TÜRK LOYDU

Chapter 61 – Offshore Units and Installation – Fixed Offshore Units

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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.

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TÜRK LOYDU

Head Office Postane Mah. Tersaneler Cad. No:26 Tuzla 34944 İSTANBUL / TÜRKİYE

Tel : (90-216) 581 37 00

Fax : (90-216) 581 38 00

E-mail : info@turkloydu.org

http://www.turkloydu.org

Regional Offices

Ankara Mustafa Kemal Mahallesi, Dumlupınar Bulvarı, Mahall Ankara B Blok Daire No:184

Çankaya - ANKARA / TÜRKİYE

Tel : (90-312) 219 56 34

Fax : (90-312) 219 68 25

E-mail : ankara@turkloydu.org

İzmir Atatürk Cad. No :378 K.4 D.402 Kavalalılar Apt. 35220 Alsancak - İZMİR / TÜRKİYE

Tel : (90-232) 464 29 88

Fax : (90-232) 464 87 51

E-mail : izmir@turkloydu.org

Adana ÇınarlıMah. Atatürk Cad. Aziz Naciİş Merkezi No:5 K.1 D.2 Seyhan - ADANA / TÜRKİYE

Tel : (90- 322) 363 30 12

Fax : (90- 322) 363 30 19

E-mail : adana@turkloydu.org

Offshore Units and Installations - Fixed Offshore Installations

SECTION 1

SCOPE, DEFINITIONS and PROCEDURES

A. Scope, Application

1. Scope

1.1 In this Chapter the requirements for the different types of fixed offshore installations are defined.

1.2 Types of fixed installations

The following types have to be distinguished:

- installations permanently fixed by piling (pile foundation)
- installations resting on the sea bed by action of gravity (gravity foundation)
- installations with excess of buoyancy, connected to a base by tensioned anchoring elements (tension leg foundation)

1.3 Materials used for construction of the main structure/hull

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

- steel
- reinforced concrete
- any other suitable material
- combination of above materials

1.4 International Standards

AISC Steel Construction Manual

API Bulletin 2V Bulletin on design of flat plate structures

API Bulletin 2U Bulletin on stability design of cylindrical shells

API RP 2A LRFD Recommended Practice for Planning and Constructing Fixed Offshore Platforms Load and Resistance Factor Design

API RP 2A WSD Recommended Practice for Planning and Constructing Fixed Offshore platforms, Working Stress Design

API RP 2T, Planning, Designing and Constructing Tension Leg Platforms.

ASTM A 307 Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength

ASTM A 325 Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

ASTM A 490 Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength

EN 10164 Steel products with improved deformation properties perpendicular to the surface of the product - Technical delivery conditions

EN 10204 Metallic products - Types of inspection documents

NF P22-255 or equivalent Metal construction. Hollow section welded assemblies on type I and H sections. Design and verification

ISO 898-1 Mechanical Properties of Fasteners Made of Carbon Steel and Alloy Steel - Part 1: Bolts, Screws and Studs

ISO 19900 Petroleum and natural gas industries - General requirements for offshore structures

ISO 19901 (Parts 1; 2; 3; 4; 5; 6) Petroleum and natural gas industries - Specific requirements for offshore structures - (Parts 1; 2; 3; 4; 5; 6)

ISO 19902 Petroleum and natural gas industries - fixed steel offshore structures

Eurocode 3 Design of steel structures

NORSOK G-001, Soil investigation

NORSOK J-003, Marine operations

NORSOK M-001, Materials selection

NORSOK M-101, Structural steel fabrication

NORSOK M-120, Material data sheets for structural steel

NORSOK N-001, Structural design

NORSOK N-003, Action and action effects

NORSOK N-004, Design of steel structures

2. Application

The following types of employment have to be distinguished:

- drilling/exploration
- production, e.g. oil/gas
- construction / installation
- accommodation
- processing/treatment
- storage or loading on/off
- research, measurements
- other types of employment

3. Manning

The following types of manning have to be distinguished:

- continuously manned installations or units
- temporarily or intermittently manned installations
- unmanned installations

Depending on the type of employment and manning, the provisions of the Rules may have to be applied to a larger or lesser extent.

B. Definitions

1. Fixed Offshore Installations

Fixed offshore installations, according to these Rules, are installations for diverse purposes, see A.2., which are fixed on the seabed and are designed to be operated permanently or for a defined period at an offshore site.

Jacket: A welded tubular space frame structure that is supported by a lateral bracing system and consists of vertical or battered legs. The jacket's purpose is to sustain topside facilities, provide supports for conductors, risers, and other appurtenances, and provide as a pattern for the foundation system.

Bottle leg: A leg section with a larger diameter to thickness ratio is employed as a buoyancy compartment during installation and to facilitate optimal pile cluster design.

Foundation pile: Steel tubular driven into the soil and fastened to the jacket component for global action transfer.

Pile cluster: Pile sleeves for foundation piles formed in groups with shear connections to jacket legs. The foundation for mudmats and skirts.

Bucket foundation: Steel plate construction inserted into the bottom of the jacket leg penetrating into the soil to secure the platform to the ground.

Multilegged jacket: A jacket with more than four legs.

A Tension Leg Platform (TLP) is described as a buoyant installation linked to a fixed foundation by tendons pretensioned. Tendons are generally parallel, near vertical components that work in tension to constrain platform motions in heavy, pitch, and roll. The platform is surge, sway, and yaw compliant.

2. Platform

The term “platform“ may also be used for fixed offshore installations.

3. Further Definitions

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

C. Design Review

1. Extent of Review

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 have to be provided. Examination or verification of the following will be undertaken:

1.1 Specification

- design basis
- design brief
- material specification
- topside interface requirements (including leg spacing, topside weight and centre of gravity, appurtenance dimensions and routing);
- cathodic protection specification
- painting specification, if applicable
- fabrication specification, if applicable

1.2 Special reports

- environmental report
- soil report/engineering soil report
- foundation, on-bottom stability and pile driving.
- seismic hazard assessment, if applicable

1.3 Design reports

- weight monitoring report
- in-place analysis report
- fatigue analysis report
- earthquake analysis report, if applicable
- boat impact analysis report
- accidental analysis report
- load-out analysis report
- transport/seafastening analysis report
- lifting analysis report, if applicable
- launching analysis report, if applicable
- floatover analysis report, if applicable
- cathodic protection calculation report

1.4 Other documents

Welding Procedure Specification (WPS) and Procedure

Qualification Record (PQR) when fabrication inspection is scope of work.

2. Plans and Calculations 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 installation 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 main structure and design data

Plans showing the scantlings, arrangements and details of the principal parts of the structure 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. Workshop drawings and parts lists are not subject to the design review.

2.2.1 General

- general arrangement
- plan indicating design loads for all decks

2.2.2 Jacket structures

- elevations
- legs
- framing
- mudmats
- risers
- conductor guides
- padeyes
- boatlanding
- anode plan
- Pile sleeves
- pile/pile make-up and marking
- pile/jacket connection (welding/grouting)
- grout details, if applicable
- ladders/stairs, if applicable
- launch frame, if applicable
- flooding system

2.2.3 Concrete structures

- formwork
- reinforcement
- pre-stressed reinforcement regarding e.g.:
- slabs
- walls
- pylons

Further all drawings with respect to structural steel internals including details like embedment plates, etc.

2.2.4 Combined structures

The documentation has to be selected in analogous form as for 2.2.2 and 2.2.3.

2.2.5 Topside

- plot plans
- accommodation
- drilling derrick
- flare boom
- crane pedestal
- life boats
- deck framing
- deck plating
- joint details
- handrails and grating
- ladders/stairs

- padeyes
- helicopter deck, if applicable

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
- technical details for auxiliary machinery
- boilers and pressure vessels
- general arrangement and particulars of the electrical installation
- 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

- general arrangement plans indicating location of hazardous/non-hazardous areas
- 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 calculations according to 1.3 are to be submitted in conjunction with the scantling plans, as may be applicable.

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 identifying and checking 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 on the wishes of any Authorities involved.

For the needs of **TL**, general descriptions, calculations and test reports have to be submitted in duplicate or in electronic format, structural plans, detail drawings and building/testing specifications in triplicate or in electronic format , 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 each installation. The booklet shall include the following information, as applicable in the particular case, so as to provide suitable guidance to the operating personel with regard to safe operation of the installation:

- 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. drilling, etc.

- minimum anticipated atmospheric and sea temperatures

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

- 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

- capacity plan showing capacities of tanks, centres of gravity, 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, if applicable

- hazardous areas plan

- 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 for electrical equipment

- 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 plans showing the exact location and extent of application of different grades and strengths of structural materials, together with a description of the material and welding procedures involved, is to be placed on the installation. 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 structure 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 installation 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 installation **TL** will ensure by surveys and inspections that:

- parts for structure 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, type-tested 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** regulations, will be attested by the Surveyor concerned on special forms, or informally, as agreed in the individual case.

3. Supervision of Installation

The extent of supervision during load-out, transport and installation (on site) procedures will be agreed upon according to the prevailing conditions and exigencies.

4. 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 installation as well as partial tests of the different systems has 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 has 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 ship, **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. Commissioning

Commissioning tests for verification of the proper function of all systems installed have to be performed at the site location of fixed installations in presence of the **TL** Surveyor.

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.

SECTION 2

PILE FOUNDED STRUCTURES

A. General

1. Definition and Application

1.1 Pile founded structures are fixed offshore installations founded by different types of piles reaching into the seabed and with a topside supported by a space frame structure (jacket), in general formed from steel tubes, to keep the topside above the highest water level and to transfer the loads directly to the seabed respectively to the piles.

The Class Notation **FIXED OFFSHORE STRUCTURE, PILE FOUNDATION** will be assigned for such a type, see Chapter 59, Section 4, C.2.1.

1.2 The following modes of operation have to be considered:

- standard operation/production

- survival condition under extreme environmental conditions

1.3 Following additional conditions have to be considered:

- transportation to site of the main bulky elements

- load out and installation of jackets and topside

2. Scope

2.1 This Section covers those specific design criteria and features of fixed offshore installations which are not dealt with in the special Sections as referred to in the following.

2.2 Machinery and electrical installations

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

2.3 Auxiliary installations and equipment

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

2.4 Lifting appliances

For the interaction of lifting appliances with the installation, 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 Lifting Appliances.

2.5 Transport and installation

Conditions for the transport on barges, special ships or afloat, for the lifting and installation procedures and for the operating phase while standing with the jackets on the sea floor unpiled, shall be clearly defined in the Design Review, compare Section 1, C.

3. Elements of the Structure

The structure consists of the following elements:

- topside structure which may be a space frame construction with several decks and with closed houses with living and working spaces

- special elements connected to the topside like helicopter landing decks, flares, etc.

- monotowers or jackets with 3 or more legs as space frame tube constructions

- piles in the sea bed

B. Requirements for the Soil

1. Influence of the Soil

1.1 As the fixed offshore installation is resting with the piles in the soil, the condition of the soil under the installation is of major importance for the design of the foundation and the safety of the whole installation. The following possibilities for a failure have to be investigated:

- soil resistance regarding skin friction, tip resistance

- soil settlements or displacements

- sliding of the foundation

- overturning of the foundation during the unpiled condition (on bottom stability)

1.2 The condition of the soil is subject to a Classification/ Certification by **TL**, and the Owners and Operators have to order a careful investigation on the situation of site from a recognized institution. A report on this subject is to be submitted to **TL** and shall be included in the Design Review.

2. Site Investigations

The extent of site investigations and the choice of investigation methods are to account the type, size and importance of the structure, uniformity of soil, seabed conditions and the actual type of soil deposits.

2.1 It is recommended that site investigations at the exact location of the installation comprise the following elements:

- site bathometry survey

- sampling and testing of the soil at site down to sufficient depth

- laboratory tests with respect to relevant soil parameters for establishing of soil profiles

- investigation of possible effects of installation activities on the soil

The soil investigation should provide the following type of geotechnical data:

- data for soil classification and description

- shear strength data and deformation properties, as required for the type of analysis to be conducted

- in-site stress conditions.

Further details and requirements with respect to the soil investigation are provided in NS 3481 /2/ and NORSOK G-001.

2.2 Definition of permissible deviations regarding unevenness and soil profiles is necessary.

3. Interaction of Seabed and Structure

3.1 Scour around the foundation has to be taken into account and, if necessary, measures against have to be provided immediately after the installation of the foundation.

3.2 The effects of foundations near to each other shall be considered.

3.3 The influence of cyclic loads from the offshore installation to the foundation and to the soil has to be investigated.

3.4 The influence of earthquake vibrations in the soil to the foundation and the complete installation shall be investigated depending on the location of the platform and the thinkable earthquake strength and frequency.

4. Additional Details

For additional details see Chapter 62, Section 7, B.

C. Design Loads

1. Loads on Topside Structure

The following loads have to be considered:

- wind loads on the topside above water level, compare Chapter 62, Sections 1, B. and 2, B.2.
- snow and ice accretion, if relevant at the location, compare Chapter 62, Section 2, B.6.1.
- permanent loads, like weight of structure, equipment, etc.
- functional loads, compare Chapter 62, Section 2, D.
- accidental loads, compare Chapter 62, Section 2, E.
- transportation and installation loads, compare Chapter 62, Section 2, F.
- earthquake loads, compare Chapter 62, Section 2, G.
- future loads, when applicable.

2. Loads on Jacket

The following loads on the jacket have to be considered:

- jacket weight
- jacket buoyancy
- hydrostatic pressure on jacket construction
- hydrodynamic loads from water currents and waves including influence of marine growth, compare Chapter 62, Section 1, C. and Section 2, B.3.
- sea ice, ridges and icebergs, if relevant at the location, compare Chapter 62, Section 1, G.
- static loads due to wind and operating forces on the topside structure, compare 1.
- hydrodynamic loads from conductors at several levels
- hydrodynamic loads from j-tubes
- damage of the jacket, e.g. from a collision of a ship with the platform
- accidental loads on the jacket by objects dropped from the working decks
- loads from other appurtenances, like ice shields, boat landing, barge bumpers
- loads from supply vessels
- earthquake loads according to Chapter 62, Section 2, G.
- Loads induced by construction, transportation, and installation
- scouring effect.

3. Loads on Piles

The following loads on the foundations have to be considered:

- Accumulated loads from the jacket according to 2. to be transferred to the soil by the piles
- load case with minimum vertical load on the piles and which is most unfavourable with respect to the pull out force
- loads during installation and piling

D. Structure

1. Basic Design Criteria

The following design criteria have to be applied for the structure:

- the system shall be able to withstand all loads occurring during installation, normal operation and extreme environmental conditions to be expected at the location for which it is designed, compare the loading conditions defined in Chapter 62, Section 3, C.

- selection of steel quality level and requirements for inspection of welds shall be in accordance with a systematic classification of welded joints as per the structural significance and complexity of joints.

- the main criterion for welded joints is the significance related to to joint complexity and the consequences of failure of the joint.

- The hydrodynamic model of a platform structure shall represent as closely as possible the exact characteristics of the real structure relatively to wave exposed areas, volumes, masses, buoyancy and hydrodynamic properties. As such, all platform appurtenances including boat landings, bumpers, fenders, walkways, stairs, grout-lines, anodes, etc., shall be taken into account in the hydrodynamic model but with no contribution to the global structural model stiffness.

- In case hydrodynamic forces on some appurtenances may have an impact on local member design, these appurtenances shall be modelled in detail as non-structural members. In the case of small appurtenances items distributed all over the structure, modelling can be done by modification of hydrodynamic coefficients, to be justified in detail.

- a sufficient air gap between the highest waves (survival condition) and the main deck shall enable a safe operation, compare Chapter 62, Section 2, B.4.10 and 4.11.

- the design shall be tolerant to damages, e.g. by collision of supply vessels with the jacket, and avoid that such an event leads to a loss of global structural integrity

- Effects of marine growth on the geometry and the hydrodynamic coefficients of structural members, conductor pipes, risers and more generally of platform appurtenances shall be modelled.

- assumptions concerning the seabed conditions have to be considered, compare B.

- preferably an integrated analysis of the topside structure, jacket and pile foundation should be carried out.

- Jacket on bottom stability (unpiled stability) and mud mat design shall be verified in accordance to API RP 2A with a safety factor of 1.5 against the overturning.

- Casing risers and all slender components shall be checked for vortex shedding effects due to environmental loads in pre-services and in-place conditions. By principle vortex induced vibrations (V.I.V.) shall be avoided. In case of V.I.V., fatigue damage shall be evaluated taking into account sensitivity of the damping factors and the full range of the environmental loads up to 100 year return period. Calculation shall be performed in accordance with OTH 92 379.

- All members in the vicinity of water level should be checked against slamming loads and up-lift loads (in-place conditions, during transport, temporary working decks).

2. Topside Structure

2.1 Structural analysis

2.1.1 The topside structure shall be designed to resist the loads defined in C.1. All permanent and functional loads are to be distributed, by an accepted method of rational analysis down to the main supports of the jacket.

2.1.2 The structure is to be considered having sufficient strength to resist all induced stresses in the operating condition. The scantlings of the structure are then to be determined consistent with this load distribution, Chapter 62, Sections 1 to 4 apply.

2.1.3 Where relevant for the location of the platform, an earthquake analysis has to be performed investigating the dynamic response especially of

- primary topside structure
- drilling derrick
- flare booms
- cranes
- helideck

2.2 Where necessary, blast walls have to be established to reduce the effect of explosions in the processing part.

2.3 Drilling derricks, cranes, etc.

Special attention is to be paid to the foundations and fastening of drilling derrick(s) and cranes, compare Chapter 62, Section 8.

2.4 Helicopter facilities

The requirements for helicopter facilities are defined in Chapter 62, Section 9.

2.5 Flares and cold vents

The requirements for flares and cold vents are defined in Chapter 63, Section 14.

2.6 Life-saving appliances

The requirements for life-saving appliances are defined in Section 5, A.

3. Jacket

3.1 The jacket shall be designed to resist the loads defined in C.2. A complete three dimensional structural model of the jacket is required. Local analysis may be required for complex joints or other complicated structural parts. Effects of marine growth on the geometry and the hydrodynamic coefficients of structural members, conductor pipes, risers and more generally of platform appurtenances shall also be modelled.

3.2 It has to be considered that a credible collision or a dropped object against a bracing member may lead to a complete failure of the member or joint. The residual strength of the jacket has to be evaluated and the influence on the global strength of the platform assessed.

The riser protector shall be extended sufficiently on the basis of an assessment of the impact zone taking account of environment and boat dimensions. Unless otherwise noted risers shall be protected, either inside the jacket or by riser protectors.

3.3 The structure is to be designed in such a way that access for inspection, maintenance and repair is to be provided, as far as possible.

3.4 In areas exposed to abrasion, e.g. by drifting ice, allowance for wear has to be considered.

4. Fatigue Design

General requirements regarding fatigue damage analysis of offshore structures are given in Chapter 60 and 62.

Repetitive actions, which may lead to possible significant fatigue damage, shall be calculated. The following listed sources of fatigue actions shall be accounted for, where relevant;

- waves
- wind
- currents

Fatigue damage analyses should include all relevant actions contributing to the fatigue damage both in non-operational and operational design conditions. Local action effects due to wave slamming, vortex shedding shall be accounted when calculating fatigue damage where relevant.

Structural components prone to fatigue damage in the jacket are given below, but not limited to;

- brace/stub to chord welds in main load transferring joints
- chord/cone to leg welds, between leg members
- brace to stub and brace to brace welds in main load transferring elements
- shear plates and yoke plates including stiffeners
- piles and bucket foundation plates including stiffeners
- appurtenance foundations / supports
- Anodes, doubler plates.

E. Pile Foundation

1. Types of Piles

The following types of piles may be used:

- driven piles
- drilled and grouted piles
- suction piles

2. Requirements for Design

The following aspects have to be considered for the design:

- the loads according to C.3.
- the soil report comprising the soil parameters for the pile design has to be submitted to **TL** for review.
- Pile design shall take into account a shift of the jacket & topsides Centre of Gravity within the uncertainty pattern.
- The pile wall thickness shall be adequate to resist the axial and lateral loads, as well as the stresses induced during pile driving and to avoid buckling.
- Fatigue assessment during driving shall be performed.
- where piles are placed close together, pile group effects have to be considered
- the pile/jacket connection has to be submitted for approval
- the diameter/thickness ratio of the pile is to be controlled to avoid buckling
- pile penetration shall be obtained without damaging the pile or causing excessive disturbance of the various soil formations which may reduce their load carrying capacity
- if no driving head is used during pile driving, allowance for cut-off at the top of the pile is to be provided
- Mud mats shall be dimensioned under the load combinations. The mud mats should ensure total stability of the structure during pile installation.

3. Further Details

For further details see Chapter 62, Section 7, D.

SECTION 3

GRAVITY BASED STRUCTURES

Page

A. General

1. Definition and Application

1.1 Gravity based structures are fixed offshore installations with a topside supported by shafts to keep the topside above the highest water level and to transfer the loads directly to the gravity foundation at the seabed.

The Class Notation **FIXED OFFSHORE STRUCTURE, GRAVITY FOUNDATION** will be assigned for such a type, see Chapter 59, Section 4, C.2.1.

1.2 The following modes of operation have to be considered:

- Standard operation/production
- Survival condition under extreme environmental conditions

1.3 The following additional conditions have to be considered:

- Transit to site of the main bulky elements
- Installation of gravity foundation, shafts and topside

2. Scope

2.1 This Section covers those specific design criteria and features of fixed offshore installations which are not dealt with in the special Sections as referred to in the following.

2.2 Machinery and electrical installations

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

2.3 Auxiliary installations and equipment

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

2.4 Lifting appliances

For the interaction of lifting appliances with the installation, 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 Lifting Appliances.

2.5 Transport and installation

Conditions for the transport including stability criteria shall be clearly defined in the Design Review, compare Section 1, C.

3. Elements of the Structure

The structure consists of the following elements:

- Topside structure which may be a space frame construction with several decks and with closed houses with living and working spaces
- Special elements connected to the topside like helicopter landing decks, cranes, flares, derricks, etc.
- One or more shafts
- Foundation base

B. Requirements for the Seabed

1. Influence of the seabed

1.1 As the foundation of gravity based installations is resting on the seabed, the condition of the seabed under the foundation is of major importance for the design of the foundation and the safety of the whole installation. The following essential seabed characteristics will influence the decision for a gravity based structure instead of a pile founded structure:

- Horizontal shear capability
- Bearing strength

- Short and long-term subsidence

- Responses to oscillating load, e.g. possible liquefaction/ fluidization

- Risk of scouring and erosion

1.2 Scour

The effect of local and global scour on the lateral resistance should be accounted for.

The scour potential may be evaluated by sediment transport studies, given the soil particle sizes, current velocity etc. However, where available, experience from near similar structures may be the most useful guidance in setting the scour criteria.

The scour protection material shall be developed to provide both internal and external stability, i.e., protection against excessive scour protection material surface erosion as well as protection against soil particle transportation from the underlying natural soil.

If erosion has the potential to lower the effective foundation area, procedures shall be made to prevent, control, and/or monitor the erosion.

1.3 The condition of the seabed is subject to a Classification/Certification by **TL** and the Owners and Operators have to order a careful investigation on the situation of site from a recognized institution. A report on this subject is to be submitted to **TL** and shall be included in the Design Review.

2. Site Investigations

2.1 Site investigations are designed to give useful information about the soil at a depth below which the presence of weak formations will have no effect on the structure's safety or performance. In general, the scope of site investigations and the selection of investigation procedures are to account for the type, size and importance of the structure, uniformity of soil, seabed conditions and the actual type of soil deposits. To account for positioning and installation tolerances, site investigations shall cover a large region.

It is recommended that site investigations comprise the following elements:

- Site geology/bathometry survey including assessment of shallow gas

- Topography survey of the seabed

- Geophysical investigations for correlation with borings and in-site testing

- Sampling and testing of the soil at site down to sufficient depth with subsequent laboratory testing with respect to relevant soil parameters

- In-site tests

Geotechnical data from the soil investigation should include the following:

- Data for soil classification and description

- Shear strength data and deformation properties, as required for the type of analysis to be carried out;

- In-site stress conditions.

Further details and requirements with respect to the soil investigation are provided in NS 3481 and NORSOK G-001 Soil investigation.

2.2 Definition of permissible deviations regarding unevenness and soil profiles is necessary.

3. Interaction of Seabed and Structure

3.1 If the characteristics of the seabed according to 1.1 are not fully suitable and the location must be kept, the seabed has to be prepared by relevant measures.

The reactions from the foundation soil shall be taken into account in the design of the supported structure for all design conditions. The rigidity of structural members shall be considered.

Possible effects of installation activities on the soil properties should be considered.

3.2 The possibility of scour around the foundation has to be taken into account and, if necessary, measures against have to be provided immediately after the installation of the foundation. (See also 1.2)

3.3 The effects of foundations near to each other shall be considered.

3.4 The influence of cyclic loads from the offshore installation to the foundation and to the soil has to be investigated.

3.5 The influence of earthquake vibrations in the soil to the foundation and the complete installation shall be investigated depending on the location of the platform and the thinkable earthquake strength and frequency.

4. Additional Details

For additional details see Chapter 62, Section 7, B.

C. Design Loads

1. Loads on Topside Structure

The following loads have to be considered:

- Wind loads on the topside above water level, compare Chapter 62, Sections 1, B. and 2, B.2.
- Snow and ice accretion, if relevant at the location, compare Chapter 62, Section 2, B.6.1.
- Permanent loads, like weight of structure, equipment, etc.
- Functional / operational loads, compare Chapter 62, Section 2, D.
- Accidental loads such as dropped object, blast and fire, compare Chapter 62, Section 2, E.
- Loads induced by construction, transportation and installation loads, compare Chapter 62, Section 2, F.
- Earthquake loads, compare Chapter 62, Section 2., G
- Temperature changes.
- Future loads, where applicable
- Deflections that may be imposed by substructure behaviour
- Displacements that may result from construction tolerances and/or settlement of bearing points.

2. Loads on Shafts

The following loads on the shafts have to be considered:

- Shaft weight
- Shaft buoyancy
- Hydrostatic pressure on shaft
- hHydrodynamic loads from water currents and waves including influence of marine growth, compare Chapter 62, Section 1, C. and Section 2, B.3.
- Sea ice, ridges and icebergs, if relevant at the location, compare Chapter 62, Section 1, G.
- Static loads due to wind and operating forces on the topside structure, compare 1.
- Hydrodynamic loads from conductors at several levels, if outside of shafts
- Tank contents, if applicable
- Damage of one of the shafts, e.g. from a collision of a ship with the platform
- Accidental loads on the shafts by objects dropped from the working decks

- Loads from other appurtenances, like ice shields, boat landing, barge bumpers

- Loads from supply vessels

- Earthquake loads according to Chapter 62, Section 2, G.

3. Loads on Base

The following loads on the gravity base have to be considered

- Weight of the base

- Weight of tank contents, if applicable

- Hydrostatic load on base

- Hydrodynamic loads due to currents at the seabed, compare Chapter 62, Section 1, C. and Section 2, B.3.

- Instability of the seabed, compare B.

- Accumulated loads from the shaft(s) according to 2. to be transferred to the soil by the gravity base

- Accidental loads due to impact of dropped objects

- Loads during installation

D. Structure

1. Basic Design Criteria

The following design criteria have to be applied for the structure:

- The system shall be able to withstand all loads occurring during installation, normal operation and extreme environmental conditions to be expected at the location for which it is designed

- The height of the main deck shall enable a safe working on the platform during normal operating conditions

- Sea wash and spray water shall not occur on the main deck during normal operation conditions, but is acceptable at extreme ambient conditions where no operation of the equipment is taking place

- The design shall be tolerant to damages, e.g. by collision of a supply vessel with one shaft, and avoid that such an event leads to a loss of global structural integrity

- Assumptions concerning the seabed conditions have to be considered, compare B.

- Preferably an integrated analysis of the topside structure, shafts and gravity foundation should be carried out.

2. Topside Structure

2.1 General

The topside structure shall be detailed to avoid corrosion and wear and minimize fatigue. Inspection and maintenance works of installed structures shall be easily accomplished. Maximum access to all elements and at all phases of platform life should be provided. For flare towers, heat resistant materials shall be used and bolts avoided.

Principles for load-out, transportation, installation, lifting, launching or for any particular phase or condition and accidental conditions, which has a major impact on certain component of the structures, shall be integrated in the design phase.

Future extensions and additional loads (if any such as owner/operator reserve) shall be accounted for and the consequent design arrangements shall be carried out.

The fabrication specifications and requirements shall be carried out in accordance with Chapter 60.

2.2 Structural analysis

2.2.1 The topside structure shall be designed to resist the loads defined in C.1. All permanent and functional loads are to be distributed, by an accepted method of rational analysis down to the shaft(s).

2.2.2 The structure is to be considered having sufficient strength to resist all induced stresses in the operating condition. The scantlings of the structure are then to be determined consistent with this load distribution, Chapter 62, Sections 1 to 4 apply.

2.2.3 Special attention has to be given to the load bearing elements between the topside and the shaft(s). These members have to be laid out for the maximum design loads.

2.2.4 For slender members and dynamic sensitive structures consideration shall be given to dynamic response and fatigue loading due to the wind gust spectrum and vortex shedding effects.

Fatigue analysis shall be carried out for all structure that is exposed to significant cyclic loading. Such structures shall include flare towers, bridges, and topsides, etc.

Fatigue assessments of slender structures such as bridges and flare towers shall consider fluctuating wind loads. All exposed lattice structures shall be evaluated for fatigue caused vortex shedding.

All stress concentration factors(SCF) shall be justified, using results of analysis or parametric equations approved by TL. Finite element analysis shall be carried out to establish SCFs where no other accepted data is available. SN curves and stress concentration factors shall be consistent, and shall allow for fabrication tolerances.

The methods of fatigue analysis shall comply with TL Chapter 60 and Chapter 62.

Weld grinding shall not be used to achieve required fatigue lives at the design stage.

2.2.5 Where relevant for the location of the platform, an earthquake analysis has to be performed investigating the dynamic respond especially of:

- Primary topside structure
- Topsides and modules
- Drilling derrick
- Flare booms
- Travelling crane and pedestal crane supports
- All installation appurtenances (padeyes, guides, docking guides)

2.3 Where necessary, blast walls have to be established to reduce the effect of explosions in the processing part.

2.4 Drilling derricks, cranes, etc.

Drilling derrick loads such as weight of stored products (mud, gas-oil, water, etc.), set back, hook and rotary table loads shall be defined in appropriate particular specifications.

Special attention is to be paid to the foundations and fastening of drilling derrick(s) and cranes, compare Chapter 62, Section 8.

2.5 Helicopter facilities

The helicopter landing area shall be designed for the heaviest and largest helicopter anticipated to be used on the platform. The types of helicopters to be considered are defined in the particular specification. The design shall also take into consideration other types of loads such as personnel, traffic, snow, freight, re-fuelling and fire-fighting equipment where required.

Further requirements for helicopter facilities are defined in Chapter 62, Section 9.

2.6 Flares and cold vents

The requirements for flares and cold vents are defined in Chapter 63, Section 14.

2.7 Life-saving appliances

The requirements for life-saving appliances are defined in Section 5,A.

3. Shafts

3.1 The shafts shall be designed to resist the loads defined in C.2.

3.2 A complete three dimensional structural model of the shaft(s) is required.

3.3 The structure is to be designed in such a way that access for inspection, maintenance and repair is to be provided, as far as possible.

3.4 In areas exposed to abrasion, e.g. by drifting ice, allowance for wear has to be considered.

E. Foundation/Base

1. Types of Foundations

The primary task of anchoring the shafts at their lower end can be met by the following types of gravity foundations:

- compact gravity foundations, without the possibility of ballasting
- gravity foundations with storage caisson for ballast water and/or tanks for the storage of oil and oil products
- gravity foundations with skirts

2. Basic Design Considerations

- special attention has to be paid to the integration of the shafts to the foundation base
- if the foundation is built up of reinforced concrete, the requirements of Chapter 62, Section 5 have to be considered
- for further details see Chapter 62, Section 7, E.

3. Compact Gravity Foundations

3.1 Compact gravity foundations are not equipped with tanks, but may include buoyancy chambers for transport to site.

4. Gravity Foundation with Tanks

4.1 Arrangements for ballasting

4.1.1 Drawings and descriptions of the ballast system and instructions for ballasting/deballasting have to be summarized in the Operating Manual. Measures for intact as well as for damaged condition of the installation have to be considered.

The Operating Manual has to be permanently available on the installation.

4.1.2 The ballast tanks are to be fitted with the following equipment:

- At the highest position of each tank air pipes are to be fitted and laid vertically to the main deck of the topside
- The number and arrangement of the air pipes is to be so performed that the tanks can be aerated and deaerated without exceeding the tank design pressure by over- or under-pressure
- The air pipes may also serve as overflow system leading the seawater directly to the sea
- The tanks are to be fitted with remote level indicators which are type approved by **TL**
- Tank filling lines are to extend to the bottom of the tank, filling lines may also be used as suction lines

- The number and capacity of the ballast pump must satisfy the operational requirements

- For further details of the piping and pumping system Chapter 63, Sections 13a – 13e shall be applied analogously

4.2 Arrangements for storage of oil and oil products

4.2.1 Drawings and descriptions of the oil storage system and instructions for loading and unloading are to be summarized in the Operating Manual.

Measures for intact as well as for damaged condition of the installation are to be considered.

The Operating Manual is to be permanently available on the installation.

4.2.2 The oil tanks are to be fitted with the following equipment:

- At the highest position of each tank air pipes are to be fitted and laid vertically to the main deck of the topside

- The number and arrangement of the air pipes is to be so performed that the tanks can be aerated and deaerated without exceeding the tank design pressure by over- or under-pressure

- An overflow system has to be installed, the overflow collecting manifolds are to be led at a sufficient gradient to an overflow tank of sufficient capacity

- The tanks are to be fitted with remote level indicators which are type approved by **TL**

- Tank filling lines are to extend to the bottom of the tank, filling lines may also used as suction lines

- An oil transfer pump is to be provided backed up by a stand-by pump, the capacities must satisfy the operational requirements

- For further details of the piping and pumping system Chapter 63, Sections13a – 13e shall be applied analogously

4.2.3 If oil is stored above ballast water in the same tank special measures have to be agreed with **TL**

5. Arrangement of Skirts

Depending on the investigation of the seabed according to B. and based on the foundation analysis, skirts may become necessary to prevent the base from sliding.

The feasibility of penetrating the skirts shall be adequately documented.

Skirts may also be necessary to avoid erosion of the seabed below the base.

If the foundation includes storage tanks, it is recommendable to situate the skirts directly below the vertical tank walls.

It is recommended to situate the skirts directly below vertical walls or other stiffeners of adequate strength.

SECTION 4

TENSION LEG PLATFORMS

A. General

1. Definition and Application

1.1 A tension leg platform (TLP) is a floating structure connected to a foundation at the seabed by tendons which are pre-tensioned by additional buoyancy of the floating structure being pulled down under its free-floating waterline. The foundation may be a fixed gravity foundation or a pile foundation. The tendons, which are arranged normally vertical and parallel are restricting the movement of hull and topside structure (heave, pitch and roll are restrained – surge, sway and yaw are allowed) thus enabling the platform to be connected to the seabed by drilling equipment or risers, etc. It will be of additional advantage to provide the floating structure in form of a column stabilized platform.

A TLP is often used for drilling, production and export of hydrocarbons and storage function.

The Class Notation **FIXED OFFSHORE STRUCTURE, TENSION LEG PLATFORM** will be assigned for this type, see Chapter 59, Section 4, C.2.1.

1.2 The following modes of operation are to be considered:

- standard operation/production

- survival condition under extreme environmental conditions

1.3 The following additional conditions are to be considered:

- transit of the upper floating structure/hull to the location, if relevant

- transit of the tendons, preferably also in floating condition, to the location

- transit of the pile or gravity foundation to the location, respectively

- anchoring of the tendons at the seabed and pretensioning them by increasing the draft of the floating topside.

A TLP shall be built with a sufficient safety margin to prevent tendon rupture. The tendon system and the securing or supporting arrangements are to be built in such a way that the failure or removal of one tendon does not result in progressive tendon failure or excessive damage to the securing or supporting arrangement at the platform or at the foundation.

2. Scope

2.1 This Section covers those specific design criteria and features of tension leg platforms which are not dealt with in the special Sections as referred to in the following.

2.2 Subdivision and watertight integrity

Subdivision and watertight integrity are dealt with in F.

2.3 Machinery and electrical installations

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

2.4 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, E.2.

2.5 Lifting appliances

For the interaction of lifting appliances with the installation, 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 Lifting Appliances.

2.6 Transport and installation, operation

Conditions for the towing of the topside structure/hull to the location, for the transport of the foundation and the tendons to the location, for the anchoring of the tendons, for the lowering and re-elevation of the floating topside to tension the tendons shall be clearly defined in the Design Review, compare Section 1, C.

Conditions for operation of the installation, especially for controlling the tendons shall be clearly indicated in an Operating Manual, compare Section 1, C.3.1. The Operating Manual shall be permanently available on the installation.

3. Elements of the Structure

The structure consists of the following elements:

- topside structure/hull which may be a deep draught floater or a column stabilized system consisting of deck structure and columns with pontoons on their lower end

- tendons as vertical tension anchors for the topside

- risers for the transport of oil and gas from the seabed to the topside

- foundation at the sea bed, provided as templates, as piles or as gravity foundation.

4. Structural Categorization

The structural categorization and scope of inspection for structural components in TLP structures that are similar to column stabilized semi-submersible units shall follow the standards in Chapters 60 and 62. Structural elements of TLPs are split into as follows;

Special category:

- External shell structure in way of connections of columns, topside deck, lower hull and tendon porch etc.

- External brackets, portions of bulkheads, and frames which are designed to receive concentrated loads at connections of major structural elements.

- Material used at connections of columns, topside decks and lower hull that are designed to provide proper alignment and sufficient loading transfer.

- Highly utilized areas supporting derrick, crane pedestals, flare booms etc.

- Tendon and tendon connectors.

- Tendon interfaces with the foundation and the TLP hull

Primary category:

- External shell structure of columns, upper and lower hulls.

- Horizontal diagonal braces and truss rows on the deck.

- Bulkheads, decks, stiffeners and girders that provide local reinforcement or continuity of structure in way of connections, except areas where the structure is accounted under special category.

- Primary supporting structure of heavy substructures and equipment such as cranes, helicopter deck, derrick, and life boat platform.

Secondary category:

- Bulkheads, stiffeners, flats or decks and girders in columns, decks and lower hulls, which are not accounted as primary or special category.

- Well-bay trusses and reaming members.

- Horizontal braces and elements on the decks.

- Other structures not categorized as special or primary.

B. Requirements for the Soil

1. Influence of the Seabed

1.1 As the tendons are anchored to the seabed, the condition of the soil under the installation is of major importance for the design of the foundation and the safety of the whole installation. The following possibilities for a failure have to be investigated:

- insufficient soil resistance
- soil settlements or displacements
- sliding of the foundation
- overturning of the foundation during the unpiled condition (on bottom stability)

1.2 The condition of the soil is subject to a Classification/Certification by **TL**, and the Owners and Operators have to order a careful investigation on the situation of site from a recognized institution. A report on this subject is to be submitted to **TL** and shall be included in the Design Review.

2. Site Investigations

2.1 It is recommended that site investigations at the exact location of the installation comprise the following elements:

- site bathometry survey
- sampling and testing of the soil at site down to sufficient depth
- laboratory tests with respect to relevant soil parameters for establishing of soil profiles
- investigation of possible effects of installation activities on the soil

2.2 Definition of possible horizontal and vertical tolerances for not exact installation shall be considered in the investigation.

3. Interaction of Seabed and Structure

3.1 Scour around the foundation has to be taken into account and, if necessary, measures against have to be provided immediately after the installation of the foundation.

3.2 The effects of foundations near to each other shall be considered.

3.3 The influence of cyclic loads from the offshore installation to the foundation and to the soil has to be investigated.

3.4 The influence of earthquake vibrations in the soil to the foundation and the complete installation shall be investigated depending on the location of the platform and the thinkable earthquake strength and frequency.

4. Additional Details

For additional details see Chapter 62, Section 7, B.

C. Design Loads

The TLP structure shall be built to withstand relevant loads associated with conditions that may occur throughout the unit's life cycle. Such stages may cover but not limited to:

- fabrication
- site transit
- mating/assembly
- sea transportation
- operation
- installation
- decommissioning

The following characteristic global sectional loads due to wave forces shall be taken into account as a minimum for a TLP hull (as similar to column stabilized semi-submersible unit):

- torsional moment about a transverse and longitudinal, horizontal axis
- longitudinal opposed forces between parallel pontoons
- split forces
- longitudinal, transverse and vertical accelerations of deck masses

The Strength Level Event (SLE) and Ductility Level Event (DLE) criteria, as applied to fixed offshore platforms, should be employed for earthquake analyses. A probabilistic seismic hazard assessment (PSHA) that is compatible with the seismic risk at the specific site should be created.

1. Loads on Hull and Topside Structure

The following loads are to be considered:

- hydrostatic loads on the hull depending on the actual draught
- hydrodynamic loads on the hull due to currents and waves, compare Chapter 62, Section 1, C. and Section 2, B.3. and B.4.
- wind loads on hull above water level and topside structure, compare Chapter 62, Sections 1, B. and 2, B.2.
- change of water level at the hull due to tides and ballasting operations
- snow and ice accretion, if relevant at the location, compare Chapter 62, Section 2, B.6.1.
- sea ice, ridges and icebergs on the hull, if relevant at the location, compare Chapter 62, Section 1, G.
- functional loads, compare Chapter 62, Section 2, D.
- tension of tendons, compare 2.
- loads from risers, compare 4.
- loads from other appurtenances, like ice shields, boat landing, barge bumpers on the hull
- loads from supply vessels on the hull
- accidental loads on the columns or pontoons of the hull by objects dropped from the working decks
- accidental loads from a collision of a ship with the platform
- transportation and installation loads, compare Chapter 62, Section 2, F.
- earthquake loads according to Chapter 62, Section 2, G.
- temperature changes
- future loads, where applicable
- deflections that may be imposed by substructure behaviour
- displacements that may result from construction tolerances and/or settlement of bearing points.

2. Loads on Tendons

The following loads on the tendons have to be considered:

- tendon weight
- tendon buoyancy
- hydrostatic pressure on tendon construction

- hydrodynamic loads from water currents, etc. including influence of marine growth, compare Chapter 62, Section 1, C. and Section 2, B.3.

- pretension at mean water level and changes for different levels

- variation of tension due to wind, waves and operating forces on hull and upper part of topside structure, compare 1.

- damage or replacement of one or several tendons.

Load effects in the tendons have both static and dynamic components.

The steady state loads may be determined from the equilibrium condition of the platform, risers and tendon.

Platform motions, any ground motions, and direct hydrodynamic loads on the tendon all have an effect on the tendon's dynamic load.

Dynamic analysis of tendon responses shall account for the possibility of platform heave, pitch and roll and excitation such as springing and ringing effects.

Linearized dynamic analysis excludes some secondary wave effects and may not adequately simulate severe wave responses. A non-linear way of checking linear analysis results may be required. Model testing may also be used to validate analytical results. Because damping may not be adequately represented, a caution shall be given when interpreting model-test results for resonant responses, particularly for loads owing to platform heave, pitch and roll.

Lift and overturning moment generated on the TLP by wind loads shall be accounted for in the tendon response computations.

Prone to vortex induced vibrations shall be assessed in accordance with operational and non-operational stages.

Interference to tendon/riser, tendon/tendon, tendon/hull, and tendon/foundation shall be assessed for the operational and non-operational stage.

3. Loads on Foundations

The following loads on the foundations are to be considered

- hydrodynamic loads due to currents at the seabed, compare Chapter 62, Section 1, C. and Section 2, B.3.

- instability of the seabed

- tension of tendons, compare 2.

- damage or replacement of one or several tendons

- loads from risers, compare 4.

- accidental loads due to impact of dropped objects or tendon/riser failure

4. Loads on Risers

The following loads on the risers are to be considered

- riser weight

- riser buoyancy

- hydrostatic pressure on riser construction

- hydrodynamic loads from water currents, etc. including influence of marine growth, compare Chapter 62, Section 1, C. and Section 2, B.3.

- loads from hull/topside structure, compare 1.

- loads from foundations, compare 3.

D. Structure

1. Basic Design Criteria

The following design criteria are to be applied for the structure:

- the TLP system is to be able to withstand all loads occurring during installation, normal operation and extreme environmental conditions to be expected at the location for which it is designed, compare the loading conditions defined in Chapter 62, Section 3, C.

- the height of the main deck is to enable a safe working on the platform during normal operating conditions

- the structural design of the tendon supporting structures is to be given special attention to ensure a smooth transfer and redistribution of the tendon concentrated loads through the hull structure without producing excessive stress concentrations.

- the internal structure in columns in way of bracings should be designed stronger than the axial strength of the bracing itself.

- a particular care is to be paid to the pontoon strength in way of connections with columns, considering for possible reduction in strength due to openings and stress concentrations.

- a particular care is to be paid to the structural design of the columns in way of connection with deck structure to ensure smooth load transfer.

- positive air gap should be maintained under the Ultimate Limit State (ULS) condition. However, wave impact may be permitted on any portion of the structure if it can be proven that such actions are appropriately accounted for in the design and that personnel safety is not significantly damaged.

- assessment of air gap sufficiency is to include consideration of all impacted structural components including lifeboat platforms, riser balconies, overhanging deck modules and module support beams.

- loss of tendon tension is only acceptable within high frequent cycles and if tendons and their interfaces to foundation and topside structure are designed for

- the design is to be tolerant to damages as far as possible and avoid that such an event leads a loss of global failure assumptions concerning the seabed conditions have to be considered, compare B.

- the overall structural integrity is to be maintained both during and after an accident. Actions taken during and after a design-accidental occurrence shall not result in catastrophic structural collapse.

- preferably an integrated analysis of hull, topside structure, tendons and foundation should be carried out.

1.1 Model Testing

TLP designs will typically require model testing as a last check. The main objective of model testing is to ensure that analytical results correlate with model tests. A sufficient number of sea states is to be calibrated to cover the appropriate limit states.

The following are the most significant parameters to consider:

- first order motions

- total offset

- accelerations

- air gap

- WF (wave frequency) motions versus LF (low frequency) motions

- set down
- maximum and minimum tendon responses
- prone to hull VIM (vortex induced motion)
- springing
- ringing

2. Hull and Topside Structure

2.1 Structural analysis

2.1.1 The buoyant hull of a tension leg platform shall be designed to resist the loads defined in C.1. All permanent and functional loads are to be distributed, by an accepted method of rational analysis down to the tendons.

2.1.2 The structure is to be considered having sufficient strength to resist all induced stresses while in the floating position and being pulled down by the tendons. The scantlings of the structure are then to be determined consistent with this load distribution, Chapter 62, Sections 1 to 4 apply.

2.1.3 Structural elements such as the outer shell, decks, bulkheads and girders shall be dimensioned according to the principles outlined in Chapter 62, Section 3. **TL** Rules, Chapter 1 – Hull may be used as a basis where applicable, e.g. dimensioning of tank boundaries.

2.2 Topside structure

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

2.2.2 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 2.1.3. Where they are close to the side shell of the structure, their scantlings may be required to conform to the requirements for bulkheads of unprotected deckhouse fronts.

2.2.3 Where necessary, blast walls have to be established to reduce the effect of explosions in the processing part.

2.3 Structure in way of tendons

2.3.1 Load carrying members which may transmit loads from the tendons to the hull structure are to be designed for the maximum design loads and are to be arranged for:

- apply, control and adjust a defined tension in the tendon
- transfer vertical tension loads to the structure
- transfer side loads and hinder bending moments or rotational forces at the tendons to be transferred to the structure

2.3.2 For the pulled down position, special attention is to be paid to the distribution of the loads from the supporting points at the upper end of the tendons into the hull structure, taking account also of possible load redistributions resulting from lack of tension at one or several tendons.

The structure surrounding the points of support of the tendons shall be designed with particular regard to the introduction of local concentrated forces; main load bearing elements should be continuous in the vertical direction.

2.3.3 The inside or outside backing structure of the supporting points shall be made accessible for inspection in the operating condition.

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

2.4 Pontoons

Special attention shall be given to the ponton strength of column stabilized types in way of intersection with columns and the possible reduction in strength due to cutouts and stress concentrations.

2.5 Drilling derricks, cranes, etc.

Drilling derrick loads such as weight of stored products (mud, gas-oil, water, etc.), set back, hook and rotary table loads shall be defined in appropriate particular specifications.

Special attention is to be paid to the foundations and fastening of drilling derrick(s) and cranes, also with regard to transit conditions, compare Chapter 62, Section 8.

2.6 Helicopter facilities

The helicopter landing area is to be designed for the heaviest and largest helicopter anticipated to be used on the platform. The types of helicopters to be considered are defined in the particular specification. The design shall also take into consideration other types of loads such as personnel, traffic, snow, freight, re-fuelling and fire-fighting equipment where required.

The requirements for helicopter facilities are defined in Chapter 62, Section 9.

2.7 Flares and cold vents

The requirements for flares and cold vents are defined in Chapter 63, Section 14.

2.8 Life-saving appliances

The requirements for life-saving appliances are defined in Section 5, A.

3. Tendons

Individual tendons are made of three major parts:

- interface at the platform
- interface at the seafloor (foundation)
- link between platform and seafloor

Mostly tendons shall also have intermediate connections or couplings along their length.

Tendon parts providing the link between the platform and the foundation consist of tendon elements such as tubulars, solid rods, termination at the platform interface and at the foundation interface, and intermediate connections of couplings along the length as needed.

The intermediate connections may take the form of mechanical couplings such as threads, clamps, bolted flanges welded joints or other types of connections.

The tendon design may incorporate specialized parts, such as:

- corrosion protection system components
- buoyancy devices
- sensors and other instrumentations for monitoring the performance and condition of the tendons
- elastomeric elements
- auxiliary lines, umbilicals etc. for tendon service requirements
- intermediate connectors with watertight bulkheads for tendon compartmentation
- provisions for tendons to be used as guidance structure for running other tendons or various types of equipment.

3.1 Tendon types

3.1.1 Tendons will normally be of the solid rod or tubular type. Tubular type tendons may be designed either with stiffened or unstiffened shells. According to the sea bed conditions envisaged, the tendons may be designed for fixed or detachable foundations.

3.1.2 Intermediate connections between parts of suitable length of a tendon may have the form of a mechanical coupling with bolted flanges/threads/clamps or of welded joints and of other systems.

3.2 Special tendon elements

3.2.1 The different types of tendons may include also buoyancy bodies, resilient elements, instrumentation for monitoring their condition, control of corrosion protection or measures for bringing down other equipment to the seabed, etc.

3.2.2 Tendon bearings

Proper consideration shall be given to the end fixation of the tendons. Depending on the type of connection, a rotational restraint of the tendon may exist also in this case.

3.2.3 Tendon tension adjustment

The adjustment devices at the top of each tendon have to be able to equalize the tension in all tendons within the limits assumed for the design.

Tension adjustment procedures and schedules are to be developed already in the design stage and have to be incorporated in the Operating Manual.

3.2.4 Tendon flexjoints

It is recommended to install flexjoints at the tendons to absorb dynamic loads. Elastomeric material in these joints has to be selected under consideration of the ambient conditions at the tendon.

3.2.5 Tendon monitoring system

3.2.5.1 The tendon system is to be equipped with a monitoring system to ensure that the tendon is operating within the design limits.

3.2.5.2 The tension monitoring system is to be established for each individual tendon and shall provide:

- continuous measuring of actual tension
- documentation of tensions measured in form of a hard copy
- an alarm (visible and audible) if tension is deviating from the design values by a pre-defined margin
- easy inspection and good repair possibilities in case of failure
- check of leakage if tendons are of watertight shell type

3.2.5.3 It is recommended to keep an accurate record of the weights taken on or taken off the platform to correlate the tendon tension with the operating activities.

3.2.6 Extreme tendon tensions

As a minimum the following tension components are to be accounted for:

- pretension
- tidal effects
- tendon weight
- WF and LF tension
- storm surge
- overturning
- set down
- hull VIM influence on tendon responses
- ringing
- tendon VIV induced loads.
- operational requirements (e.g. ballasting operations)
- margins for fabrication, installation and tension tolerances
- allowance for foundation mispositioning

- loads due to spooling during transportation and storage of flexible tendons.

- field subsidence

- foundation settlement and uplift

3.3 Structural design analysis

The structural design of tendons is to be performed in accordance with API RP 2T.

Buckling checks of tendon body/pipes may be carried out in accordance with API RP 2T or NORSOK N-004.

When calculating maximum tendons stresses, appropriate stress components must be superimposed on the stress induced by maximum tendon tension, minimum tendon tension, or maximum tendon angle, as applicable.

Such additional stress components may be:

- tendon-bending stresses induced by lateral loads and motions of the tendon

- tendon-bending stresses induced by flex-element rotational stiffness

- thermal stresses in the tendon induced by temperature differences over the cross sections

- hoop stresses induced by hydrostatic pressure.

3.3.1 The tendons shall be designed to resist the forces and bending moments resulting from the loads defined in C.2. and considering operational conditions defined in the following. Tendon failure may have substantial consequences and hence the tendons shall be designed with sufficient safety margin. The safety factors according to loading condition 2 according to Chapter 62, Section 3, C. and D. apply. For fatigue criteria, see Chapter 62, Section 3, H.

Dropped objects may result in damage to the tendons and especially the top and bottom connectors may be exposed. Shielding may be required to be installed.

Flooding of hull compartments and its consequences on design shall be thoroughly investigated.

The most relevant accidental events for the tendons are:

- missing tendon

- tendon flooding

- dropped objects

- flooding of hull compartments

As material of the tendons steel is assumed. The use of other types has to be specially considered and agreed with **TL**.

3.3.2 Ocean transit condition

For ocean transit conditions of the platform, the tendons will be removed from the platform, divided into suitable length and transported separately. The approved condition is to be included in the Operating Manual.

3.3.3 Field transit condition

Field transit moves with tendons connected to the hull may only be undertaken when the depth of the water remains the same in the field and the predicted weather is such that the anticipated motions of the platform will not exceed the design condition. The duration of a field transit move may be for a considerable period of time and should be related to the accuracy of weather forecasting in the area concerned.

The approved condition is to be included in the Operating Manual.

3.3.4 Condition while lowering the platform

The maximum design motions, water depth and sea state while lowering the platform are to be clearly indicated in the Operating Manual.

3.3.5 Condition while re-elevating the platform

The tendons are to be designed to withstand the loads acting on both, the floating structure and the tendons themselves, during the re-elevating procedure. The environmental conditions are the same as foreseen for lowering the platform (3.3.4).

3.3.6 Working condition

The pretension of each tendon is to be checked Regularly, see 3.2.5, and adjusted as far as possible to the design value.

3.4 Tendon failure

The tendon system and its connecting devices are to be designed in a way that the failure of one tendon does not cause other tendon failures in a progressive way. Also the connection to the topside structure and to the foundations shall in this case not create excessive damage at their support structure.

3.5 Tendon inspection

Independent from the surveying intervals for the TLP, see Chapter 59, Section 5, intervals for tendon inspection have to be defined depending on the tendon design and the possibilities and speed for development of deficiencies.

3.6 Fatigue design

Fatigue damage shall be investigated in structural parts where fatigue may be a crucial mode of failure. All substantial loads including non-operational and operational that contribute to fatigue damage shall be accounted for. For the fatigue limit state of a TLP, the effect of springing and ringing resonant responses shall be studied.

Fatigue design of hull and deck structure shall be carried out in accordance with principles given in Chapters 60 and 62.

All components of the tendon system shall be evaluated for the fatigue damage.

First order wave loads such as direct or indirect shall usually be governing, however also fatigue due to springing shall be taken into account. Combined load effect due to wave frequency, high frequency and low frequency loads shall be accounted for fatigue damage analysis.

In case of wet transit (surface or subsurface) to site, these fatigue contributions shall be considered in design.

Vortex induced vibrations (VIV) shall be taken into account. This applies to operation and non-operational stages.

Weld grinding shall not be used to achieve required fatigue lives at the design stage.

4. Risers

The following aspects have to be considered for the design:

- loads according to C.4.

- the risers shall not hinder in any way the functioning of the system topside structure including hull/tendons/foundation

- other aspects of the riser system are part of the production/processing plant and not subject to Classification by **TL**.

E. Foundations

The foundation system shall provide a secure connection to the ground throughout the life of the TLP.

The foundation system shall be built to withstand the same in-place loading conditions as the tendon system it supports, including cases of tendon damage and removal. The study shall take into account installation tolerances as well as installation loads such as pile driving.

The foundation system shall be appropriately built to resist yielding, fatigue, and corrosion, and fabrication shall be done in compliance with recognized standards. Permanent long-term or dynamic deflections shall be considered.

1. Types of Foundations

The primary task of anchoring the tendons at their lower end can be met by the following foundation types:

- piles using their skin friction in the soil of the seabed to withstand the directly anchored tendon and its pretension

- a template anchored to the seabed by several piles distributing the tendon forces

- a gravity foundation using its weight to allow tensioning of all the tendons

2. Pile Foundation

The following aspects have to be considered for the design:

- the loads according to C.3.

- the soil report comprising the soil parameters for the pile design has to be submitted to **TL** for review

- where piles are placed close together, pile group effects have to be considered

- the pile/template connection, which may be grouted pile sleeves, steel constructions or other arrangements, has to be submitted for approval

- a smooth transition of the tendon forces to the template has to be ensured by the design

- the design of the tendon anchors to the pile or to the template has to be submitted for approval

3. Gravity Foundation

The following aspects have to be considered for the design:

- the loads according to C.3.

- the ability of the soil of the seabed to resist the loads from the foundation is to be investigated under the consideration of the weight, sliding forces, turning moments and combinations thereof

- if the sea bed conditions are characterized by very soft mud and silt particular attention is to be given to the framing and bracing of the foundation, in order that the loads are properly distributed

- if the foundation is made of steel, the requirements of Chapter 62, Section 3 and 4 are to be observed

- the envelope plating of foundation 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

- if the foundation is made of concrete the requirements of Chapter 62, Section 5 are to be observed

- Provisions for ballasting and de-ballasting the gravity foundation are to be installed. These may be pipelines running down at tendons into the foundation to vent off trapped air during ballasting or to induce air for displacing the water and thus de-ballasting the foundation. These pipelines may also be used to blow air under the bottom of the foundation with the aim of facilitating the lifting of the foundation from the bottom of the sea.

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

F. Subdivision, Stability and Load Line

The intact and damaged stability of a TLP in a free-floating condition during the construction, transit, and installation phases shall in general meet the standards for column-stabilized units as defined in Chapters 60 and 62.

Stability of a TLP in the in-place condition is often provided by the pretension and stiffness of the tendon system, rather than by the waterplane area.

The purpose of the stability analysis is to evaluate that the system is sufficiently restrained by the tendon system and is safe from overturning in all environmental conditions. As a result, it is critical to monitor weight shift and COG (Center of Gravity) changes in various operational modes and environmental conditions.

The permissible horizontal shift of the COG shall be computed for at least the following three load conditions:

- still water
- operating environment
- survival environment

The permissible weight and horizontal COG shift shall be computed in accordance with maximum and minimum allowable tendon tension. Variation of the vertical COG causing changes in motion response and dynamic loads shall be accounted for in the calculation.

To precisely calculate the weight and COG of the TLP, an inclining test shall be performed. To control weight, COG, and tendon tensions during service, proper load management tools shall be installed onboard, and relevant procedures shall be outlined in the operations manual.

1. Tests During Construction

1.1 The weight of hull and topside structure shall be controlled by an exact calculation. It is recommended to weigh the equipment to be brought on board.

1.2 At the end of construction of hull and topside structure an inclining test shall be carried out to define the centre of gravity. For details see Chapter 60, Section 7, D.

2. Intact Stability

2.1 Free floating during transfer

For the free floating condition reference is made to the requirements defined in Chapter 60, Section 7.

2.2 Floating in operating condition

2.2.1 During the floating of the hull with tendons already engaged the following situations with overturning moments have to be considered in addition to the conditions of 2.1:

- tendons partly engaged during the installation phase
- unequal pre-tension of the tendons
- failure of one or several tendons at one side of the structure

2.2.2 Ballasting

As ballasting of the hull/topside structure is an important activity for TLPs, the following situations are to be considered:

- change of the centre of gravity for towing, installation and operation
- establish tension of the tendons and its adjustment
- inspection and maintenance of ballast tanks

- correction of weight and centre of gravity in damage condition

2.2.3 Where the hull is made of concrete, the effect of longterm water absorption is to be considered.

2.2.4 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. It has to be clearly defined in the Operating Manual up to which failure stability is already secured.

2.2.5 It is assumed that noticeable inclinations of the hull 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.

3. Subdivision and Damage Stability

3.1 Extent of damage

Depending of the type of hull the following extent of damage has to be assumed:

- any one compartment adjacent to the sea shall be assumed at a time

- any other compartment with sea water piping may be assumed flooded in case of piping failure

- for a deep draught, surface type hull a vertical extent from 6 m below waterline at lowest tide up to 10 m above highest tide, for the other parameters see Chapter 60, Section 7, F.1.

- for a column stabilized type of hull the same vertical extent as for the surface type and the requirements of Chapter 60, Section 7, F.3. are to be observed.

- for concrete hulls a reduced damage penetration zone may be assumed

- where a lesser extent of damage than defined above will lead to less stability, such a condition has to be considered.

3.2 Stability criteria

Depending on the type of hull the stability criteria defined in Chapter 60, Section 7, E. are to be met.

4. Watertight Integrity

4.1 For openings in the outside shell of the hull/topside structure not only the waterline in free floating condition is to be considered, but also the operating condition with increased draught and pretensioned tendons. In addition any water level for a heel caused by unequal tendon tension, partial tension failure or environmental loads as well as increased draught and heel for damage condition shall be taken into account.

Watertight closing appliances are to be provided for any opening below the resulting highest waterline of the hull/topside structure.

4.2 For other aspects of watertight integrity see Chapter 60, Section 7, G.

5. Load Line

5.1 The floating hull/topside structure shall be provided with marks defining the maximum draught in all operating conditions.

5.2 For other aspects of load lines see Chapter 60, Section 7, H.

SECTION 5

LIFE-SAVING APPLIANCES

A. General

1. Scope

1.1 Life-saving appliances shall comply with the relevant applicable international and/or national regulations according to 2. and shall be suitable for the type and use of the fixed offshore installation. All life saving appliances shall be type approved.

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 offshore installations by **TL.** However, their arrangement in the overall design of the installation 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

Life-saving appliances and equipment shall comply with the relevant applicable International and/or National Regulations and **TL** Rules.

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, as far as practicable

- The Construction and Equipment of Mobile Offshore Drilling Units (MODU code), Chapter 10 – Life Saving Appliances and Equipment

- 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.