:

- Design environmental conditions of waves, wind, currents, tides, and ranges of water depth
- Anchor holding capacities for various seabed soil conditions
- Air and sea temperature
- Ice conditions, if applicable
- Description of analysis methodlogy

2.1.3 Plans showing the towing arrangement(s) and equipment are to be submitted for information.

2.2 Design conditions, safety factors

2.2.1 Redundancy

The anchoring system should be designed so that a sudden failure of any single anchor line will not cause progressive failure of the remaining lines in the anchoring arrangement.

2.2.2 Loads

Anchoring system components should be designed utilizing adequate safety factors and a design methodology suitable to identify the most severe loading condition for each component. In particular, sufficient numbers of heading angles together with the most severe combination of wind, current and waves are to be considered, usually from the same direction, to determine the maximum tension in each mooring line.

When a particular site is being considered, any applicable cross sea conditions are also to be considered in the event that they might induce higher mooring loads.

2.2.3 Quasi static methods

When the Quasi static method is applied, the tension in each anchor line is to be calculated at the maximum excursion for each design condition defined in 2.**7**.4, combining the following steady state and dynamic responses of the unit:

a) Steady mean offset due to the defined wind, current, and steady wave forces.

b) Most probable maximum wave induced motions of the moored unit due to wave excitation.

For relatively deep water, the effect from damping and inertia forces in the anchor lines is to be considered in the analysis.

The effects of slowly varying motions are to be included for **MODUs** when the magnitudes of such motions are considered to be significant.

2.2.4 When the Quasi Static Method outlined in 2.**7**.3 is applied, the minimum factors of safety at the maximum excursion of the unit for a range of headings should be considered according to Table 8.1.

Table 8.1 Minimum factors of safety

Design condition	Safety factor
Operating	2,7
Severe storm	1,8
Operating-one line failed	1,8
Severe storm-one line failed **(1)**	1,25
(1) *See Chapter 62, Section 3, C : Extreme environmental loads*	

Safety factor = P_B / T_{max}

T_{max} = characteristic tension in the anchor line, equal to the maximum value obtained according to **2.7.3.**

P_B = minimum rated breaking strength of the anchor line.

2.2.4.1 Operating

For the most severe design environmental condition for normal operations as defined by the Owner or Designer see Chapter 62, Section 3, C.4.2.

2.2.4.2 Severe Storm

For the most severe design environmental condition for severe storm as defined by the Owner or Designer see Chapter 62, Section 3, C.4.3.

2.2.4.3 Operating - One Line Failed

Situation which follows a failure of any one mooring line in the operating condition.

2.2.4.4 Severe Storm - One Line Failed

Situation which follows a failure of any one mooring line in the severe storm condition.

2.2.5 Dynamic analysis

When a dynamic analysis is employed, other safety factors may be considered to the satisfaction of **TL**.

The defined operating and severe storm conditions are to be the same as those identified for the design of the unit, unless **TL** is satisfied that lesser conditions may be applicable to specific sites.

2.2.6 In general, the maximum wave induced motions of the moored unit about the steady mean ofset should be obtained by means of model tests. **TL** may accept analytical calculations provided that the proposed method is based on a sound methodology which has been validated by model tests.

In the consideration of column stabilized MODUs, the value of C_S and C_H, as indicated in Chapter 60, Section 7, B.3 (Table 7.1 and Table 7.2), may be introduced in the analysis for position keeping mooring systems. The intent of Chapter 60, Section 7, B.7 (Wind tunnel tests), and of Chapter 60, Section 7, C.2 (Alternative Stability Criteria), may also be considered by **TL**.

Wind loads shall be determined according to the principles shown in Chapter 62, Section 1, B. and Section 2, B.2. The results of wind tunnel tests, as well as other recognized criteria, may be considered.

2.2.7 **TL** may accept different analysis methodologies provided that a level of safety equivalent to the one obtained by 2.**7**.3 and 2.**7**.4 is ensured.

2.2.8 **TL** may give special consideration to an arrangement where the anchoring systems are used in conjunction with thrusters to maintain the unit on station.

2.3 Structural strength

For long-term mooring, the local structural strength of structures such as turrets and anchor structures shall be specified for a design load equal to the anchor line's typical breaking strength. As per **TL** requirements, the nominal equivalent membrane and bending stress shall be checked.

The total restoring mooring force, permanent and live loads, including accelerations due to ship motions and sea pressures acting on the turret, shall be used to determine the turret's overall structural strength. The calculations shall be performed using a 100-year response load.

The anchor pad eye is the connection point to the anchor shackle for anchors other than fluke and plate anchors.

3. Anchors

3.1 General

Type/design, materials, manufacture and testing of anchors used for position mooring shall comply with the **TL** Rules mentioned under B.3., if Certification by **TL** is requested.
Anchors specially designed for position mooring are normally not to be used for temporary mooring, see B.3.5.

3.2 Anchor Type and Piles and Structural Considerations

Fluke, plate, pile, suction, and gravity anchors are commonly used anchor types. In a case by case, other anchor types may be permitted upon **TL** review and approval. The embedment type anchors for mobile offshore units such as drilling, accommodation shall be constructed in such a way that additional anchors may be secured.

3.2.1 Pile, gravity and suction anchors

The load bearing part of the anchors shall be primary structural category, while the pad eye and the section of the structure distributing the load to the load bearing part shall be special structural category in accordance with **TL** requirements.

3.2.2 Fluke Anchors

Drag embedment anchors are a type of fluke anchor that is commonly used. The drag-in plate anchor, which is fitted as a fluke anchor but operates as an embedded plate anchor in its operational mode, is a further refinement of this anchor type.

The structural category shall be primary in accordance with **TL** requirements.

3.2.3 Plate Anchors

Plate anchors are anchors designed to withstand applied loads by orienting the plate approximately normal to the load after embedding. The plate anchor can be embedded by dragging (as with a fluke anchor), pushing, driving, or suction.

3.2.4 Anchor Piles

Anchor piles shall take into consideration pile bending stresses as well as ultimate lateral pile capacity. Pile embedment shall also be adequate to produce the axial capacity to withstand vertical loads with an appropriate factor of safety. The design shall be in accordance with recognized codes and standards. Pile fatigue during installation shall be accounted for.

3.3 Testing

Anchors shall be subjected to load tests according to the Rule requirements, in approved testing installations.

After application of the test load, it must be shown that the anchor is free of any defects/ deformations resulting from testing, and fully operable.

Test loads are shown in Chapter 1, Hull, Table 17.3. For anchors with increased holding capacity, the following test loads have to be applied:

HHP anchors : A load corresponding to 1,33 × mass of anchor.

VHHP anchors : A load corresponding to 2 × mass of anchor.

3.3 Anchors are to be securely stowed on board to prevent movement during transit/towage.

4. Anchor lines (mooring chain cables)

4.1 General requirements

4.1.1 **TL** are to be ensured that the anchor lines are of a type/composition that will satisfy the design conditions of the anchoring system. In general anchor cables may be of wire, rope, chain or any combination thereof. For wire ropes see B.4.8.

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

4.1.3 Means are to be provided for measuring anchor line tensions.

4.1.4 Anchor lines are to be of adequate length to prevent uplift of the anchors under the maximum design load condition for the anticipated area(s) of operation.

4.2 Offshore mooring chain cables – material requirements

For materials design, manufacturing and testing of offshore mooring chains and accessories see Chapter 2, Section 10.

4.3 Accessories

Anchor shackles to be used in long-term mooring system shall be of quality R3, R3S, R4, R4S or R5 and they shall be fabricated and tested according to **TL** requirements.

The chain qualities of K1, K2 and K3 intended for temporary mooring of commercial ships shall not be utilized for position mooring of offshore units.

Kenter shackles, D-shackles, C-links, and swivels are common connecting elements. Due to their poor fatigue properties, Kenter shackles, ordinary D-shackles, C-links, and pear links are usually not allowed in long-term mooring systems as fatigue life cannot be predicted due to a lack of fatigue data for these connecting pieces. However, for Kenter shackles may be used based on API RP 2SK which contains information to calculate the fatigue life of kenter shackles.

Non-traditional connectors shall be documented and qualified for the intended purpose if they are to be used in long-term mooring systems.

Connection components such as pear links and C-links should not be utilized in mobile mooring systems. Kenter shackles are accepted. Non-conventional connectors shall be validated and qualified for the intended purpose if they are to be utilized in mobile mooring systems. The fatigue capacity should be equivalent to Kenter shackles.

Swivels are not allowed in long-term mooring systems unless they are qualified in terms of functioning, structural strength, and fatigue.

The chain links shall not be twisted. The maximum angle that can be allowed between each link is 5 degrees.

5. Winch system

5.1 Winches

The requirements for mooring winches including their controls are defined in Chapter 63, Section 8, C.

5.2 Fairleads and sheaves

Fairleads and sheaves shall be designed to prevent excessive bending and wear of the anchor lines. The attachments to the hull or structure are to be such as to comply with the requirements of B.1.5.

6. Quality control

Details of the quality control of the manufacturing process of individual anchoring system components are to be submitted. Components shall be designed, manufactured, and tested in accordance with recognized standards and, if included in the Classification procedure according to 1.2, also in accordance with **TL** Rules. Equipment so tested shall, insofar as practical, be legibly and permanently marked with **TL**'s stamp and delivered with documentation which records the results of the tests. Concerning details on chain cables see 4.2.

7. Dynamic positioning systems

Thrusters used as a sole means of position keeping shall provide a level of safety equivalent to that provided for anchoring arrangements, to the satisfaction of **TL**, see also Chapter 63, Section 6, E. and Chapter 64, Section 12, E.

The Class Notations **DK1** to **DK3** will be assigned if the offshore unit is equipped with such a system, compare Chapter 59, Section 2, C.2.7.

The assessment for the assignment of a DK notation covers the following items:

- mooring lines
- mooring system components
- chain stoppers
- fairleads
- anchors.

Further details are defined in the **TL** Rules, Chapter 22 – Dynamic Positioning Systems.

D. Arrangement and Devices for Towing of Mobile Units

The installation unit shall have a permanent arrangement for towing. Towing bridles and pennants shall have access to the fairlead from the fastening devices. A bridle is usually used for column-stabilized units.

Typically, the towing arrangement shall be arranged for the usage of a single tug with suitable capacity. If the unit's size necessitates the employment of two or more tugs pushing in the same direction, this shall be indicated in the design. There shall be arrangements for hang-off and retrieval of the unit's towing bridles and towing pennants.

The design load for the towing arrangement shall be specified in the Appendix to the classification certificate.

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

Arrangements, equipment and fittings provided in accordance with both normal and emergency conditions should meet the appropriate requirements of the Administration or an organization recognized by the Administration.

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

E. Mooring System Analysis

The mooring system shall be analysed in accordance with design criteria with respect to three limit state equations such as ULS, ALS and FLS.

- An ultimate limit state (ULS) refers that the individual mooring lines have sufficient strength to sustain the load effects caused by extreme environmental loads.

- An accidental limit state (ALS) refers that the mooring system has sufficient capacity to sustain the failure of one mooring line, failure of one thruster or one failure in the thrusters' control or power systems for unknown reasons. A single failure in the control or power systems may lead to several thrusters are not operating.

- A fatigue limit state (FLS) refers that the individual mooring lines have sufficient capacity to sustain repeated loading.

The mooring lines shall be evaluated for strength in intact, damaged and transient conditions and for fatigue capacity assessment, Tension-Tension (T-T) and In-Plane/Out-of-Plane Bending (OPB/IPB) shall be accounted for. Time domain calculation shall be employed for the mooring analysis.

The response of the mooring system analysis shall be in accordance with a dynamic procedure. Quasistatic method may be accepted if it is shown that effects from anchor line dynamics are ignorable., Fatigue damage analyses shall be performed for mooring lines and connection elements by means of site-specific environmental data.

Corrosion allowance for chain, including wear and tear of chain and connection elements shall be accounted for as per NORSOK M-001.

It is important to note that the recommended stud chain reduction factor is only valid when the stud is perfectly fitted in the chain link. The fatigue life of a stud chain link is particularly sensitive to variations in stud tightness. When the stud comes loose, the stress distribution scenario changes completely, potentially resulting in a considerable reduction in fatigue life. Using studless chain eliminates these issues.

Stress concentration factors (SCF) due to out of plane bending shall be taken into account in the fatigue analysis for long-term mooring systems.

1. Mooring loads

Various methods can be applied to keep an installation unit on site. Spread mooring, external turret, internal and submerged turret systems, buoy, and dynamic positioning are all of these methods. Loads shall be imposed on the hull structure by each mooring system design. These loads shall be taken into account in the unit's structural design and integrated with other relevant load components. See Fig.8.5 for spread mooring and Fig.8.6 for external turret.

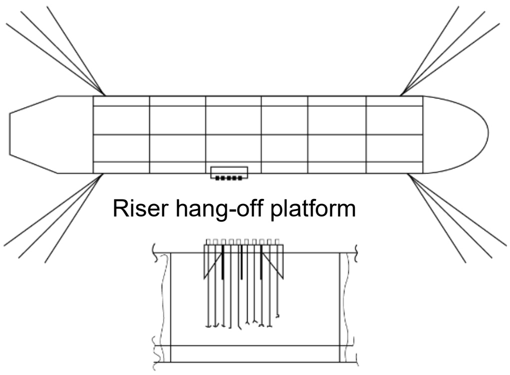

Figure 8.5 Example of a spread mooring system

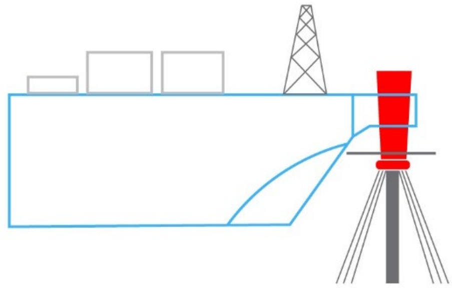

Figure 8.6 Example of an external turret system

2. Environmental conditions and loads

This section defines the environmental data to be used in the mooring system analyses.

The following environmental effects shall be accounted for a specific mooring location:

- waves
- wind
- current
- tide and storm surge
- marine growth
- temperature
- earthquake
- snow and ice when relevant

Comprehensive metocean criteria should be established for long-term mooring system. The study of the metocean criteria shall be issued available for information in connection with mooring design evaluation.

The environmental effects to be used in mooring line response calculations for the ULS and ALS must include the most adverse combination of wind, wave, and current, with a return time of no less than 100 years. Unfavorable conditions are those that result in increased mooring loads.

The load effects are based on the estimated tensions in the mooring lines, which are generally calculated. The analysis of line tensions shall consider the motion of the floating unit caused by environmental loads, as well as the response of the mooring lines to these motions. For stationary environmental states, the characteristic load effects are observed.

A specific environmental condition may be represented in followings:

- Significant wave height
- Wave period
- Wave direction
- Wave spectrum
- Wave energy distribution
- Mean wind speed
- Wind direction
- Wind spectrum function
- Surface current speed
- Current direction
- Current profile over depth

The same environmental conditions should be accounted for the ULS and ALS, whereas a wider range of environmental conditions shall be accounted for the FLS.

A set of environmental states shall be given for the fatigue analysis of long-term moorings in order to cover the range of conditions that may be encountered and allow accurate fatigue damage assessment.

3. Model tests

Basin (or tunnel) tests are generally required to determine load coefficients for wind and current on the installation unit. Model experiments in the basin shall be performed to validate the overall behavior of the system and to confirm the analyses.

In a case by case, model tests conducted on a very similar system in equivalent metocean conditions and water depth may be accounted for.

4. Marine growth

Long-term mooring systems for production and storage vessels must take into account marine growth on mooring lines. The thickness of the marine growth shall meet the requirements for the specific area. The weight of the line segments is increased, and the drag coefficients are increased, to accommodate for the increased marine growth.

5. Wind loads

Wind tunnel tests should be used to determine the wind load. Wind loads from model basin tests can only be used to calibrate an analytical model. Wind loads computed according to recognized standards may be acceptable such as: OCIMF, MEG 4 (See A.2).

Note: *OCIMF wind force coefficients are only relevant for trading tankers, and may be used for FSO's provided the above water geometry is similar.*

6. Current loads

Wind tunnel tests should be used to determine the current load. Alternatively, current loads can be predicted via model basin tests or calculations based on well-known theories, such as: OCIMF, MEG4 (See A.2).

7. Wave loads

The load analysis method's documentation shall be provided. The reliability of numerical models should be determined by measuring them to full scale or model tests. The reliability of model test findings used in the design must also be quantified.

8. Soil condition

The sea bed soil conditions for the intended site shall be assessed for long-term mooring to give data for anchor design. Soil data should be in accordance with soil borings at a depth representative of anchor penetration at a specific location.

SECTION 9

LIFE-SAVING APPLIANCES

Page

A. General

1. Scope

1.1 Life-saving appliances shall comply with the relevant applicable International Regulations according to 2.1 and/or National Regulations and shall be suitable for the type and use of the mobile offshore unit.

1.2 The design and testing of lifeboats, liferafts and rescue boats with their launching appliances is in general not within the scope of Classification of mobile offshore units by **TL**. However, their arrangement in the overall design of the unit and the structure in way of launching appliances taking into account the forces from above appliances are always part of Classification.

2. Rules and regulations

2.1 International Regulations

- International Maritime Organisation (IMO): International Convention for the Safety of Life at Sea (SOLAS), Chapter III - Life-Saving Appliances and Arrangements

- IMO: International Life-Saving Appliance Code (LSA Code), Resolution MSC.48(66) as amended

- IMO: Testing and Evaluation of Life Saving Appliances, Resolution MSC.81(70), as amended by MSC.200(80)

- IMO: Code for the Construction and Equipment of Mobile Offshore Drilling Units (MODU Code), Chapter 10

- IMO: Code of Safety for Special Purpose Ships, Resolution MSC 266(84), Chapter 8 as amended.