

GENERAL SPECIFICATION

STRUCTURAL

GS EP STR 631

Deepwater CALM Buoy Terminals

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1. Scope

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

This specification covers all types of CALM buoys moored in deep waters (say above 100 m). It does not cover other types of Single Point Moorings, such as SALM, SALS, 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 also referred as CALM or buoy in the present specification requires a specific export line. Requirements for such a system are in the Project Particular Specification (PPS) and have to comply with [OCIMF SMOG](#).

The purpose of the buoy is to moor a vessel, usually a tanker, by its 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, the CALM buoy allows the moored tanker, or the combination F(P)SO/tanker, to weathervane according to the environment while transferring fluids.

The CALM buoy system, hereinafter designated as the Buoy, shall typically consist of the following components:

- A **buoy body**, comprising a fixed part (connected to the risers) and a rotating part (connected to the floating hoses)
- **Mooring lines** and their **anchor points** to moor the buoy on the seabed
- **Floating hoses** connecting the buoy body to the tanker ship
- **Hawser line(s)** to moor the ship to the buoy
- **Export lines** liaising between the FPSO and the buoy.

Therefore, the boundaries of the Buoy scope are:

- The spool piece between at the end of export line and the buoy piping
- 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	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 B31.3	Process Piping
API RP 2SK	Design and Analysis of Stationkeeping Systems for Floating Structures
ASME BPVC Section VIII Div 1	ASME Boiler and Pressure Vessel Code (BPVC) - Section VIII: Rules for Construction of Pressure Vessels - Division 1
ASTM A148	Standard Specification for Steel Castings, High Strength, for Structural Purposes
ASTM E709	Standard Guide for Magnetic Particle Testing
EN 1765	Rubber hose assemblies for oil suction and discharge services - Specification for the assemblies
IEC 60079-10	Explosive atmospheres - Part 10: Classification of areas
ISO 19901-7	Petroleum and natural gas industries - Specific requirements for offshore structures - Part 7: Stationkeeping 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	Guidelines for offshore tanker operations
OCIMF	SPM Hose System Design Commentary
OCIMF	Guide to Purchasing, Manufacturing and Testing of Loading and Discharge Hoses for Offshore Moorings
OCIMF	Guidelines for the Purchasing and Testing of SPM Hawser
OCIMF	Recommendations for Equipment Employed in the Bow Mooring of Conventional Tankers at Single Point Moorings
OCIMF MEG	Mooring equipment guidelines
OCIMF SMOG	Single Point Mooring Maintenance and Operations Guide
SIGTTO	Guidelines for the Alleviation of Excessive Surge Pressures on ESD

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

Reference	Title
GS EP COR 100	Cathodic protection of offshore 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 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 GEO 101	Offshore Geotechnical Survey
GS EP GEO 201	Offshore Geophysical Site Investigation
GS EP GEO 501	Meteorological and Oceanographic survey
GS EP INS 102	Instrumentation Identification
GS EP INS 146	Generation and Distribution of Hydraulic Energy
GS EP LSO 202	Personnel transfer between watercrafts and between watercrafts and offshore structures
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 151	Design of steel catenary riser systems
GS EP PVV 111	Piping design specification
GS EP PVV 112	Piping material classes
GS EP PVV 141	Piping Material Data Sheets
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 PVV 173	Pneumatic testing of above ground piping systems
GS EP STR 201	Materials for offshore steel structures

Reference	Title
GS EP STR 202	Cast materials for steel structures
GS EP STR 203	Forged materials for Offshore steel structures
GS EP STR 301	Fabrication of offshore steel structures
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 433	Structural design of skirted foundations and suction anchors
GS EP STR 601	Floating Unit Integrity Management System Requirements
GS EP STR 611	Determination of the location of an offshore terminal
GS EP STR 653	F(P)SO - Hull fabrication requirements
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.

“PPS” designates the applicable Project Particular Specifications.

“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.

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3.2 Classification/MWS

The CALM shall be covered by classification. The classification society shall be selected and/or approved by the Company. The items covered by class include the buoy, the anchoring and anchoring points, the hoses, the hawsers and including all ancillaries and parts (piping, rotating parts, swivel, monitoring equipment, etc.) and the pulling equipment.

The Classification Society shall be responsible for verifying the Engineering and Works and will stipulate the design and operating limits of the CALM Buoy in the class certificate.

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

The program of inspections and test required for the classification certificate renewal shall be approved by Company.

The CS and MWS are selected by Company on a project specific basis.

All requirements from **GS EP STR 601** shall be applied in the frame of the Floating Unit Integrity Management System.

3.3 Abbreviations

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

4. Basis of design

All units are to be in SI (metric) system. All co-ordinates shall be given in the UTM, WGS-84 system and in the SITE national system.

4.1 Buoy design life

Unless otherwise specified in the PPS, the design life of a CALM buoy shall be 30 years without drydocking.

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 shall be taken into account by Contractor in the design of the Buoy.

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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 shall be motivated 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 the offloading lines, the means available (assistance tugs, service boat) shall be described in the PPS.

4.5 Fluid characteristics & pigging

The fluid characteristics will be provided in the PPS.

According to the fluid characteristics, the requirement or not to pig the sealine (with consequences on PLEM and possibly risers design) will be stated in the PPS and shall 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 studies including surge analysis (see paragraph 5.3 for more details).

Requirement for flushing the lines shall be addressed in the PPS.

A detailed pressure drop calculation shall be performed, in order to determine and the offloading risers / OLS piping diameter and design pressure. The results of the pressure drop analysis shall be specified for all elements and equipment along the fluid path.

4.7 Site general chart, bathymetry, CALM Buoy location

If not already available, a geophysical site survey shall be conducted as specified in **GS EP GEO 201** to determine the local water depth and bathymetry map on the expected footprint of the buoy terminal.

A complete chart of the proposed mooring area and subsea layout shall be included in the PPS. This chart is to show depth soundings (reduced to Chart Datum levels, to be the same as LAT levels), obstructions, all possible existing installations (FPSO, subsea layout), maneuvering area, and where applicable the approach channel from deep water or an established navigation channel.

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

Final site selection shall be safe with respect to possible existing installations and shall allow safe maneuvering, mooring and complete weathervaning of the tanker of the established maximum size.

4.8 Metocean conditions

If not already available, a metocean survey shall be conducted as specified in **GS EP GEO 501**, to determine the local environmental conditions.

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

The metocean document shall also 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 shall, if possible, indicate corresponding possible changes in direction, intensities and corresponding durations. Reversals shall be understood as changes in direction and intensities over time.

The applicable metocean conditions are stated in the PPS.

4.9 Site soil conditions

If not already available, an offshore geotechnical soil survey shall be conducted as specified in **GS EP GEO 101**.

The applicable soil conditions are stated in the PPS.

4.10 Hazardous area considerations

The buoy shall be considered at least as a hazardous area class 2 for all electrical equipment. Particular aspects such as break-away coupling operation, discharge capacities, vents, etc., have to be specifically addressed and may lead to zone 1 requirement.

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 mooring system of the buoy is composed of the following parts: *mooring lines, anchors, chain stoppers, connecting elements* and *hawser*.

For all components of the mooring system, the method of *installation*, tensioning, re-tensioning, monitoring, *inspection* and *maintenance*, as well as the possible need for *replacement* 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 and their design.

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

5.1.1.1 Mooring lines

Mooring lines shall comply with the requirements from **GS EP STR 661**.

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5.1.1.2 Anchor points

If not already prescribed in the PPS, Contractor shall determine, with Company Approval, the most suited 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 shall be of the ratchet type, whose design is to be submitted to Company for Approval.

The chain stoppers shall be dual articulated.

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, wearing in terms of strength and fatigue resistance.

5.1.1.4 Connectors

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

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

The material of the bushing of the connector bearings shall be of low friction to minimize the stick/slip angle of the connector and therefore the Out of Plane Bending. As far as wear is concerned, a safety factor of 2 on the bushing material thickness is required.

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, if mooring ships are over 150,000 tonnes deadweight as required by OCIMF "Recommendations for equipment in the mooring of ships 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 to be as per OCIMF standards. The chaffing chain for mooring on the tanker side shall be made by the chain Manufacturer. A special link between diameter 76 mm and diameter 54 mm links shall be provided instead of a Kenter link to avoid risk of jamming through the stopper.

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 mandatory.

Requirement for storage of the hawser on a reel between 2 consecutive offloading operations shall be addressed by PPS. One spare hawser shall be supplied and properly store according to Manufacturer recommendation.

Protections of the buoy body and/or turntable against hawser chafe chain ragging shall be fitted and renewable.

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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 riser/export line to be accommodated, local water depth and metocean conditions. As such, the offset limits shall be determined in conjunction with the export line design analysis, as well as by advice from riser/export line Manufacturer.

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

5.1.2.2 Mooring line length

Requirements from **GS EP STR 661** shall be complied with.

5.1.2.3 Hawser length

Hawser length shall be determined to minimise fishtailing, slackness and high loads in the hawser during tanker offloading as well as the risk of collision.

5.1.2.4 Maximum tension limits for mooring lines and anchors

Maximum tension shall comply with requirements from **GS EP STR 661**.

5.1.2.5 Corrosion and wear allowance

Corrosion and wear allowance shall comply with **GS EP STR 661**.

5.1.2.6 Maximum tension limits for hawser and related equipment

The Safety Factor for hawsers loads shall 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 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 will be such that it is 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.

5.1.2.7 Fatigue life

Fatigue life and analysis for mooring components and fairlead shall comply with **GS EP STR 661**. Requirements for OPB fatigue life and the relevant SN curve shall be defined in the PPS.

5.1.2.8 Contacts

There shall be no contact between mooring lines, export lines or mooring lines and export lines.

5.1.2.9 Fiber rope lines case

Possibility of using fiber rope shall be defined by Company in the PPS. If allowed, all requirements for fiber ropes in **GS EP STR 661** shall be applied.

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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 shall be provided. The proposed methodology shall comply with all requirements and paragraphs stated hereafter.

The mooring system study shall 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 fully coupled analysis.

For details not covered in the present specification, requirements in **GS EP STR 661** shall be used.

5.1.3.2 Model tests

Model tests shall be performed for a deepwater CALM buoy in particular when the design has unconventional features, unless the Contractor has already performed model tests for an identical terminal. The decision not to perform model tests will be made on a project specific basis.

The aim of the model test is to calibrate the hydrodynamic numerical models, to confirm the design results and determine the operational limits.

If tank tests are performed, a specific test program shall 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**.

If prior model test data is used to supplement numerical models, Contractor has to prove the relevance of the model test data to the project and describe clearly how it will be used in the design methodology.

5.1.3.3 Export lines

Contractor shall include the influence of the export lines in the mooring calculations, as coupling effects between the buoy and export lines may not be negligible.

Particular attention has to be paid to the possible modification of the system stiffness and buoy RAOs due to the presence of export lines, and additional drag load and damping due to current on export lines. Those effects are to be evaluated through a fully coupled analysis.

5.1.3.4 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.

5.1.3.5 Input data file

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

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The input data file contains at least the following information:

- Environmental conditions and parameters, bathymetry characteristics
- Buoy, F(P)SO, tanker and tug(s) characteristics
- Mooring lines characteristics creeping and stiffness in used conditions
- 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.

Following are some specific requirements on some of these items:

5.1.3.5.1 Hydrodynamic data

Refer to [GS EP STR 661](#).

Hydrodynamic data includes 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.

5.1.3.5.2 Wind and current forces data

Wind and current forces can be obtained from [OCIMF](#) for tankers or from [API RP 2SK](#), [ISO 19901-7](#) guidelines, or from recognized software such as WINDOS for wind forces.

5.1.3.5.3 Damping data

Refer to [GS EP STR 661](#).

5.1.3.5.4 Slow drift data

Refer to [GS EP STR 661](#).

5.1.3.5.5 Hawser data

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

5.1.3.6 Design load case matrix

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

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

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The damaged case shall correspond 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 shall consider 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 shall be selected.

When dealing with squall events, the designer shall not consider any corrective or improving actions from the tugs that would minimize the line tension results. The full time series of the squalls as provided in the metocean specification shall be used in the computation.

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 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 shall be used to determine worse cases, as part of the methodology to be described.

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

5.1.3.7 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.

5.1.3.8 Wind/current reversals

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

When dealing with squalls, the full time series of the squalls as provided in the metocean specification shall be used in the computation.

5.1.3.9 Extreme response analysis

Frequency domain analysis can be used for initial design, determination of the sizing cases and screening when numerous simulations are needed (typically for operational case).

Time domain simulations, with minimum duration of 3 hours, shall then be performed on the sizing cases.

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For time domain analysis of critical cases, storm duration of 3 hours shall be simulated at least five (5) times, and statistical fitting techniques (such as Weibull) shall be used to determine Most Probable Maximum values over the 3 hours storm duration.

The extreme response analysis have to provide maximum loads in anchor lines, anchor points, and hawser, as well as buoy maximum excursions, all according to the design load case matrix.

Fully coupled time domain simulations are to be run.

In particular, the chosen rating of main bearing shall be stated and design maximum hawser mooring load shall be shown to be less.

The no contact criteria as defined in paragraph 5.1.2.8 shall be checked under survival and operating cases.

Contractor shall advise, based on results for operating conditions, the bollard pull requirements for a tug assisting during the offloading operations.

5.1.3.10 Fatigue analysis

A fatigue analysis shall be performed at least on the most loaded and critical mooring line (including chain stoppers) according to a methodology to be described by Contractor, such as the one described in [API RP 2SK](#).

The fatigue curves and stress concentration factors used shall be clearly identified and justified.

For Deep Water CALM Buoy, the particular project specification shall define the percentage of time when a lifting tanker is moored at the buoy. It is emphasised that the presence of the lifting tanker will significantly modify the hydrodynamics of the buoy and therefore affect the fatigue lives of the mooring line components.

For deep water, fatigue analysis shall include the damage induced by the Out of Plane Bending and, the use of Rayleigh distribution shall be validated against rain flow counting method.

5.1.3.11 Anchor point design

Following the determination of design loads on anchors, Contractor will perform the anchor point design according to the type of anchor selected.

5.1.4 Operating thresholds, terminal availability analyses

5.1.4.1 Disconnect criteria

Contractor shall indicate the different thresholds, in terms of joint allowable Hs, wind speed and if possible current speed, up to which a tanker may remain safely connected to the CALM buoy (or to the F(P)SO), with loading already stopped.

This is referred to as the cast off or disconnect criteria and shall consist of a table summarising the allowable weather operating envelope. The thresholds will be defined by the following limiting criteria: maximum allowable mooring force in hawser and buoy structural components, maximum allowable tension in anchor legs, maximum allowable load in anchor point.

Contractor has to clearly define the methodology used to determine the disconnect criteria and be based on recommendations from [OCIMF MEG](#) and [OCIMF "Guidelines for offshore tanker operations"](#).

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5.1.4.2 Connect and stop loading criteria

Any specific requirements in term of weather limits for connecting to the buoy and to stop loading shall be indicated by Contractor.

5.1.4.3 Availability study

Based on the operating envelope, a simple terminal availability analysis shall be performed, which will confirm the numbers of days per month and per year when the operating thresholds are not exceeded, understanding that this will not take into account the issues of connecting / disconnecting, stop loading and duration of offloading.

5.1.5 Deliverables

The deliverables of the mooring design study shall consist of:

1. The design load report, determining the extreme loads in anchor lines, anchor points, hawser, buoy maximum excursions, fatigue results, mooring lines make up and characteristics, hawser line characteristics and length, CALM buoy design hawser mooring load, as per paragraphs 5.1.3, 5.1.4, 5.1.5.
2. Input data file used for mooring analysis.
3. The anchor point design report, determining the anchors size.
4. The mooring lines specifications and anchors specifications sent to Manufacturer.
5. The buoy monitoring system definition and specification (for deep water).
6. The offloading operating report, summarising offloading thresholds, terminal availability, tug requirements, as per paragraph 5.1.3.9.
7. The general arrangement drawing of the buoy terminal, proposed mooring system and existing installations if any.
8. Detailed drawings of each part of the mooring system make up.
9. Data sheets of equipment proposed.
10. The installation, test, retensioning procedure.
11. The inspection, maintenance procedure.

5.2 Buoy body

5.2.1 Buoy body components and design types

The buoy body is composed of the following main parts: the *buoy hull* providing buoyancy and stability, a *rotating part* allowing the tanker to weathervane, a *fixed part* to which the mooring lines and risers are connected. Depending on the CALM buoy design, the buoy hull may be the fixed part or the rotating part.

In the case of “turntable buoys”, the fixed part is the buoy hull itself, directly moored to the seabed. The rotating part is called *turntable*, providing a platform where the hawser and floating hoses are connected. The turntable can rotate on the buoy via roller bearing or bogie bearing.

In the case of “turret buoys”, the rotating part is the buoy hull and the fixed part is a turret structure directly moored to the seabed.