

GENERAL SPECIFICATION

STRUCTURAL

GS EP STR 632

Shallow Water CALM buoy

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1. Scope

This specification defines the general requirements for the design, fabrication and installation of a offshore Catenary Anchor Leg Mooring (CALM) buoy.

This specification covers all types of CALM buoys moored in typical shallow waters (say 80 m or less). It does not cover other types of Single Point Moorings, such as Single Anchor Leg Mooring (SALM), Single Anchor Leg Storage (SALS) or Articulated Loaded Platform (ALP).

It covers the export of oil or condensate and should not be applied without careful assessment to LPG or LNG.

Deep water CALM buoys requiring a specific export line are not mentioned in this specification.

Special features not covered in this specification will be detailed in the Project Particular Specification (PPS).

Purpose of a buoy is to moor a vessel, usually a tanker, by her bow to transfer one or more fluids between the buoy and the vessel. In certain cases, the vessel may be an F(P)SO permanently connected to the buoy, with an offloading tanker connected to the F(P)SO in tandem or alongside.

As a single point mooring, a CALM buoy allows a moored tanker, or a combination F(P)SO/tanker, to weathervane according to the environment while transferring fluids.

A CALM buoy system, hereinafter designated as a Buoy, typically consists of the following components:

- A **buoy body**, comprising a fixed (geostationary) part (connected to the risers) and a rotating part (connected to the floating hoses and the hawser(s))
- **Moorings lines** and their **anchor points** to moor the buoy on the seabed
- **Floating hoses** connecting the buoy body to the tanker to transfer the product
- **Hawser line(s)** to moor the ship to the buoy
- One or more subsea Pipe Line End Manifolds, or **PLEM**, located at the seabed and providing a link between the submarine pipeline(s) and the risers
- **Risers** (or underwater hoses) connecting the PLEM to the buoy body
- **Umbilicals/cables** connecting the PLEM to the buoy body.

Therefore, the boundaries of the Buoy scope are:

- The spool piece between the PLEM and sealine (spool piece included in scope)
- The end of the floating hoses on tanker side (tanker rail hose).

2. Reference documents

The reference documents listed below form an integral part of this General Specification.

The Buoy will comply with applicable International and National regulations. In case of conflict, the most stringent requirement applies unless derogated by written approval of Company and CS.

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External Documents

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and addendums, is the latest revision published at the effective date of this document.

Reference	Title
ABS 8	Rules for Building and Classing Single Point Moorings - Chapter 4.1
ASME B16.20	Metallic Gaskets for Pipe Flanges
ASME B16.5	Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard
ASME BPVC Section VIII Div 1	ASME Boiler and Pressure Vessel Code (BPVC) - Section VIII: Rules for Construction of Pressure Vessels - Division 1
EN 1765	Rubber hose assemblies for oil suction and discharge services - Specification for the assemblies
IEC 60079-10-1	Explosive atmospheres - Part 10-1: Classification of areas - Explosive gas atmospheres
ISO 19901-7	Petroleum and natural gas industries - Specific requirements for offshore structures - Part 7: Station keeping systems for floating offshore structures and mobile offshore units
ISO 898 (Parts 1; 2)	Mechanical properties of fasteners made of carbon steel and alloy steel - Parts 1; 2
OCIMF	Buoy Mooring Forum Hose Standards
OCIMF	Guidelines for the Purchasing and Testing of SPM Hawsers
OCIMF	Recommendations for Equipment Employed in the Bow Mooring of Conventional Tankers at Single Point Moorings
OCIMF GMPHOM	Guide to Manufacturing and Purchasing Hoses for Offshore Moorings 2009 (GMPHOM)
OCIMF MEG	Mooring equipment guidelines (MEG)
OCIMF SMOG	Single Point Mooring Maintenance and Operations Guide (SMOG)

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Reference	Title
GS EP COR 100	Cathodic protection of offshore structures
GS EP COR 103	Cathodic protection of offshore floating structures
GS EP COR 201	Galvanic anodes
GS EP COR 350	External protection of offshore and coastal structures and equipment by painting
GS EP COR 351	External protection of structures and equipment by painting. Floating structures
GS EP COR 356	Corrosion Protection of Fasteners
GS EP COR 560	Physical and chemical treatment of hydrostatic test water
GS EP ELE 031	Design of Earthing and Bonding Systems for Offshore Installations
GS EP ELE 079	Electrical Apparatus for Potentially Explosive Gas Atmospheres
GS EP ELE 151	DC Uninterruptible Power Systems (UPS)
GS EP ELE 161	Electrical Cables
GS EP ELE 261	Solar Power System
GS EP EXP 101	Pre-commissioning and Commissioning specification
GS EP EXP 103	Pre-commissioning and Commissioning engineering and preparation
GS EP EXP 105	Pre-commissioning Execution
GS EP EXP 107	Commissioning Execution
GS EP GEO 101	Offshore Geotechnical Survey
GS EP GEO 201	Offshore Geophysical Site Investigation
GS EP GEO 501	Meteorological and Oceanographic survey
GS EP GEO 504	Comprehensive evaluation of metocean conditions
GS EP INS 101	Instrumentation Design
GS EP INS 102	Instrumentation Identification
GS EP INS 110	Instrumentation for package units
GS EP INS 137	On/Off Valve Control Panels and Actuators
GS EP INS 146	Generation and Distribution of Hydraulic Energy

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Reference	Title
GS EP LSO 202	Personnel transfer between watercrafts and between watercrafts and offshore structures
GS EP PLR 100	Submarine pipeline systems
GS EP PLR 109	Design, fabrication and testing of submarine unbonded flexible pipes and risers
GS EP PLR 110	Design, fabrication and testing of submarine bonded flexible pipes
GS EP PLR 160	Design, fabrication and testing of Subsea Umbilicals
GS EP PLR 401	Installation of submarine pipelines
GS EP PVV 111	Piping design specification
GS EP PVV 112	Piping material classes
GS EP PVV 143	Metallic pipes
GS EP PVV 144	Fittings
GS EP PVV 145	Flanges
GS EP PVV 146	Bolting for piping
GS EP PVV 147	Gaskets for piping and vessels
GS EP PVV 154	Ball Valves according to API SPEC 6D or API SPEC 6A
GS EP PVV 155	Gate, Globe and Check Valves
GS EP PVV 171	Steel piping fabrication
GS EP SPS 024	Subsea Valve Manual Actuators
GS EP STR 001	Weight monitoring and weighing offshore and onshore units
GS EP STR 100	Offshore steel structures – General
GS EP STR 202	Cast materials for steel structures
GS EP STR 203	Forged materials for Offshore steel structures
GS EP STR 204	Subsea structures: Carbon Steel Material and Fabrication
GS EP STR 401	Loadout, seafastening, transportation and installation of offshore structures
GS EP STR 403	Acceptable criteria of a support vessel for offshore works
GS EP STR 611	Determination of the location of an offshore terminal
GS EP STR 653	F(P)SO - Hull fabrication requirements

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Reference	Title
GS EP STR 661	FPSO - Design requirements for mooring and anchoring systems
GS EP STR 901	Design rules and construction standards for ancillary structures of offshore installations

3. General

3.1 Definitions

For the purpose of this document, the following terms and definitions apply:

“Classification Society” designates any of the agreed Classifications Societies responsible for the classification of the CALM buoy.

“Buoy” means the complete CALM buoy system, including mooring system, buoy body, fluid transfer system from PLEM to floating hose and all buoy equipment.

“Engineering” designates all drawings, calculations and procedures required for the design, fabrication and installation on site of the Buoy.

“Works” means all and any part of the works and services required to be performed by Contractor for the fabrication and installation of the Buoy.

“Installation” designates all operations necessary for the safe positioning of the buoy on its operation site, namely all transport, installation works, services and tests.

“Manufacturer” designates any subcontractor that has been awarded a contract for the supply of the buoy or any of its components.

“Approval” Means Managing entity of the referential written assent. Approval by managing entity will in no way relieve Contractor of any of his obligations, responsibilities or liabilities. The words "Approve", "Approved" and "Approval" shall be construed accordingly.

3.2 Classification / MWS / Local Port Authorities Approval

The Buoy shall be classed by a Classification Society selected and/or approved by Company. The items covered by Class include the buoy, the PLEM, the anchoring and anchoring points, the hoses, the hawsers and all ancillaries and parts (piping, rotating parts, swivel, monitoring equipment, winch, etc.).

The Classification Society is responsible for verifying the Engineering and Works and will stipulate the design and operating limits of the Buoy in the Class Certificate (Design Criteria Statement).

A Marine Warranty Surveyor (MWS) will be responsible to verify the Installation.

The scope of work of the CS and MWS is approved by Company and mutually agreed between Company, Contractor and CS/ MWS prior to CS/MWS Contracting.

The CS and MWS are selected by Company on a project specific basis and specified in the PPS.

As a loading/offloading facility, the Buoy is considered as a terminal and complies with corresponding international and local regulations.

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3.3 Abbreviations

CALM	Catenary Anchor Leg Mooring
CFD	Computational Fluid Dynamics
CPY	Company
CS	Classification Society
FPSO	Floating Production Storage Offloading
FSO	Floating Storage Offloading
MWS	Marine Warranty Surveyor
OLS	Offloading System
PLEM	Pipeline End Manifold
PPS	Project Particular Specification
SPM	Single Point Mooring

4. Basis of design

All units are to be in SI (metric) system.

All co-ordinates are given in the SITE national system and in the UTM, WGS-84 system.

Basis of Design will be indicated in PPS.

Below list provides main necessary inputs specified in PPS and default values when relevant.

4.1 Buoy design life

Unless otherwise specified in PPS, the design life of a CALM buoy is 30 years. Possibility to perform drydocking or not during design life will be specified in the PPS.

4.2 Project specific constraints

Any project specific constraints (such as existing local equipment and logistics, technical support available) will be indicated in the PPS along with all relevant drawings and are to be taken into account by Contractor in the Buoy design.

4.3 Maximum and minimum tanker size

The maximum and minimum tanker size and loading conditions to be accommodated by the CALM Buoy will be defined in the PPS and documented by an early specific study, based on the terminal needs and output characteristics, survey of local available tankers and desired size of parcels.

4.4 Marine operations

The marine assistance for the operations of mooring of the export tanker, handling of the offloading lines, the means available (assistance tugs, service boat) are described in the PPS.

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4.5 Fluid characteristics & pigging

The fluid characteristics are provided in the PPS.

Requirement or not to be able to pig the sealine (with consequences on PLEM and risers design) will be stated in the PPS and is to be based on an early specific study.

4.6 Flow rate and design pressure

The required flow rate (in m³/h) and design pressure are specified in the PPS, based on early specific study.

Ability to flush the lines is to be defined in the PPS.

A detailed pressure drop calculation shall be performed, to determine piping diameter and design pressure. The results of this pressure drop analysis will be specified for all elements and equipment along the fluid path.

4.7 Site general chart, bathymetry, CALM Buoy location

The PPS shall include a chart of the proposed mooring area and sealine route. This chart is to show depth soundings (reduced to Chart Datum levels, to be the same as LAT levels), obstructions, all possible existing installations (platforms, sealines, cables, etc.), maneuvering area, and where applicable the approach channel from deep water or an established navigation channel.

If data are not already available, a geophysical site survey shall be conducted as specified in **GS EP GEO 201** to document the local water depth (bathymetry) on the expected footprint of the buoy terminal, including the sealine.

The site selection for the buoy implantation, and in particular the selection of required water depth and safety distances to existing installations (if any), follow **GS EP STR 611** recommendations.

Final site selection shall be safe with respect to possible existing installations and traffic routes. It allows for safe maneuvering, mooring and complete weathervaning of a tanker of the maximum specified size.

4.8 Metocean conditions

The directional wave, wind, current conditions and tides (MSL, HAT, LAT and storm surges) are to be defined for extreme environments (at least 100 yr and 1 yr return period), as well as for operating environments (scatter diagrams).

The metocean document is also to provide a general description of the zone of interest, identifying known processes, existence of prevailing directions, correlation or not between wind, waves and currents.

If the zone of interest is known to have current and wind reversals, the metocean document will, if possible, indicate corresponding possible changes in direction, intensities and corresponding durations. Reversals are understood as changes in direction and intensities over time.

The applicable metocean conditions are stated in the PPS.

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If data is not already available, a metocean survey shall be conducted as specified in [GS EP GEO 501](#), to determine the local environmental conditions as required by [GS EP GEO 504](#).

4.9 Site soil conditions

The applicable soil conditions are stated in the PPS.

If data are not already available, an offshore geotechnical soil survey shall be conducted as specified in [GS EP GEO 101](#).

4.10 Hazardous area considerations

All electrical equipment installed on the buoy shall be suitable for hazardous area zone 2 ([IEC 60079-10-1](#)). Particular aspects such as break-away coupling operation, discharge capacities, vents, etc., have to be specifically addressed and may lead to zone 1 requirement.

Buoy is to be fitted with flammable gas detection system with visual and audible alarms. The monitoring system may be permanently installed system or portable equipment (stated in PPS). The gas detection system is to give alarm when LEL reach 25%. Where a permanently installed system is provided, the alarm is transmitted to the FPSO/terminal control room and automatic shutdown of the installation is to take place when 50% LEL is reached in the hazardous area.

4.11 Monitoring

The need for global behavior, motion or hawser tension monitoring is defined in the PPS.

5. Design

All deliverables identified hereafter for the design of the buoy shall be provided by Contractor to Company and CS for their approval prior to procurement and commencement of the buoy fabrication.

5.1 Mooring system

5.1.1 Mooring system components and basic requirements

The buoy mooring system is composed of: mooring lines, anchors, chain stoppers and connecting elements. It shall be designed to [ISO 19901-7](#) requirements for permanent mooring except for fatigue strength as such systems can usually be repaired without major consequences.

For all mooring system components, the method of installation, tensioning, re-tensioning, monitoring, inspection and maintenance, as well as the possible requirement for replaceability of components during service life shall be carefully assessed by Contractor at an early stage of design, as these operations can have an important impact on the choice of the mooring lines composition.

Particular attention will be paid for the initial installation which may require length adjustment to achieve the target position.

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5.1.1.1 Mooring lines

Unless otherwise specified by the PPS and subject to CS agreement, mooring lines may be made of marine grade chain (U3).

Particular care shall be taken to limit and to evaluate local effects such as but not limited to in-plane and out-plane bending, shear, torsion, corrosion, wearing in terms of strength and fatigue resistance in particular at the chain-stopper, hawse, anchors, etc.

5.1.1.2 Anchor points

If not already prescribed in the PPS, Contractor will determine, with Company Approval, the most adapted type of anchors for the project, based on soil conditions, ease of installation, equipment availability, type of mooring, or other.

5.1.1.3 Chain stoppers

Unless otherwise specified in the PPS, the chain stoppers of the buoy will be of the ratchet type, whose design is to be submitted to Company Approval.

The chain stoppers shall swivel about a horizontal axis perpendicular to the direction of the anchor chain. The link gripped in the chain stopper will be in a vertical plane to avoid working under a bending load.

5.1.1.4 Connectors

In the choice of connectors, Contractor shall demonstrate that the arrangement chosen will allow for easy installation and replacement of those sections particularly exposed to wear and corrosion.

Contractor has also to demonstrate that the connectors have equal or greater properties than the mooring lines in terms of strength and fatigue resistance.

The chains will be connected to the anchors by shackles.

5.1.1.5 Hawser

If the Buoy is used to directly moor offloading tankers, there shall be two separate and identical (2) hawsers each connected to its own chafe chain when, mooring ships over 150,000 tonnes deadweight as required by OCIMF "Recommendations for Equipment Employed in the Bow Mooring of Conventional Tankers at Single Point Moorings".

If the Buoy is used to moor an F(P)SO (semi)permanently, with offloading tankers connecting to the F(P)SO, there shall be two (2) identical, redundant hawsers between the Buoy and F(P)SO, and one (1) hawser between the tanker in tandem and the F(P)SO.

The hawser, hawser make up shall follow OCIMF guidelines and fittings be as per OCIMF standards. The chafing chain for mooring on the tanker side shall be made by the chain Manufacturer.

The hawser shall be protected by polyurethane sheathing over a length of 10 m on both ends to protect the nylon from chafing.

The use of a hook with manual release is recommended and should be confirmed in the PPS.

The buoy body and/or turntable shall be protected against hawser chafe chain ragging and the protections replaceable.

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5.1.2 Design criteria

5.1.2.1 Offset limits

The allowable offset limits of the buoy, both in intact and damaged conditions, are based on the type of risers/umbilicals/cables to be accommodated, local water depth and metocean conditions. As such, the offset limits will be determined in conjunction with the risers/umbilicals/cables design analysis, as well as advice from riser Manufacturer and included in PPS.

Final offset limits shall be shown by Contractor to be compatible with riser design.

5.1.2.2 Mooring line length

If drag embedment anchors are used, no uplift force at the anchor will be accepted for intact or damaged conditions, in either extreme or operational environments. A typical one (1) shot of chain length (27.5 meters) shall always remain on the seafloor.

For vertically loaded anchors, such as piles, the line length and corresponding amount of uplift shall be compatible with the anchor design.

5.1.2.3 Hawser length

Hawser length will be determined to minimize fishtailing, slackness and high loads in the hawser during tanker offloading as well as the risk of collision. A typical range for a hawser length is between 50 to 80 m and will be defined in the PPS.

5.1.2.4 Maximum tension limits for mooring lines and anchors

Safety factors for maximum tension in mooring lines vary according to references. However, for dynamic analysis, standard safety factors as defined by [ISO 19901-7](#), as modified by the following table, are applicable.

Damage case corresponds to one line missing case only.

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Unless otherwise specified in the PPS, no two lines broken damage case is to be analyzed. Summary tables of recommended values are provided below:

Mooring line	Mooring system condition	
	Intact	Damage
(Quasi static)*	2.00	1.43
Dynamic	1.67	1.25

Drag anchor	Mooring system condition	
	Intact	Damage
(Quasi static)*	1.80	1.50
Dynamic	1.50	1.3

Piles anchor	Mooring system condition	
	Intact	Damage
(Quasi static)*	2.00	1.50
Dynamic	1.50	1.30

* For reference only, since quasi static analysis is only valid for preliminary studies.

5.1.2.5 Corrosion and wear allowance

A corrosion and wear allowance for the anchor lines and connecting elements shall be added to the diameters/sizes of the lines make up determined by the mooring analysis and above safety factors, in order to determine the final schedule of the elements.

A minimum value of 0.4 mm per year of service life on line diameter will apply,

In tropical area or severe environment the above minimum value will be increased in the PPS, based on local return of experience.

5.1.2.6 Maximum tension limits for hawser and related equipment

The minimum Safety Factor for hawsers loads will be three (3), meaning that the final hawser selected shall have a minimum wet guaranteed breaking load (in used condition) of three times the extreme load found in the design analysis.

Factor is to be checked with calculation method (quasi-static/extreme).

The strength of the ancillary equipment (such as the hook and its supports) and the chain stopper of all sizes of expected tankers at SPM shall be such that they are not the weak point in the line. Protection by calibrated weak point at a value not lower than the extreme load can be envisaged if required.

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5.1.2.7 Fatigue life

The fatigue life of any component of the mooring system (chains, wire, shackles, Kenter links, chain stoppers, etc.) shall be as per class Society Rules minimum requirements unless otherwise specified in the PPS, using [ISO 19901-7](#) curves for conventional material.

5.1.2.8 Contacts

There shall be no contact between mooring lines and risers/umbilicals/cables and pipes/PLEM.

5.1.3 Design procedure

5.1.3.1 Methodology

Contractor is required to provide a detailed description of the methodology and numerical tools used for the determination of mooring lines, anchors and hawser loads, which are to be reported in the design load report. If the numerical tools used are not publicly recognized, evidence for quality controls and calibrations will be provided. The proposed methodology shall comply with all requirements and paragraphs stated hereafter.

The mooring system study will consider two main configurations: *stand-alone* (no tanker connected) and *operational* (buoy with tanker and tug(s) connected, or buoy with F(P)SO, tanker and tug(s) connected).

In any case, quasi-static analysis is only acceptable for preliminary design. Final detailed design shall be based on a dynamic analysis. Quasi-dynamic analysis (in the sense of Bureau Veritas safety factors) will be accepted only if line dynamics are proved to be insignificant.

For details not covered in the present specification, [ISO 19901-7](#) for steel mooring design shall be used.

5.1.3.2 Model tests

Model tests will be performed for CALM buoy in particular when the design has unconventional features, such as a CALM Buoy in a swell dominated environment resulting in large pitch and surge motions, or CALM buoy in very shallow waters and harsh environments, or when the Contractor did not already perform model tests or calibrated CFD for a similar terminal. The decision not to perform model tests will be made on a project specific basis and indicated in PPS.

The aim of the model tests is to confirm the design results and determine the operational limits.

If tank tests are performed, a specific test program will be prepared and submitted to Company in a separate document, prior to the model tests and after preliminary numerical simulations, so as to determine specific test objectives. Model tests preliminary considerations to be followed are indicated in [GS EP STR 661](#) section 3.6.

If existing model test data is used to supplement numerical models, Contractor shall prove the relevance of the model test data to the project and describe clearly how this information will be used in the design methodology.

5.1.3.3 Hawsers

For the operational cases, the hawser dynamic loads induced by both horizontal and vertical motions at the hawser extremities shall be taken into account.

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5.1.3.4 Input data file

The complete input data file used for numerical simulations shall be provided by Contractor to Company, and included in the design load report.

The input data file will contain at least the following information:

- Environmental conditions and parameters, bathymetry characteristics
- Buoy, F(P)SO, tanker and tug(s) characteristics
- Mooring lines characteristics
- Hawser characteristics (stiffness in used conditions)
- Wind and current forces (areas, coefficients and corresponding forces at different headings)
- Hydrodynamic data (added mass, radiation damping, first order wave forces, RAOs, mean drift)
- Damping coefficients and expressions (viscous, mooring lines, slow drift)
- Slow drift forces.

5.1.3.4.1 Hydrodynamic data

Hydrodynamic data will result from a 3D Diffraction-Radiation Calculation of the buoy and the tanker (no hydrodynamic interaction requested) using a recognized software, accounting for the impact of the shallow water depth.

Behavior of the tanker with its hawser and of the buoy with its mooring lines may be analyzed independently.

Hydrodynamic data shall include effects of changes in tanker draft for the full and ballast conditions, unless it is demonstrated that the effect is insignificant.

Unless more precise data is available, tanker ballast draft can be taken as 40% of the full draft.

5.1.3.4.2 Wind and current forces data

Wind and current forces can be obtained from [OCIMF MEG](#).

5.1.3.4.3 Damping data

Damping coefficients shall be documented. They can be based on formula recommended by Classification Societies or documented model test calibration reports.

5.1.3.4.4 Slow drift data

Slow drift will be computed using 3D diffraction radiation software. If the water depth is below 20 m, PPS will state if model tests with actual bathymetry are required and if hydrodynamic model shall account for 2nd order incident wave using full QTF.

5.1.3.4.5 Hawser data

Characteristics of hawser (Minimum Wet Breaking Load, load-elongation curve, weight, etc.) shall come from specifications of a recognized Manufacturer.

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5.1.3.5 Design load case matrix

A design load case matrix will be prepared by Contractor for the *stand-alone case* and *operational case*, for both *intact* and *damaged* cases. The two matrices will summarize all cases studied, and be included in the design load report.

The stand-alone case will correspond to the 100 yr return period events. The operational case will correspond, as a first approximation, to the 1 yr return period events. The corresponding waves, wind and current conditions are defined in the PPS.

The damaged case corresponds to the failure of one (1) mooring line, which will be either the most loaded line or second most loaded line, whichever is the most critical from the strength point of view.

The operational case considers at least two drafts for the tanker, namely the ballast draft and fully loaded draft. In case of an FSO and tanker connected to the buoy, the two cases FSO fully loaded/tanker on ballast, FSO on ballast/tanker fully loaded shall be covered.

For both stand-alone and operational cases, the water depth giving the maximum design forces will be selected.

Notes on operational cases:

To determine the load cases direction-wise, Contractor shall find the combinations in direction of wind/wave/current that lead to the maximum design forces for the mooring, anchors, risers/umbilicals/cables and hawser. For this exercise, Contractor will usefully consider all information provided in the metocean design basis, in particular prevailing environments directions and existing correlations of environments, if any identified. If not, a systematic approach will be used to determine worse cases, as part of the methodology to be described.

To determine the load cases intensity-wise, Contractor will use the wind/wave/current intensities associated to each direction, up to ± 22.5 deg. For example, if a current coming from North is considered, its associated intensity will be the maximum of NE, N, NW intensities.

5.1.3.6 Sensitivity analyses

Due to the importance and uncertainties on wave periods and wave spectra on floaters motions, the design load case matrix shall include, for the identified sizing cases, a sensitivity study on the wave period (± 2 seconds) and spectrum parameters.

In practice, the steady one-minute mean average wind can be used for preliminary design. In detailed design, the influence of wind dynamics shall be checked for the extremes due to the possible influence on slow drift motion of the tanker.

Other sensitivity analyses may be required if other uncertainties are identified, which can have an impact on the mooring design.

5.1.3.7 Wind/current reversals

Due to the importance of current and wind reversals on the moored tanker behavior, the design load case matrix shall cover at least two cases of such reversals, when identified in the metocean report.