



Exploration & Production

## GENERAL SPECIFICATION

### STRUCTURAL

#### GS STR 102

#### Design of offshore topside structure

|      |       |                                                                                                                                       |
|------|-------|---------------------------------------------------------------------------------------------------------------------------------------|
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| 00   | 02/01 | First issue                                                                                                                           |
| Rev. | Date  | Notes                                                                                                                                 |

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## 1. Scope

This specification covers the design of offshore superstructures including all relevant appurtenances such as, but not limited to:

- Topsides and Modules
- Bridges
- Flare booms
- Flare towers
- Travelling crane and pedestal crane supports
- Walkways, stairways, ladders
- All installation appurtenances (padeyes, guides, docking guides)
- Living quarter structures.

This document amends supplements and replaces various clauses/sections of [API RP 2A](#) for the studies and works to be performed for the design of offshore superstructures.

The section numbers that appear in the following sections refer to the corresponding section of the [API RP 2A LRFD](#) referenced above.

The design shall be performed according to [API RP 2A WSD](#) or [API RP 2A LRFD](#), unless otherwise indicated in the present specification.

In all cases, the design principle (i.e. WSD or LRFD) shall be the same for all parts of the platform (jacket, deck, etc.), and for all conditions.

Materials for procurement, welding and associated inspections are covered by specifications [GS STR 201](#), [GS STR 301](#) and [GS STR 304](#).

Fire protection provisions are not included in this specification. Passive fire protection design and installation is covered by specification [GS COR 353](#).

The jacket design shall be conducted in accordance to specification [GS STR 101](#), and shall utilise the same design principle (i.e. WSD or LRFD) as for the superstructures.

## 2. Reference documents

The reference documents listed below form an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the EFFECTIVE DATE of the CONTRACT.

The structural design superstructures shall be conducted in accordance to the reference documents including codes and standards defined hereafter.

Where national regulations exist, their provisions and those of the standards and codes to which they refer shall apply, supplementing or amending the provisions of this document, subject to prior COMPANY approval.

If there are no national regulations covering all or part of the subject of this document, the reference documents shall be strictly applied, as supplemented by the provisions of this specification and the project documents.

In case the design of a particular structure or part of a structure is not covered by any of the listed reference documents, CONTRACTOR shall propose the use of a reputed and fit for purpose international code or regulation, subject to COMPANY approval.

In all cases, CONTRACTOR shall avoid to mix the requirements of several different codes or regulations when designing a particular item of a structure.

Only the main reference documents are mentioned; the CONTRACTOR shall be responsible for complying with all secondary reference documents dealing with the subject of this document.

### Standards

| Reference                           | Title                                                                                                                                          |
|-------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| ISO 19900                           | Offshore structures                                                                                                                            |
| API RP 2A LRFD<br>(ISO 13819-2,)    | 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 Bulletin 2V                     | Bulletin on design of flat plate structures                                                                                                    |
| API Bulletin 2U                     | Bulletin on stability design of cylindrical shells                                                                                             |
| ISO 1000                            | International system of units                                                                                                                  |
| HSE - OTO 2001/070                  | The structural design of helidecks for offshore installations.                                                                                 |
| ICAO – Annex 14                     | Volume II Heliports                                                                                                                            |
| CAP 437                             | Offshore helicopter landing areas                                                                                                              |
| AISC LRFD                           | Manual of steel construction - Load & resistance factor design latest edition ( subject to COMPANY approval)                                   |
| AISC ASD                            | Manual of steel construction. Allowable Stress Design                                                                                          |
| DNV classification notes<br>n° 30.5 | Environmental Conditions and Environmental Loads                                                                                               |
| DNV Rules                           | Rules for the design, construction and inspection of offshore structures. Appendix B, Loads, 1977                                              |
| DNV Rules                           | Offshore standard DNV OS E401 Helicopter decks Section 3                                                                                       |
| API SPEC 2C                         | Specification for offshore cranes                                                                                                              |
| F.E.M. 1.001 or equivalent          | Règles pour le calcul des appareils de levage (pour monorails, poutres roulantes, potences). (Rules for the calculation of hoisting equipment) |
| NF P 22-255 or equivalent           | Metal construction. Hollow section welded assemblies on type I and H sections. Design and verification                                         |
| BS 8100                             | Lattice towers and masts. Code of practice for loading                                                                                         |

**Professional Documents**

| Reference      | Title |
|----------------|-------|
| Not applicable |       |

**Regulations**

| Reference      | Title |
|----------------|-------|
| Not applicable |       |

**Codes**

| Reference       | Title                                            |
|-----------------|--------------------------------------------------|
| AWS D 1.1       | Structural Welding Code - Steel                  |
| ASME VIII Div 1 | Rules for construction of pressure vessels       |
| PD 5500         | Specification for unfired fusion pressure vessel |

**Other documents**

| Reference      | Title |
|----------------|-------|
| Not applicable |       |

**Total General Specifications**

The provisions of this document shall be applied in the light of the supplementary documents supplied by the OWNER, including:

- Country specificity appendices
- Particular specification
- Data sheets
- Articles and conditions; list of tasks
- Quality assurance provisions.

| Reference  | Title                                                                              |
|------------|------------------------------------------------------------------------------------|
| GS COR 240 | Fusion bonded epoxy based coatings works for conductor pipes of drilling platforms |
| GS COR 350 | External protection of offshore and related structures and equipment by painting   |
| GS COR 353 | Design and application of passive fire protection coatings                         |
| GS STR 001 | Weight monitoring and weighing of offshore units                                   |
| GS STR 002 | Permanent lifting or handling devices for offshore installations                   |

| Reference  | Title                                                                                      |
|------------|--------------------------------------------------------------------------------------------|
| GS STR 100 | Fixed offshore steel platforms - General                                                   |
| GS STR 101 | Design of offshore jacket and subsea structures                                            |
| GS STR 103 | Design and fabrication of steel structures supporting equipment                            |
| GS STR 104 | Design and construction of technical cubicles for offshore oil installations               |
| GS STR 201 | Materials for offshore steel structures                                                    |
| GS STR 301 | Fabrication of offshore steel structures                                                   |
| GS STR 304 | Fabrication of welded plate girders                                                        |
| GS STR 401 | Load out, sea-fastening, transportation and installation of offshore structures            |
| GS STR 901 | Design rules and construction standards for ancillary structures of offshore installations |
| GS CIV 404 | Design and construction of offshore living quarters                                        |
| GS SAF 221 | Safety rules for buildings                                                                 |
| GS LSO 110 | Environmental effects considerations for helidecks                                         |

### 3. General design requirement

#### 3.1 General principles

The following principles shall be taken into account in the design of structures:

- Principles for load-out, transportation, installation, lifting, launching or for any particular phase or condition, which has a major impact on certain component of the structures, shall be integrated in the design at the very beginning of the design phase
- Hook-up works shall be reduced to a minimum and shall be made as easy as possible. Consequently, each element, even if of secondary importance, shall be analysed in order to maximise the amount of work to be carried out on the fabrication site
- 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
- Unnecessary or duplicated permanent loads (skids + flooring underneath, modules + flooring underneath, etc.) shall be avoided
- Safety shall be considered as priority and shall be taken into consideration from the beginning of the design, including for the temporary phases (load-out, transport and installation). Particular attention shall be paid to accessibility, circulation routes, escape routes, muster areas, partitions, fire resistance, finish materials, etc.
- Future extensions and additional loads (if any such as COMPANY reserve) shall be considered and the consequent design arrangements shall be made.

## 3.2 Importance of structural members

### 3.2.1 Structural members

The structural members of the resisting structures are distributed into three categories of importance, mainly in regard of the consequences of their possible failure during platform production or during installation of constituting parts of the platform (lifting of packages, etc.), as defined in [GS STR 100](#).

This distribution of structural members into categories of importance shall be submitted to COMPANY for prior approval.

### 3.2.2 Non structural members

Accessory and finishing elements, i.e. not participating in the overall strength of the platform structures (walkways, handrails, stairs, ladders, grating, flooring, etc.) constitute a class separate from that of Structural Members defined above.

## 3.3 Air-gap

The bottom of the lowest superstructure (deck) or piece of equipment shall be located at an elevation such as to provide a clearance “air-gap” above the highest foreseeable wave crest elevation superimposed on the maximum surge height plus the normal Mean High Water Springs (MHWS) (or HAT if required by project documents).

Unless stipulated otherwise, the air-gap shall be taken as 1.50 m minimum from the lowest part of the structure or piece of equipment, and shall also take into account:

- Setting down after installation and operation
- Tolerance concerning seabed levels and wave crest information on installation site
- Subsidence.

100 years return period wave crest elevation shall be used unless otherwise noted.

Whenever it is unavoidable to have a minor part of the superstructure or a piece of equipment located within the air-gap defined above, wave loads shall be taken into consideration on this part of the structure or piece of equipment. However they will not be cumulated to the global wave loads acting onto the and the foundations unless noted otherwise in the project specification.

Local verification of this part of the superstructure or piece of equipment, and its connection to the rest of the structure, shall also be carried out.

These wave forces affecting the items located in the air-gap may be evaluated as per [API RP 2A WSD](#), section 2.3.4g.

In case of large equipment located in the air-gap, COMPANY may request to consider global wave load effect (i.e. effects on deck, jacket and pile design).

### 3.4 Splash-zone

The splash-zone to be considered for structural design shall extend between:

- The crest level of the 100 years wave superimposed on the maximum surge height plus the normal Mean High Water Springs (MHWS)
- Below the Lowest Astronomical Tide (LAT) minus 3 meters or the annual swell trough whichever is the greater.

### 3.5 Corrosion allowance

Unless otherwise specified in the particular specifications, a corrosion allowance equal to 6. mm shall be added to the thickness of the special or first category members located in the splash zone including deck legs and transition pieces.

A corrosion allowance of 3 mm shall be added to the thickness of the bottom chords of the bridges and of the first vertical panel at both ends. Where the inspection and maintenance access is not possible, a corrosion allowance of 6 mm shall be added.

For fatigue analyses, the corrosion allowance may be considered equal to one half of the above values (3 mm).

Corrosion allowance for subsea structures shall be defined in the project documents.

### 3.6 Minimum thickness

The minimum thickness shall be:

- 8 mm for special and first category components
- 5 mm for other components
- 3.7 mm for handrails

### 3.7 Maximum slenderness ratio of members

The maximum slenderness ratio for deck, flare, mast tubular members shall be limited to 120. For sensitive non-redundant members COMPANY may limit the maximum slenderness ratio to 90. For deck, flare and mast located in particular seismically active areas, COMPANY may limit the maximum slenderness ratio to 80 (API RP 2A WSD Earthquake design requirements).

### 3.8 Connections

#### 3.8.1 Welded connections

The connections shall be designed in such a way that:

- They shall allow for a direct, straightforward and simple load transfer from one structural member to another, avoiding stress concentration and induced bending stresses as far as possible
- Their fabrication shall be as simple as possible; constructibility and welding access shall be particularly verified during design
- Notching effects are eliminated

- Corrosion is reduced to a minimum. This means avoiding shapes or arrangements that induce retention or ponding of water or hydrocarbons, in order to avoid hazards and ease inspection and maintenance/painting.
- The minimum fillet weld leg size shall be 6 mm.

All structural connections shall be justified by calculations.

### 3.8.2 Bolted connections

Bolted connections between structural members pertaining to special or first category shall be avoided as far as possible.

Mechanical / locking devices of nuts shall be provided for bolted connections between structural members pertaining to special or first category, to masts, to equipment superstructures, to vibrating equipment, etc.

In case bolted connections have to be implemented, they shall be designed according to AISC "Allowable Stress Design" (latest edition):

- Part 4: Connections ( using A 307 bolts)
- Part 5: Specifications and Codes:
  - Chapter J: connections, joints and fasteners
  - Specification for structural joints using [ASTM A 325](#) or A 490 bolts.

For the splash zone and above, the bolting shall be zinc plated or galvanized and then painted.

Reference shall also be made to section 13 of [GS STR 201](#).

### 3.9 Hollow sections

Hollow sections that cannot be serviced from the inside due to their dimensions or their location, are to be made watertight by closure plate and welding.

Manholes or trapdoors giving access to normally closed spaces (e.g. crane pedestal) shall be equipped with leak-proof seals.

## 4. Design loads and loading conditions ([API section C](#))

In general, the design of an offshore steel structure shall be carried out using the definition of loads and loading conditions as per [API RP 2A LRFD](#), section C or [API RP 2A WSD](#), section 2, with the additional requirements stated in the following paragraphs and in [GS STR 100](#).

### 4.1 Definition of loads and loading conditions

The following loads and any dynamic effect resulting from them shall be used to develop the loading conditions to be considered for the design of an offshore steel structure.

#### 4.1.1 Definition of loads

##### 4.1.1.1 Dead loads

Dead loads are the weights of the platform structure, appurtenances, and any permanent equipment, which do not change with the mode of operation, such as (but not limited to): steel structure, piles, grout, ballast, hydrostatic forces, permanent equipment, etc.

#### 4.1.1.2 Live loads

Live loads are the gravity loads, which may change during the operation of the platform or from one mode of operation to another mode of operation, such as (but not limited to): weight of drilling equipment, weight of equipment which may be added or removed, weight of consumable supplies, weight of production/utilities equipment and piping contents, blanket live loads as defined in specification **GS STR 102**, forces exerted on the structure during operations such as drilling, material handling, vessel and helicopter landing, crane operation, etc.

#### 4.1.1.3 Environmental loads

Environmental loads are imposed on the platform by natural phenomena such as wind, wave, current, tide, earthquake, snow and ice, and soil movement. Environmental loads shall be anticipated from any direction, unless otherwise demonstrated.

#### 4.1.1.4 Dynamic loads

Dynamic loads are the loads due to the response to an excitation of a cyclic nature or due to an impact or due to the sudden application of a load (impulse type). Dynamic loads may be induced by waves, wind, current, earthquake, crane or lifting equipment operation, drilling operation, boat or helicopter landing, rotating equipment, blast, etc.

#### 4.1.1.5 Construction loads

Construction loads are the loads resulting from fabrication, load-out, transport and installation of a platform, and shall be considered in the design as further indicated.

### 4.1.2 Definition of loading conditions

The loads defined in 4.1.1 above shall be combined to develop the appropriate loading conditions such as to produce the most severe effects on the structure.

Operating environmental load conditions are those, which are not severe enough to restrict normal platform operation.

Design environmental load conditions are those resulting from the selected design events (i.e. extreme environmental conditions), which may induce a restriction of platform operation.

The design of an offshore structure shall consider load conditions combining environmental loads with appropriate dead and live loads in the following manner:

- Operating environmental load condition (including dynamic loads if any) combined with dead loads and maximum live loads (including dynamic loads if any) appropriate to normal operation of the platform
- Operating environmental load condition (including dynamic loads if any) combined with dead loads and minimum live loads (including dynamic loads if any) appropriate to normal operation of the platform
- Design (Extreme) environmental load condition (including dynamic loads if any) combined with dead loads and maximum live loads (including dynamic loads if any) appropriate for combination with extreme environmental condition
- Design (Extreme) environmental load condition (including dynamic loads if any) combined with dead loads and minimum live loads (including dynamic loads if any) appropriate for combination with extreme environmental condition

- Earthquake environmental condition (including dynamic effects) combined with dead loads and live loads as detailed in section 4.8
- Temporary load condition occurring during fabrication: load-out, transport, installation shall consider combinations of dead loads, maximum temporary loads (including dynamic loads if any) and appropriate environmental loads (including dynamic loads if any).

Environmental loads shall be combined in a manner consistent with the probability of their simultaneous occurrence during the loading condition being considered.

Earthquake loads shall be applied on the structure as a separate environmental condition, and shall not be cumulated with wave, current and wind loads.

Operating environmental condition should represent a moderately severe condition at the platform location; typically, a 1-year return period wave, current and wind shall be used for operating environment, to be confirmed in the particular specification, or unless specified otherwise by national/local regulations.

Extreme environmental condition shall be generated by the 100-year return period wave, current and wind, to be confirmed in the particular specification, or unless specified otherwise by national/local regulations.

Earthquake environmental condition is detailed in the particular specification, or unless specified otherwise by national regulations.

#### 4.1.3 Modelling of loads and loading conditions

In view of their combinations such as to represent loading conditions, the loads shall be classed according to the following principles:

##### 4.1.3.1 Elementary load case

The elementary load case shall be defined as a set of indivisible loads of the same type acting concomitantly on a structure.

As such, dead weights and live or operational loads shall be splitted in different elementary load cases, such as but not limited to:

- The dead weight of the primary structures
- The dead weight of the secondary structures
- The dead weight of the itemised empty piping
- The weight of the fluid content in the piping
- The weight of the itemised mechanical equipment
- The dead weight of the bulk electrical equipment
- The loads due to operating waves oriented at 90°
- The blanket live load at cellar deck
- The dead weight of the platform crane
- The operating load of the platform crane (force + momentum).

#### 4.1.3.1.1 Traceability of elementary loads

Both calculation note and computer model file shall fully document and trace in detail the origin of each and every load input in the model. As such, individual loads pertaining to each piece of itemised equipment shall be related to the equipment reference number.

Calculation notes shall include elementary loading sketches detailing for each equipment the magnitude of the load, the identification of the structural members supporting the load the location of the load on the structural member and the identification of the equipment. The above is also applicable to the main itemised piping supports, electrical cables supports, etc.

Additionally, loading diagrams summarising all gravity loads per level for the platform, including dead weights, operational loads and live loads for all itemised and bulk equipment, blanket live loads, shall be issued and updated by the CONTRACTOR throughout the complete duration of the project.

#### 4.1.3.2 Loading types

##### 4.1.3.2.1 Definition

Loading types shall be defined as the combinations of elementary load cases having the same origin, such as but not limited to:

- Dead loads (or dry weight)
- Normal operational live loads
- Blanket live loads
- Future loads
- Exceptional (or test) operating live loads
- Operating environmental loads
- Extreme environmental loads
- Seismic loads
- Accidental loads such as dropped object, blast and fire
- Loads induced by construction
- Loads induced by transportation
- Loads induced by installation.

##### 4.1.3.3 Loading condition

The loading condition shall be defined as a combination of different loading types which, acting together, induce maximised stresses on the structure.

The loading condition and the rules for combination of the loading case are defined in paragraph 4.1.2.

Examples of loading conditions are:

- Installed structure in operating conditions
- Installed structure in design condition (i.e. combinations with extreme environmental load)
- Installed structure in seismic conditions

- Structure during load-out phase
- Structure during transportation phase (head seas)
- Structure during installation phase.

## 4.2 Gravity design loads

### 4.2.1 General

In case a simplified jacket model is used in the deck calculations, CONTRACTOR shall take all measures to ascertain that the modelled jacket loads and stiffness at jacket/deck interface are representative of the true jacket and appurtenances behaviour.

### 4.2.2 Dead load 1, $D_1$ (C.2.2.)

All the gravity loads included in the calculation model must correspond item for item to the target weight of the weight report. A weight and centre of gravity summary shall be provided. Any changes will be incorporated in the weight control report.

The weight and COG shall be updated on a regular basis.

### 4.2.3 Dead load 2, $D_2$ (C.2.3.)

All these loads included in the studies must correspond item for item to the target weight indicated in the weight control report.

#### 4.2.3.1 Drilling loads (Derrick Set on upper deck if applicable)

The following drilling dead loads shall be included in the calculations:

- Weight of stored products (mud, gas-oil, water, etc.) to be defined in particular specification.

#### 4.2.3.2 Drilling loads on upper deck with no derrick set

- A load of 150 kN distributed on a 2mx4m area at any location of the upper deck shall be taken into consideration. No reduction factor shall be applicable to this load.

### 4.2.4 Live load 1, $L_1$ (C.2.4.)

#### 4.2.4.1 Equipment loads

The loads to be taken into account are loads in normal platform operating conditions.

In the absence of specific information concerning loads under normal operating conditions, the following loading shall be applied:

- Vessels intended for liquids are full of water or full of the liquid they are intended to hold, whichever is the heavier
- Separators are half-filled with water
- Vessels for gas are 10% filled with water
- Gas lines plus weight of contained pressured gas
- Liquid lines are full of water or full of the liquid they are intended to hold, whichever is the heavier.

#### 4.2.4.2 Floor blanket live loads

##### 4.2.4.2.1 Definition

These loads apply to free areas of floors. They do not represent equipment loads.

- Upper deck or weather deck.  
A uniform load of 10 kN/m<sup>2</sup> is applied to the free area.  
On a drilling platform, a uniform load of 15 kN/m<sup>2</sup> is applied to the free area.
- Production floors
  - A uniform load of 5 kN/m<sup>2</sup> is applied to the area free of equipment on all production floors.
- Miscellaneous floors and technical rooms : 2.5 kN/m<sup>2</sup>
- Living quarter floors  
These shall include light furniture such as beds, tables and chairs only. Heavy kitchen equipment, partition, floor and wall finish, insulation, plumbing, HVAC, etc., shall not be part of blanket live load and shall be modelled separately as permanent dead weight
  - Premises seldom occupied (bedrooms, etc): 1.75 kN/m<sup>2</sup>
  - Kitchens, meeting rooms, refectories, etc.: 5.0 kN/m<sup>2</sup>.
- Handling zone and equipment lowering zone: 20.0 kN/m<sup>2</sup>
- Storage areas – Heavy: 20.0 kN/m<sup>2</sup>, light: 10.0 kN/m<sup>2</sup>
- Gangway, footbridge, walkway, intervention zones, stairway: 2.5 kN/m<sup>2</sup>
- Muster areas/platforms for lifeboat: 10 kN/m<sup>2</sup>
- Rigging platform: If a rigging platform is used, it shall be designed to support the slings and for a load of 2 kN/m<sup>2</sup> over the entire surface.
- Helideck : 2 kN/m<sup>2</sup>.

Unless otherwise specified in Particular Specification, deck plating, grating and joisting shall be designed with an additional point load of 5 kN distributed on a 0.1m by 0.1 m area.

##### 4.2.4.2.2 Applied load factors

According to the element to be analysed, the drilling floor, production and living quarter loads shall have a coefficient Ks, given as follows, to be applied on blanket live loads defined in 4.2.4.2.1:

|                                                                  |           |
|------------------------------------------------------------------|-----------|
| Plating, floor beams and secondary trusses                       | Ks = 1    |
| Topside primary trusses, including frame beams on various levels | Ks = 0.5  |
| Module supports or deck supports (1)                             | Ks = 0.25 |

(1) Ks = 0 for circulation areas blanket load

##### 4.2.4.3 Helicopter landing 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.

The location and configuration of a helicopter landing facility must comply with national regulations of civil aviation authorities and the regulatory standard ICAO-Annex 14. The following requirements address structural considerations only.

The helicopter loads and helideck verifications shall be defined and done according to [HSE/OTO 2001/070](#) and [DNV OS E401 section 3](#).

The design shall be carried-out considering that the total load imposed by the helicopter is divided equally between the two main under-carriages, and then applied as concentrated loads on the landing area.

The loads imposed at the two main under-carriages shall be applied at several positions, in order to produce the most severe load path allowing for maximising the stresses in each structural element constituting the landing area (plating, joists, main beams, cantilevers if any, helideck support points or supporting structure, etc.).

The loads necessary to the design of the landing area are defined in section 3.1 of [HSE/OTO 2001/070](#), including dynamic impact loads, structural response loads, overall superimposed load, lateral loads, etc. together with the different load combinations to be performed.

It shall be considered the maximum take-off weight (MTOW) for both a heavy normal landing with an impact load of 1.5 x MTOW and an emergency landing with an impact load of 2.5 x MTOW.

For a heavy normal landing, elastic design with normal allowable stresses shall be considered. The maximum vertical deflections of the floor beam shall be limited to  $1/300^{\text{th}}$  of the span and the maximum deflection of the plating shall be limited to its thickness.

For an emergency landing, plastic design may be accepted for the plating and joists only. Elastic design with one-third increase of the normal allowable stresses shall be applied for the other structural components.

#### **4.2.4.4 Inertial loads**

Structures shall be verified under loads due to motion and vibration caused by the environmental loads.

#### **4.2.5 Live load 2, L2 (C.2.5.)**

##### **4.2.5.1 Drilling loads (Derrick set on upper deck if applicable)**

Set back, hook and rotary table loads shall be specified in appropriate particular specifications.

Unless otherwise specified, the following loading shall be applied:

|                                                    | <b>Set back</b>                                                                                            | <b>Hook load</b>                  | <b>Rotary table</b>               |
|----------------------------------------------------|------------------------------------------------------------------------------------------------------------|-----------------------------------|-----------------------------------|
| <b>Operating conditions with hook load</b>         | Maximum capacity for drilling                                                                              | To be defined in particular spec. |                                   |
| <b>Operating conditions with Rotary table load</b> | Maximum capacity for drilling                                                                              |                                   | To be defined in particular spec. |
| <b>Extreme drilling conditions</b>                 | Maximum capacity for drilling                                                                              | Maximum static rate hook load     |                                   |
| <b>Standby conditions</b>                          | Maximum capacity for drilling                                                                              |                                   |                                   |
| <b>Rig set removal</b>                             | <b>Equipment positioned at ends of skidding beams, with free access, without weight of stored products</b> |                                   |                                   |

#### 4.2.5.2 Exceptional operating loads

For exceptional operating loads due to hydrostatic tests, exceptional equipment loads shall be applied, but considered as single loads according to the test program (lines and vessels should not be tested at same time).

#### 4.2.5.3 Cab-operated and pendant-operated travelling crane

For structures carrying live loads that induce impact, the assumed nominal live load shall be increased to allow for this impact, as follows:

- For cab-operated travelling crane support girders and their connections: 25%
- For pendant-operated travelling electric crane support girders and their connections: 25% (for lift speed < 25 m/min)
- For pendant-operated travelling manual crane support girders and their connections: 10%.

The test load shall be 1.50 times the safe working load (SWL).

Horizontal load, fixed support case = 10% SWL.

Horizontal load, floating support case = 10% SWL increased by forces due to the movement of the support.

#### 4.2.6 Thermal load

For verification of flare boom, flare tower, etc.

For yield stress, the Young's modulus should be modified according to local steel temperature. Additional thermal stress due to temperature variations along the member should be taken into account.

#### 4.2.7 Rigging platform

If a rigging platform is used, it shall be designed to support the slings and for a load of 2 kN/m<sup>2</sup> over the entire surface.

## 4.3 Environmental loads

### 4.3.1 Definition

The environmental loads encompass all loads induced by actions of atmospheric and marine elements on the whole or part of the platform. These are essentially produced by:

- Wind
- Waves
- Currents
- Ice
- Snow
- Temperature changes.

The environmental loads shall be calculated based on the oceano-meteo conditions and criteria included in the Particular Specification.

Unless otherwise specified in the Particular Specification or in local/national applicable regulation, environmental loads shall be calculated according to the requirements of [API RP 2A](#) and section hereafter:

- A 1-year return period wave, wind and current characteristics shall be used to derive the environmental loads to be combined in the operating load condition
- The extreme (design) loading condition shall consider the environmental load resulting from the most stringent combination chosen from:
  - 100-year wind and wave + 10-year current
  - 10-year wind and wave + 100-year current

If available, the joint probability 100-year environmental condition shall be used.

### 4.3.2 Loads induced by waves and currents

Whenever it is unavoidable to have a minor part of the superstructure or a piece of equipment located within the air-gap, wave loads shall be taken into consideration on this part of the structure or piece of equipment.

Local verification of this part of the superstructure or piece of equipment, and its connection to the rest of the structure, shall also be carried out.

These wave forces affecting the items located in the air-gap may be evaluated as per [API RP 2A WSD](#), section 2.3.4g and according to section 5.3.1 of [GS STR 101](#). Local dynamic effect such as wave run up shall be considered.

## 4.4 Vortex shedding (wind)

Local verification of members shall be done against vortex shedding due to wind 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.

#### 4.5 Loads on stairs, walkways, outfitting

Staircases in areas that may be subject to heave shall withstand, in addition to the gravity and traffic loads, all hydrodynamic forces, slamming in particular.

#### 4.6 Topsides design loads due to floating support motions

The design loads shall take into account the motion of floating support (sway, surge, heave, roll, pitch, yaw) and the corresponding forces in terms of maximal loads as well as cyclic loads. These loads shall be determined for in place, transportation and installation cases.

The topsides shall be checked regarding the following aspects (this list is not exhaustive):

- Floating support deflections for in place, transportation, installation conditions in all possible vessel loading conditions
- Loading support vibrations
- Frames maximum deflections
- Relative deflections between modules
- Fatigue of the structures under dynamic displacements and supports deflections
- Equipment supports design
- Handling equipment.

#### 4.7 Combination of loads for in-place design

The following load combinations shall be verified for two types of loading, operating conditions and extreme conditions, denoted in the table as:

|     |                                                            |      |                                                      |
|-----|------------------------------------------------------------|------|------------------------------------------------------|
| Op1 | Operating condition without derrick set                    | Ext1 | Extreme condition without derrick set                |
| Op2 | Operating condition and drilling operation                 | Ext2 | Operating condition with extreme drilling conditions |
| Op3 | Operating condition during installation of the derrick set | Ext3 | Extreme condition and drilling in stand by           |

| Loads combinations<br>Load cases               | Op1 | Op2 | Op3 | Lifting | Ext1 | Ext2 | Ext3 |
|------------------------------------------------|-----|-----|-----|---------|------|------|------|
| Self weight of the structures (D1)             | X   | X   | X   | X       | X    | X    | X    |
| Weight of equipment and other objects (D2)     | X   | X   | X   | X       | X    | X    | X    |
| Future equipment (D2)                          | X   | X   | X   |         | X    | X    | X    |
| Drilling equipment (D2)                        |     | X   |     |         |      | X    | X    |
| Drilling equipment during installation(D2)     |     |     | X   |         |      |      |      |
| Weight of consumable supplies and fluids (L1)  | X   | X   | X   |         | X    | X    | X    |
| Adjusted deck live loads (drilling floor) (L1) | X   |     |     |         | X    |      |      |
| Adjusted deck live loads (other) (L1)          | X   | X   | X   |         | X    | X    | X    |
| Short duration forces (L2)                     | X   | X   | X   |         | X*   | X    | X*   |
| Drilling loads operating (L2)                  |     | X   |     |         |      |      |      |
| Drilling loads extreme (L2)                    |     |     |     |         |      | X    |      |
| Drilling loads Standby (L2)                    |     |     |     |         |      |      | X    |
| 1-year environmental conditions (Wo)           | X   | X   | X   |         |      | X    |      |
| 100-years environmental conditions (We)        |     |     |     |         | X    |      | X    |

X\* without load crane

## 4.8 Seismic loads

Whenever mentioned in the particular specification, the design of an offshore steel structure shall consider the effects of the seismic loads, as required by [API RP 2A LRFD](#) or [API RP 2A WSD](#).

Both strength requirements and ductility requirements shall be taken into account in the design.

As a minimum a spectral response analysis shall be performed, according to [API RP 2A LRFD](#) or [API RP 2A WSD](#).

[API RP 2A](#) response spectrum shall be used unless otherwise requested by particular specification.

Seismic loads shall not be combined with other environmental loads.

Platform foundations shall also be part of the verification against seismic loads.

The computer model used for seismic response analysis shall take due consideration to the global mass modelling of the platform, and in particular to the hydrodynamic masses (entrapped water and water added masses) of the jacket and appurtenances. Also the right mass location and direction shall be modelled. A global modal participation mass justification in each direction shall be detailed.

Sufficient number of modes shall be generated in order to obtain a global modal participation factor of 90% in each direction.

The 10 first mode shapes shall be plotted and identified.

Simplified seismic design (such as UBC method) is not acceptable for offshore steel structures.

Resulting spectral accelerations and displacements at each deck levels shall be given.

#### 4.9 Fabrication and installation loads (API C5)

In the following, the weight to be taken into account is the target weight of the weight monitoring plus the weight of temporary components.

##### 4.9.1 Fabrication and erection loads (API C5)

Structural components or sub-assemblies weighing more than 50 tones or presenting a high degree of flexibility shall be verified according to API RP 2A and AISC for the fabrication and erection phase (deck frame roll-up, stacking, etc.).

##### 4.9.2 Load-out (API C5.6)

The structural calculations shall take into account all the relative motions of the barge and the structure. The quay soil verification, barge grillage/structure and supports as well as the structure itself shall be verified with the structure stiffness and relative displacements.

Load-out operation and design shall comply with the requirement of Specification GS STR 401.

##### 4.9.3 Transportation and sea fastening (API C5.7)

Transportation and sea fastening operations and design shall be covered by GS STR 401.

The transportation studies shall include the sea fastening and barge grillage design and calculation. They shall also justify the barge strength (global and local justification). The calculation method shall include the static gravity loads applied to the unfastened structure, and the dynamic loads applied to the fastened structure. When available, the stiffness of the support vessel deck shall be taken into account.

A fatigue analysis shall be performed for transportation time greater than seven days.

The slenderness coefficient for sea fastening components shall be not less than 1 in the calculations.

Sea fastening braces shall be welded on structure with intermediate of doubler plates.

##### 4.9.4 Lifting (API C5.5)

The first calculation shall be performed using provisional weight and centre of gravity locations (one theoretical and four in an uncertainty pattern) with a sling angle of 60°. Then, when the weight, COG and sling arrangement are known, a new calculation will be carried out to assess the structure and pad eye design.

Unless otherwise specified, the area of COG uncertainty in the horizontal plane shall be taken as a rectangle centred on the theoretical COG with each side parallel to the outer surface of the package, a length and a width equal to 10% of the overall respective length and width of the package. This rectangle defines the four extreme locations of the COG.

The lift points shall be located at strong points on the structure, as symmetrically as possible around the COG position. The location of the COG shall be within an elliptic area centered on

the geometrical center of the lifting points with large & small diameters equal to one-third of the corresponding distances between the lifting points. Counterweight shall be considered if required to achieve this criteria.

Lifting operations and design shall be as per requirements of **GS STR 401**.

#### 4.10 Summary of loads factors for LRFD design

Members shall be checked with a force Q such that:

$$Q = \gamma_1 D + \gamma_2 L_1 + \gamma_3 L_2 + \gamma_4 (W + \gamma_5 D_n)$$

The following coefficients shall apply unless otherwise noted in the particular specification.

|                                              | $\gamma_1$ (D) | $\gamma_2$ (L <sub>1</sub> ) | $\gamma_3$ (L <sub>2</sub> ) | $\gamma_4$ (W) | $\gamma_5$ (D <sub>n</sub> ) | $\gamma_6$ (E) |
|----------------------------------------------|----------------|------------------------------|------------------------------|----------------|------------------------------|----------------|
| Annual environmental conditions (Operating)  | 1.3            | 1.5                          | 1.5                          | 1.2            | 1.25 <sup>(*)</sup>          | 0              |
| 100-years environmental conditions (Extreme) | 1.1            | 1.1                          | 0                            | 1.35           | 1.25 <sup>(*)</sup>          | 0              |
|                                              | 0.9            | 0.8                          | 0                            | 1.35           | 1.25 <sup>(*)</sup>          | 0              |
| Load out                                     | 1.3            | 0                            | 0                            | 1.3            |                              | 0              |
| Transport                                    | 1.3            | 0                            | 0                            | 1.35           | 1.25 <sup>(**)</sup>         | 0              |
| Lifting                                      | 1.3            | 0                            | 0                            | 1.3            |                              | 0              |
| Seismic                                      | 1.1            | 1.1                          | 0                            | 0              | 0                            | 0.9            |
|                                              | 0.9            | 0.8                          | 0                            | 0              | 0                            | 0.9            |

#### 4.11 Vibration analysis

A detailed vibration study shall be carried out on the supporting deck of vibrating equipment.

By principle, the rotating equipment shall be mounted on a three point skid.

If anti-vibration mountings (A.V.M.) are implemented between the equipment skid and the supporting structure, multi supports (min. 4) shall be considered.

All main sources of vibration shall be considered in the design of the structure. The « vibrating » equipment list shall be defined taking into account the following parameters: type of rotating machine (centrifugal, screw or reciprocating), electric power, excitation frequencies and dynamic forces, total mass, insulating systems with anti-vibration mountings (A.V.M.).

As a minimum the following shall be analysed for their effects on the structure:

- Operating mechanical equipment

In the frequency range of 5 to 80 hertz, a vibration analysis of the structure shall be carried out taking account of vibrating equipment with the following acceptance criteria:

(\*) D<sub>n</sub> may be disregarded when the platform's natural period is less than 3 seconds.

(\*\*) D<sub>n</sub> is the effect of dynamic amplification due solely to structure eigenvalues (the transportation loads are considered static and included in W adjusted by  $\gamma_4$ )

1. For equipment insulated with anti-vibration mountings (A.V.M.), if the AVM are implemented between the equipment skid and the supporting structure:
  - a) the six suspension modes shall be less than one half of the lowest principal excitation frequency of the equipment,
  - b) the supporting structure stiffness (N/m) shall be twenty times higher than the A.V.M.'s stiffness.
2. In all cases, equipment skid and supporting structure significant natural frequencies ( i.e. mode shape involving equipment skid and surrounding supporting structure : estimated participating mass, above 10 % of the total mass of the equipment skid and surrounding structure) shall be out of the frequency range of +/- 20% of the principal excitation frequencies less than 35 Hertz or +/- 10% of the principal excitation frequencies above 35 Hertz.
3. If the requirements of above paragraph 2 are not verified or achievable, a dynamic response shall be performed. The computed vibration levels shall verify the machinery acceptance criteria. For the calculation, the modal damping factor  $\eta$  (  $\eta = 2 C / C_r$  ) shall be less or equal to 0.04 with C = viscous damping and  $C_r$  = critical viscous damping.

In complement, the supporting structure cartography, if requested, shall be computed regarding human exposures to vibrations that shall not exceed the allowable limits as defined in **GS SAF 221**.

For four stroke diesel engines, the first excitation frequency is given by half the rotating speed.

Large cantilevers (whether formed by simple beams or trusses) forming an integral part of the topsides, but excluding mast or booms, should generally be proportioned to have a natural period of less than 1 second in operating conditions.

In the absence of a complete vibration calculation, the following construction provisions shall be adopted. The support beams of reciprocating machines should have a depth larger than one tenth of the distance between the two main supports. This rule applies for all beams up to the connection to the topside legs.

- Vibrations from variations of fluid flow in piping systems, in particular slugging
- Oscillations from vortex shedding on slender tubular structures
- Global motion from the effect of environmental loads on the total platform structure
- Vortex shedding and fatigue on structural tubes

An assessment of the possible vortex shedding due to wind that might cause fatigue on exposed members shall be undertaken including the temporary construction or transportation phases in particular for « X » frame arrangement. Flare booms, drilling derricks, telecommunication mast and large bridge shall also be considered.

#### 4.12 Blast wall design

The design of blast walls shall be based on plastic/dynamic methods in order to justify the blast energy absorption.

The blast walls shall not be part of the main bearing structure to be maintained intact after blast.

The blast walls shall be connected with hinged connections to the main beams of the decks which shall be justified accordingly. Connections to the truss members shall be avoided.

Sufficient clearance behind the blast wall shall be provided to avoid impact on the main bearing structure or equipment.

#### 4.13 Dropped object

Structure shall be designed against dropped object according to the safety and handling studies.

#### 4.14 Lattice structures (flare booms and towers)

The wind loads shall be evaluated by the method of BS 8100 or equivalent method subject to COMPANY approval.

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.

### 5. Structural steel design (API sections D and E)

#### 5.1 General

The studies shall be supported by all the documents required for the complete definition of the structure: static in-place analysis including modal response, fatigue analysis, seismic analysis, vibration analysis, load out and transport analysis, installation analysis, fabrication studies, all associated design, fabrication and installation drawings. This list is not exhaustive.

The assumptions and methods used at each stage of the calculations must be collected in a document named "Basis of design" submitted to the COMPANY or its representative for approval before starting any calculations. The CONTRACTOR should be responsible for collecting all the necessary information as required from others (Construction, Transportation, Installation matters, etc.).

Aspects of design requiring special attention include:

- Corrosion protection system (paint, coatings, cathodic protection, etc.)
- Access route, floors and gratings
- Inspection of hot-work (welding and cutting)
- Difficult-to-inspect areas
- Survey operations during lifetime
- Node construction details.

#### 5.2 Structural modelling

The structure shall be modelled by entering node co-ordinates, member incidences and properties.

CP, risers, I tubes, caissons, boat landings and equipment supports shall be modelled but shall not be incorporated in the overall structure stiffness.

When the participating wall plates and/or deck plating are modelled with relevant properties and locations, the computed stresses in the plate elements shall be justified.

The detailed jacket model should preferably be added to the deck model. A representative jacket stiffness could be part of the structural model, subject to verification that the modelled

jacket loads and stiffness at jacket/deck interface are representative of the true jacket and appurtenances behaviour, as mentioned in paragraph 4.2.1.

### 5.2.1 Modelling limits (API Section E)

Connections: Additional nodes shall be modelled if the eccentricity exceeds one quarter of the chord diameter. Stress concentration shall be minimised. Overlaps shall be avoided. The theoretical gap (g) between braces shall be 75 mm minimum in order to account for fabrication tolerances and achieve a final 50 mm gap between weld toes.

Except in the area of conductor pipe frames, members with nominal diameters less than or equal to 6" may not be modelled, provided that wave exposed area is otherwise considered.

### 5.2.2 Connections

Calculations of non-tubular joints (beam/tubular joints), shall be performed using proven and sound engineering practice in considering in particular the effective load path. Specific attention shall be paid to the method of design (WSD or LRFD) to be carried out.

## 5.3 Allowable displacements

### 5.3.1 Horizontal deck displacements

Relative horizontal displacements shall be limited to 1/300 of the topsides height between the upper deck level and the upper jacket horizontally braced level under extreme environmental conditions.

### 5.3.2 Local deflections

Types of deformations:

$d_0$  pre camber (hogging) of a beam or element in the unloaded state.

$d_1$  the value of deflection from the permanent loads.

$d_2$  the value of deflection from the variable loads.

$d_{max} = d_1 + d_2 - d_0$

| Vertical deflections                                                             |                            |                     |
|----------------------------------------------------------------------------------|----------------------------|---------------------|
| Condition                                                                        | $d_{\max}$                 | $d_2$               |
| Floor beam                                                                       | 1/200 <sup>th</sup>        | 1/300 <sup>th</sup> |
| Equipment supports                                                               | 1/500 <sup>th</sup>        |                     |
| Rotating equipment supports                                                      | 1/1000 <sup>th</sup>       |                     |
| Travelling beams                                                                 | 1/500 <sup>th</sup>        |                     |
| Deck plate (thickness = t)                                                       | t                          |                     |
| Horizontal deflections                                                           |                            |                     |
| Wall flat plate (thickness = t)                                                  | t (between stiffeners)     |                     |
| Telecommunication masts (allowable rotation at the top under extreme conditions) | 1/100 <sup>th</sup> Radian |                     |
| Pedestal structure                                                               | 1/300 <sup>th</sup>        |                     |

### 5.3.3 Modal response

The modal responses of the platform (including deck and equipment) shall be determined up to the first mode whose natural period is less than 1 second.

## 5.4 Weights and weight monitoring

The weights shall be monitored at each stage of design according to specification **GS STR 001**. All the gravity loads included in the studies shall correspond item for item to the target weight of the weight monitoring. Any further changes shall be incorporated and a new weight report and COG supplied to COMPANY according to specification **GS STR 001**. The weight report shall contain the location of the centre of gravity for the in-place, load-out, transportation and installation lift configurations. The in-place weight report shall clearly define the dry weight, the operating weight (including fluids) and the weight of future equipment.

## 6. Structural component and systems (API Sect. H)

### 6.1 Deck design model (API H.1.2)

The design model shall be defined by a space frame model with beam elements and finite elements, plus other elements needed to model specific structural characteristic. All primary structural elements and equipment supports shall be modelled in the space frame analysis. The effects of secondary members (with nominal diameter less than 6" or beam depth less than or equal to 200 mm) (if not included in the space frame) should be accounted for in a detailed local analysis. The effect of joint eccentricities and joint flexibility should be accounted for in the model, as should plate stiffness (deck plating and wall steel).

Gap: Additional nodes shall be used in the model if the gap exceeds one quarter of the chord diameter.

## 6.2 Lifting and handling appliances, except platform crane

Platform lifting and handling appliances (chain blocks, travelling blocks, travelling beams, winches, pulleys, anchor points, etc.) shall be characterised by their safe working load (SWL) which is function of the load to be handled.

A specific layout drawing shall define in detail the type, the location and the capacity (SWL) of each lifting and handling appliance.

The design of the structural components supporting lifting and handling equipment shall be based on the safe working load (SWL) of the concerned piece of equipment, factored as required to take into consideration the induced dynamic effects when operating the lifting/handling appliance (to be documented after clarification with the equipment Vendor).

Similarly, the loads induced by the operation of the lifting appliance such as horizontal transverse load and longitudinal acceleration or braking loads, etc., shall be also taken into consideration (to be documented after clarification with the equipment Vendor).

In case the Vendor documentation is uncomplete or not available, the following shall be taken into consideration, as a minimum:

- Dynamic effects (vertical) - For the static calculations of the structural components supporting the lifting equipment, the following dynamic factors shall be applied to the vertical SWL:
  - Electric monorails, cranes, travelling crane: 1.25
  - Manual monorails, cranes, travelling cranes: 1.10
  - Lifting winches and pulleys incl. life-boats davits: 1.40
  - Fork lifts: 1.50
  - Belt conveyors: 1.20
  - Elevators and hoists: 2.00
- Horizontal loads - The following horizontal loads shall be considered as acting simultaneously for the travelling cranes and monorails.
- A transverse force equal to 10% of the load at each wheel, without dynamic factor, applied to the point of contact between the wheels and the support beam or rail.
- A longitudinal force applied to the same points as in a) above, equal to two times the load defined in a) above, for the drive wheels only.
- The force due to the impact on the stoppers of the gantry beam, calculated using the mass of the lifting equipment and the maximum translation speed (the mass of the lifted load shall not be considered if the load is not rigidly connected to the lifting equipment).

Similarly, the following shall be considered for loads generated by fork-lift trucks:

- The gross vehicle weight (increased by the dynamic factor) is acting on the axle close to the forks. Unless otherwise indicated, it shall be assumed that this axle has two wheels and a contact surface with the flooring of 0.20 m x 0.15 m.
- The braking load is equal to 0.5 times the total gross vehicle weight (not increased by the dynamic factor).

### 6.3 Crane supporting structure (API H.3.)

The crane supporting structure comprises the crane pedestal and its connections to the topsides primary steelworks. It does not include the slew ring or its equivalent or the connections between the slew ring and the pedestal.

The supporting structure of the platform crane shall be designed in general according to [API RP 2A](#).

Crane support structures should, where practical, be attached at the intersection of topside primary trusses and connected at main deck elevation with minimal eccentricities.

During its use, the crane is subject to loads due to its own weight, the lifted load, environment, motions of the platform / vessel, and dynamics caused by movements such as hoisting, boom luffing, slewing, and for off board lifts, motions of the supply vessel from which the load is being lifted.

The Crane Loads for the analysis and design of the Platform Structure shall be defined according the API Spec 2C section 4.2, 4.3 and 4.4 as follows:

- The crane vertical load is to be equal to the rated load or safe working load (SWL) multiplied by the dynamic coefficient  $C_v$  determined in section 4.3.1.
- The Safe Working Load (SWL) shall be the largest lifted load that satisfies the requirements of the section 4.1.1 when the worst combination off all loads defined herein are applied to the crane.
- Offlead and sidelead loads, loads due to supply boat motions, and static inclination and motions of the crane base as defined in section 4.3.2.
- Wind, ice, and other environmental loads acting on the crane shall be taken onto consideration as defined in section 4.5.

#### Notes:

1. For onboard lifts on fixed platform only (i.e. crane lifts from / to the decks of the platform), the dynamic coefficient shall be  $C_v=1.33$ .
2. For off board lifts (i.e. crane lifts from / to supply vessels) this dynamic coefficient shall be determined taking into account the vertical spring rate of the crane (from the hook through the pedestal structure), the maximum actual steady hoisting velocity for the SWL to be lifted, the sea significant wave height for the load chart in question. For fixed platforms only and in areas with very mild sea and wind conditions, a default minimum dynamic coefficient  $C_v = 2.0$  may be used.
3. When load chart are given with onboard and off board data, the consistency with the above requirements shall be checked.

Pedestals and their attachment to the platform shall be designed for the loads defined above with an additional 1.5 factor applied to the vertical design load and to the horizontal loads due to the vertical design load (offlead and sidelead forces due to the vertical design load). The design moment, thrust, and torque for these components shall be increased accordingly with no allowable stress increase.

In conclusion of the above:

1. For Dynamic Design of the Pedestals and their attachment to the platform ("Crane Supporting Structure" ref. API RP 2A §7.3.2) – for off board lifts on fixed platforms only (i.e. crane lifts from / to supply vessels), the minimum dynamic coefficient  $C_v = 2.0$  shall be

used and this will result in design loads for load components that include the effects of crane dead load, wind, offlead, sidelead and min 3 times rated load ( $2.0 C_v \times 1.5$  factor = 3.0), and

2. For Static Design of the Pedestals, King Posts, and their attachment to the platform ("Crane Supporting Structure" ref. API RP 2A §7.3.1) - for onboard lifts on fixed platform only (i.e. crane lifts from / to the decks of the platform) the minimum dynamic coefficient  $C_v=1.33$  shall be used, and this will result in design loads for load components that include the effects of crane dead load, wind, offlead, sidelead and min 2 times rated load ( $1.33 C_v \times 1.5$  factor = 2.0), and
3. The Global Design of the Platform Structure shall be checked as above but without the additional 1.5 factor, i.e. this will result in design loads for load components that include the effects of crane dead load, wind, offlead, sidelead plus minimum 2.0 times rated load ( $C_v=2.0$  minimum) for Dynamic Design. For Static Check only,  $C_v=1.33$  can be used.

The fatigue design of the crane supporting structure, including the connection of the pedestal to the platform structure, shall be carried out considering the static rated load increased by a 1.33 factor. A minimum of 25,000 cycles shall be considered, unless noted otherwise in the particular specification

## 7. Selection of materials for offshore structures (API section I)

### 7.1 General

Unless otherwise specified, the resisting structural elements shall be distributed into three categories as per requirements of specification **GS STR 100**, and selection of material grade and quality for each category shall be carried out as per requirements of specification **GS STR 201**.

### 7.2 Through-thickness property (quality Z)

In complete joint penetration groove welded angular connections or cross joints, and for which the equations  $1.5e + s \geq 55$  and  $e \geq 20$  ( $s$  = main member thickness,  $e$  = branch member thickness, expressed in mm) are simultaneously satisfied, the main member shall have a minimum average reduction of area in the through-thickness direction of 35%.

In this case, the steel quality shall be Z35 according to **GS STR 201**.

## 8. Detailed engineering documents (API section J)

### 8.1 General

Engineering design documents should conform to the Quality Plan in respect of the procedures.

The documents shall be self-contained and contain all the information needed to assess the design.

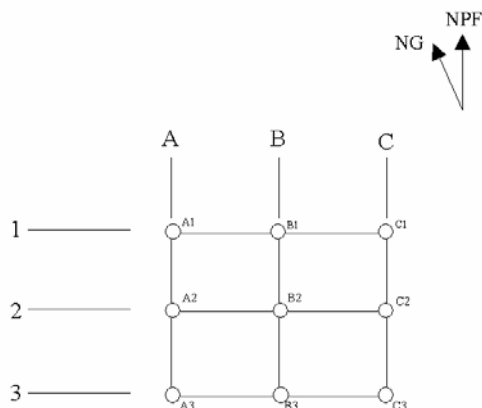
The document(s) shall be checked and approved by the CONTRACTOR following the procedures outlined in its quality plan.

The engineering design file shall be submitted to the COMPANY or its representative for review.

All engineering documents shall use the SI system of units. Stresses shall be given in MPa.

The use of inches is allowed for tubular sizes.

Unless otherwise noted in the project specification, files shall be marked as follows:



## 8.2 Calculation notes

The calculation notes shall include but not to be limited to:

- Basis of design (main characteristics of the structures, assumptions of each calculation)
- In-place
- Fatigue ( safety factor of 2 for the critical nodes )
- Dropped object
- Blast and fire
- Vibration
- Seismic
- Load-out
- Transportation
- Lifting
- Installation
- Fatigue under transport conditions
- Other studies depending of the structure type.

## 8.3 Content of the detailed engineering calculation notes

The engineering document shall clearly state at least the following information for each of the cases analysed (in-place including foundations, fatigue, dropped object, blast and fire, vibrations, load-out, transportation, installation, etc.):

- Hypotheses
- Conclusions and recommendations
- Software used and references
- Resultants of loads (basic cases and combinations)

- The computerised weight and centre of gravity of the structure for each configuration, and for each discipline (main structure, secondary structure, equipment, piping, etc.)
- Reactions at joint supports
- Forces in all members for all combinations
- Displacements of main nodes of the structure for annual and 100-years conditions
- Stresses in members other than the usual prismatic beams (box girders, etc.) for all combinations
- Member stress API ratios greater than 0.5 for the most stringent combinations
- Punching shear API ratios greater than 0.5 for the most stringent combinations
- SCF values for each node
- Node fatigue, the lifetime of which is less 50 years
- Natural periods
- All hand verifications.

The results shall be provided on a CD-Rom, in a WORD format.

## 8.4 Drawings

In addition to the calculation notes, the following documents shall be provided:

- AFC drawings and relevant material take-off
- Weight reports with the location of the centre of gravity for the in-place, load-out, transportation and installation configurations.

### 8.4.1 Drawing general recommendations

Minimum areas requiring the use of Z 35 steel shall be clearly identified.

All welds shall be full penetration and double sided, unless noted otherwise.

All fillet welds shall be continuous in particular for welds of joists to plating.

Each structure component shall normally be accessible for inspection.

Overlaps of bracings shall be avoided.

Ratholes shall be avoided.

A minimum 75 mm gap shall be provided between bracing foot prints. A minimum 100 mm gap shall be provided when welding access is restricted due to a flat surface.

If the cutting of "window" in structural pipes or hollow sections is necessary, written approval shall be obtained from the COMPANY.

Inaccessible hollow bodies shall be hermetically sealed and withstand hydrostatic pressure.

Plates and Stiffeners that do not have rounded edges shall have their exposed edges broken to facilitate painting.

At all vertical surfaces all gratings shall be adequately supported.

All grating penetration (piping, cables, etc.) shall be protected by a flat bar to avoid foot traps.

Unless otherwise noted on the Construction Drawings, all handrail welds shall be ground smooth. When removable, all handrail sockets shall be fitted with the panels and the sockets welded in place.

All supports (piping, cables tray, lights, etc.) less than 100 mm high welded on Special & First category elements shall be with doubler plate. All welds on Special & First category elements shall comply with a qualified welding procedure and be executed by a qualified welder. Non structural components such as all supports of piping, cable trays, lights, etc. higher than 100 mm shall be addressed and welded as structural items.

#### 8.4.2 "I" and "J" tubes for electrical cable

The "I" and "J" tubes and their fixings shall be sized to absorb the dragging forces of the lines for which they are intended. The particular characteristics of these lines shall be taken into account in defining diameters, curvature and both ends.

Ventilation openings in the top part shall be provided to cool electrical cables.

A messenger line should be provided in each tube.

A typical drawing of an I-tube is given in specification **GS STR 901**.

#### 8.4.3 Installation aids

Installation aids shall be provided as defined by the installation procedure, and shall include, but not be limited to:

- All installation aids to be cut offshore shall be welded on legs with doubler plates. They shall be ground to allow painting. Doubler plates shall be justified by adequate calculations
- If lifting trunnions are used, the sling shall be secured with a pin.

#### 8.4.4 Standards of Construction

Standards of Construction are collated in specification **GS STR 901**. They define the minimum requirements to be applied in the design and construction of standard ancillary structural elements on petroleum installations.

The OWNER may accept proposals for recommendations based on international standards and codes or national or foreign standards and codes. These documents shall be subject to the OWNER's approval.

The standards cover:

- Stiffened plates for floors and bulkheads
- Decking plates
- Grating plates
- Handrails including drawing
- Staircases including drawing
- Fixed vertical ladders including drawing
- Service hatches on wells
- Penetration through class A and/or H bulkheads

- Splash protection/flameproof/fire wall
- Skidding beams for the drilling rig
- I-tube for electrical cable drawing
- Steel wires
- Skid mounted equipment
- Helistation
- Protection of transformers
- Protection of flowlines
- Identification panel
- Helideck safety mesh including drawing.

## 9. Engineering provisions

Considerations applicable to topsides - Aspects of topside design and structural integrity management that may require special attention include:

- Corrosion protection system (paint, coatings, etc.)
- Fire protection system (active and passive)
- Access route, floors and gratings
- Supports for equipment including safety-critical communications, electrical and firewater systems, etc.
- Feasibility of welding and painting
- Penetrations for pipework, cabling, etc.
- Difficult-to-inspect areas.

The design shall ensure that the sequence of construction and any temporary erection conditions, including any jacking and weighing conditions are considered in the design. Distribution of loads to the support during fabrication will depend on the stiffness of the structure and the supporting foundation. Stresses on the structure due to uneven support points, but within specified tolerances, shall be determined.

## 10. Engineering supervision plan

The COMPANY shall, as a minimum, require a Hold Point or a Review Point on the following activities (to be completed after review of the CONTRACTOR's Quality Plan):

- Design premises: hold point
- Calculation notes: review
- AFC drawings: hold point
- Weight report: review
- Material Take Off: review

## 11. Fabrication principles

The fabrication specifications are covered by the specification **GS STR 301**. The following requirements referring to the fabrication stage are given to the design CONTRACTOR in order to ensure that a consistent structure design is obtained.

### 11.1 Fabrication studies

These shall be carried out in accordance with **API RP 2A**. Erection, stacking, weighing procedures during the course of the fabrication shall be documented by calculations and subject to COMPANY for approval before proceeding with the work.

Load-out equipment such as skidding beams, spreader bars, etc. shall be checked by calculations.

The load-out studies shall include the ballasting calculations and procedure of the support vessel.

A fully documented load-out procedure shall be submitted to COMPANY for approval by COMPANY and Warranty Surveyor. The content of the procedure shall be strictly in accordance with specification **GS STR 401**.

### 11.2 Weight monitoring

A weight monitoring report must be issued in accordance with specification **GS STR 001**. This shall be a direct continuation of the weight monitoring carried out during the Engineering phase.

### 11.3 Sea-fastening: miscellaneous

All equipment, installation aids such as slings, shackles, etc., shall be sea-fastened by the CONTRACTOR with angle bars and welded on the structure via doubler plates.

Cables shall not be used except for small and light pieces, submitted to COMPANY approval.

## 12. Specific requirements for floaters

The requirements listed above are to be applied for the floaters-topsides with the following additions and amendments:

### 12.1 Requirements for F(P)SO

The following applies generally to ship-shaped vessel such as F(P)SO, production barges.

#### 12.1.1 General design requirements

Main differences to general requirements of this document are due to three points:

- The inertia loading due to vessel global motions (transport, inplace)
- The deflections of the support under different ballasting/cargo loading configurations.
- The accidental inclined FPSO after damage

In addition, the variable draft may lead to green-water loading in full loading conditions.

## **12.1.2 Design loads and loading conditions**

### **12.1.2.1 Design loads**

#### **12.1.2.1.1 Permanent inclination loads**

Hydrostatic and hydrodynamic analysis in normal and damaged conditions shall determine design heel and trim conditions.

#### **12.1.2.1.2 Deflection loads**

Topsides are supported on a deformable hull structure. Global deflection (hogging and sagging, deck transverse deflection) occurs due to the different tank loading conditions. The way to consider these loads depend of the actual topsides structural concept. The way to handle these deflections has to be justified.

#### **12.1.2.1.3 Environmental loads**

The green-water loading on topsides supports and elements shall be included in global and local calculations. Combination with inertia loading requires the study of phases between motions and waves. Design sea-state shall be selected taking into-account relative positions and critical periods.

#### **12.1.2.1.4 Dynamic loads**

Design accelerations shall be developed for extreme loading conditions. Combinations of accelerations should be done taking into account the phase shifts between the different motions and the location to the motion centre.

Specific resonance effects shall be searched for and analysed, for example for the cranes design.

### **12.1.2.2 Loading conditions**

Additional loading conditions have to be introduced to deal with the different additional loads.

### **12.1.3 Detailed engineering documents**

Specific interface documents have to be developed between hull and topsides.

### **12.1.4 Weight monitoring**

Weight monitoring shall deal specifically with vertical location of c.o.g. and wind screen follow-up.

## **12.2 Requirements for other floaters**

To be developed in the relevant particular specification.