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	AREA:	SCALE: -
<b>E&amp;P-LMS</b>	<b>OFFSHORE LOADING SYSTEM REQUIREMENTS</b>	

### INDEX OF REVISIONS

REV.	DESCRIPTION AND/OR AFFECTED SHEETS
	New Version
01	General revision
A	Revision item 6.5
B	Revision items 1.4, 4.3, 4.8, 5.2, 6.1, 6.5, 7.4
C	Revision item 6.7
D	Revision items 5.1, 5.4.1, 5.4.2, 5.4.3, 7.4.2
E	Revision items 1.1, 3
F	Revision Item 4.3
G	Revision Item 6.5.3
H	Revision Item 1
I	Added items 7 and 8 taken from ET 006. Item 7 was modified in compare to the original.
J	Revision Item 1.4
L	Revision Item 7.1
M	Revision I-ET Number
N	General revision
O	General revision
P	Revision Item 6.5.3
Q	General revision

	REV. H	REV. I	REV. J	REV. L	REV. M	REV. N	REV. O	REV. P	REV. Q
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THIS FORM IS IN ACCORDANCE WITH PETROBRAS STANDARD N-381 – REV. F

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**1 - INTRODUCTION**

**1.1 - GENERAL**

The purpose of this document is to provide the basic technical requirements for the engineering design, fabrication, inspection, maintenance, testing, commissioning, delivery and operational procedures for the OFFLOADING SYSTEM and its components of offshore loading tandem operations in the FPSO.

The offloading system comprises the mooring hawsers, the hose strings, the equipment for hawser and hose handling and all other equipment required to export the stabilized crude oil from the FPSO (“the Unit”) to a tandem moored Shuttle Tanker or to a different offloading alternative approved by PETROBRAS.

The offloading system and all its components, devices and mechanisms shall be of a FIELD PROVEN design, as well as designed and fitted in accordance with the OCIMF guidelines where applicable. In addition, the system shall be according to the rules and regulations of the Unit’s Classification Society.

Basically, the referred system consists of a loading station, valves and devices for the hose string and hawser handling/storage, installed on the main deck and on suitable side of the F(P)SO as described in Table 1.

Terminal type	SMS
Offloading system type	DDS
Offloading hose string type	Floating
Number of loading stations	Two (02)
Loading station location	Aft and forward
	Starboard for the stern stations Portside for the forward stations

Table 1 – Types and location of the offloading systems

Note: For SPM system (Turret Moored FPSOs) only one offloading station is required and shall be used a floating hose string.


**Remark:**

- 1- This technical specification describes all the necessary equipment for offloading operations with DPST or any other vessel/system approved by Petrobras that requires a similar configuration.

## 1.2 - ACRONYMS

The following acronyms are used throughout this document:

- ABNT NBR**..... Brazilian standard
- BLS** ..... bow loading system
- CCR** ..... central control room
- CS** ..... classification society
- DARPS** ..... Differential Absolute and Relative Positioning System
- DDS**..... double discharge system
- DGNSS**..... Differential Global Navigation Satellite Systems
- DGPS**..... Differential Global Positioning System
- DP**..... Dynamic Positioning
- DPST**..... dynamically positioned shuttle tanker
- DWT** ..... deadweight tonnage
- EQRM** ..... emergency quick release mechanism
- F(P)SO** ..... floating (production) storage and offloading unit
- HMPE** ..... high modulus polyethylene
- HPU**..... hydraulic power unit
- IMO** ..... international maritime organization
- ISGOTT** ..... international safety guide for oil tankers and terminals
- MBF**.....minimum breaking force
- MUS** ..... minimum ultimate strength
- OCIMF**..... oil companies international marine forum
- OESD** ..... offloading emergency shut down
- PRS**..... positioning reference systems
- RCS** ..... recognized classification society
- SDS** ..... Stern Discharge Systems
- SMS** ..... spread mooring systems
- SPM** ..... single point mooring
- OT**..... Oceanic Terminal
- UPS** ..... Uninterruptible Power Supply
- WLL** .....working load limit

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### 1.3 - DEFINITION OF TERMS

APPROVAL - Approval by the CLIENT or by the CLASSIFICATION SOCIETY

CLASSIFICATION SOCIETY - organization that may be named in the CONTRACT, or appointed by the CLIENT.

CLIENT - the PURCHASER'S CLIENT for whom this equipment is being supplied

CONTRACTOR - the company that will assemble the OFFLOADING SYSTEM and related parts as described in this document

HAWSER WINCH - the Reel to storage the HAWSER and its structural supports

HOSE REEL - the Reel to storage the HOSE STRING and its support frame

HOSE REEL ASSEMBLY - the assembly consisting of Hose Reel, Reel Drive and control, fastening mechanism, other devices and access platforms

OESD (Offloading Emergency Shutdown) – Emergency/Contingency Plan for operation with vessels equipped with BLS, which purpose is to allow stopping the oil flow from the Unit to the vessel, disconnect the offloading hose line and the mooring system automatically or manually.

### 1.4 - CONTRACTOR'S DUTIES


It shall be CONTRACTOR's responsibility to undertake all the engineering work necessary for the design, fabrication, inspection, testing, supplying and commissioning of the OFFLOADING SYSTEM.

The CONTRACTOR shall submit the design of the offloading system to PETROBRAS approval. PETROBRAS may request changes to the arrangements, equipment and redundancies proposed by the CONTRACTOR, in order to optimize the security and availability of the system during its life cycle.

CONTRACTOR's scope of supply shall include a complete engineering package with certified drawings showing dimensions, weights, connections and further information necessary to facilitate the installation work. All necessary approvals or certificates, test sheets, instruction books and other documents required for proper operation and maintenance of the equipment during its lifetime shall be provided by CONTRACTOR.

CONTRACTOR shall also provide a Technical Manual of the OFFLOADING SYSTEM comprising of:

- Technical data of the system and its components;
- Functional description of the main systems;
- Guidelines for the regular maintenance, replacement, repairs, inspection, handling and tests for the offloading system and its components;
- Operational procedures for mooring, unmooring, emergency situations (hawser and hose string disconnection at the vessel) and offloading (including flushing the hose string);
- Weight list of the offloading and the mooring systems (main parts);
- Recommendations from the manufacturer where applicable.

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**Remark:**


- 2- The Operational Procedure shall be made according to the Offloading Guidelines issued by PETROBRAS, which manages the Offloading Operations. If any operational modification occurs in the PETROBRAS Guidelines during the lifetime of the unit it shall be included in the CONTRACTOR procedure.
- 3- The equipment required to comply with PETROBRAS Offloading Guidelines are described in the I-ET-005 Technical Specifications.
- 4- CONTRACTOR shall submit the proposed design, operational procedures and technical specifications for PETROBRAS APPROVAL.

## 2 - NORMATIVE AND NON-NORMATIVE REFERENCES

The following referenced documents are mandatory for the application of this specification. Where is mentioned an edition or issue date, only this specific reference is applicable. Where is not mentioned the edition or issue date, shall be used the latest edition of the document.

### 2.1 - NORMATIVE DOCUMENTS

- IMO MSC / Circ. 474 - Guidelines for Bow and Stern Loading and Unloading Arrangements on Oil Tankers;
- Offshore Loading Safety Guidelines with special relevance to harsh weather zones - OCIMF, latest edition
- Guide to Purchasing, Manufacturing and Testing of Loading and Discharge Hoses for Offshore Moorings, latest edition
- Guidelines for the Handling, Storage, Inspection and Testing of Hoses in the Field – OCIMF;
- Guidelines for the purchasing and testing of SPM hawsers - OCIMF , latest edition
- Buoy Mooring Forum – SPM Hose System – Design Commentary, 1993 – OCIMF;
- Recommendation for oil tanker manifolds and associated equipment, OCIMF; latest edition
- SPM hose ancillaries guide, OCIMF; latest edition
- International Safety Guide for Oil Tankers & Terminal – ISGOTT;
- Rules and Regulations of the Classification Society.
- ABNT NBR 13715-2, Offshore structure – chain cable, part 2: Requirements and test methods
- ABNT NBR 13545 , Lifting purposes – schackles
- ISO 10554 - Polyamide fibre ropes – double braid construction
- ISO 10325 – Fibre ropes - high modulus polyethylene

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**Remark:** In addition to the rules and regulations of the CS referred above, the design of the offloading system shall be based on the following references:

- AWS D1.1: 2000 Structural Welding Code – Steel
- AISC ASD latest edition (For shear, axial, bending strength, beam and column buckling of other than cylindrical members).
- API RP2A-WSD latest edition (For shear, axial, bending and buckling strength of cylindrical members and code checking of tubular joints. Also for requirements for lifting analysis).

## 2.2 - NON-NORMATIVE DOCUMENTS

- Technical Specification - Metocean Data

## 3 - OFFLOADING OPERATIONAL MODES

For the terminals operated by PETROBRAS, in Brazilian waters, the offshore loading operation is performed keeping the DPST connected to the F(P)SO using a mooring line (hawser), in a tandem configuration, and the oil hose is connected at the BLS of the DPST, a dynamic positioning. The offloading operation is carried out according to the modes described below.

### Operational Mode 1 - "Full DP mode"

This is an operational mode typically used for F(P)SOs fitted with absolute and relative PRSs. In this operational mode, the shuttle tanker has the DP system wholly available (power generation, propulsion and control systems). Under this mode the positioning control of the ST is automatically done by the DP system, either in absolute or relative mode, via simultaneous control of the distance between vessels (F(P)SO - Shuttle) and relative heading. The hawser is kept slack all the time.

### Operational Mode 2 - "DP AutoPos mode"

It is a DP operational mode normally used for operations with F(P)SOs where a SETUP has not been performed yet. In this operational mode the relative PRSs are available but not into the Shuttle Tanker DP Software. Under this mode the positioning control of the ST is automatically done by the DP system only by means of absolute positioning reference system (DGPSs)

### Operational Mode 3 - "DP Taut Hawser mode"

This is an operational mode normally used for F(P)SOs, which are not equipped with relative PRS. In this operational mode the shuttle tanker keeps the position under manual control, through the DP console (joystick) or the propeller console (control over each thruster individually). In this way, the DPST Master controls the position of the DPST by monitoring the hawser tension and the relative heading between the two vessels, limited to the values specified in PETROBRAS' operational procedures.



**Remarks:** 1- Regardless of the operational mode employed, all operations shall be necessarily assisted by the operators.

2- For operations with DPST, the messenger lines are launched using an air gun, from the F(P)SO's or from the ST. No support vessels are used for this objective.

#### 4 - DESIGN PREMISES

##### 4.1 - ENVIRONMENTAL CONDITIONS

The Unit shall be designed to operate normally with a Suezmax sized shuttle tanker (up to 150,000 dwt), moored in tandem configuration. The design shall ensure that the Unit can withstand any range of draft conditions for the Unit itself and the shuttle tanker in tandem configuration, and varying from only 3 (three) risers connected (production, gas-lift and umbilical control risers for one production well) to all risers connected.

Maximum offloading design conditions to be considered are:

Winds - 1 (one)-year return period, 10-minute average wind speed, 10 m above sea level or 50 knots, whichever is the most stringent;

Waves - The waves shall be considered as being aligned with the wind and limited up to: HS = 5m ;

Current - 1 (one)-year return period. Current shall be considered as propagating to in any direction, up to 45 degrees out of alignment with wind and waves incidence direction. The worst case shall be accounted for.

The incidences directions to be considered range from 0° to 360°, with increments of 22.5°. The shuttle ship and Unit longitudinal alignment can be either bow-to-bow or bow-to-stern for offloading operations.

The unit shall be ready to start any phase of the offloading operation (mooring, connection, transfer, disconnection and mooring) during the day or during the night, without any restrictions.

##### 4.2 - MOTIONS AND ACCELERATIONS

###### 4.2.1- GENERAL DESIGN CONDITION (TRANSIT, STORM, ....)

All structures and the OFFLOADING SYSTEM shall be designed to withstand the 100-year return period condition according to the environmental parameters specified in the METOCEAN DATA.

CONTRACTOR shall calculate the motions and accelerations, in order to estimate the expected maximum amplitudes and maximum accelerations.

##### 4.3 - OFFLOADING OPERATION TOTAL TIME AND FREQUENCY



The entire OFFLOADING SYSTEM shall be designed and manufactured for a lifetime according to the related oil field project. A minimum of 75 utilizations per year shall be considered as a general design premise.

The offloading operations will be performed at least once a week and shall not take more than 36 h (thirty-six hours).

Notwithstanding the above, the system shall be designed to offload one million (1,000,000) barrels of crude oil to the DPST in no more than 24 (twenty-four) hours. The offload rate shall be proportional to different volumes, e.g. five hundred thousand (500,000) barrels of crude oil in no more than 12 (twelve) hours.

**Remark:** There shall be no restrictions to either start, proceed or finish offloading-related connecting or disconnecting operations during night time.

#### 4.4 - CRUDE OIL DATA

See document I-ET-001, General Technical Description.

#### 4.5 - DESIGN LIFE

The OFFLOADING SYSTEM shall have a design life identical to that of the F(P)SO . See document I-ET-001, General Technical Description.

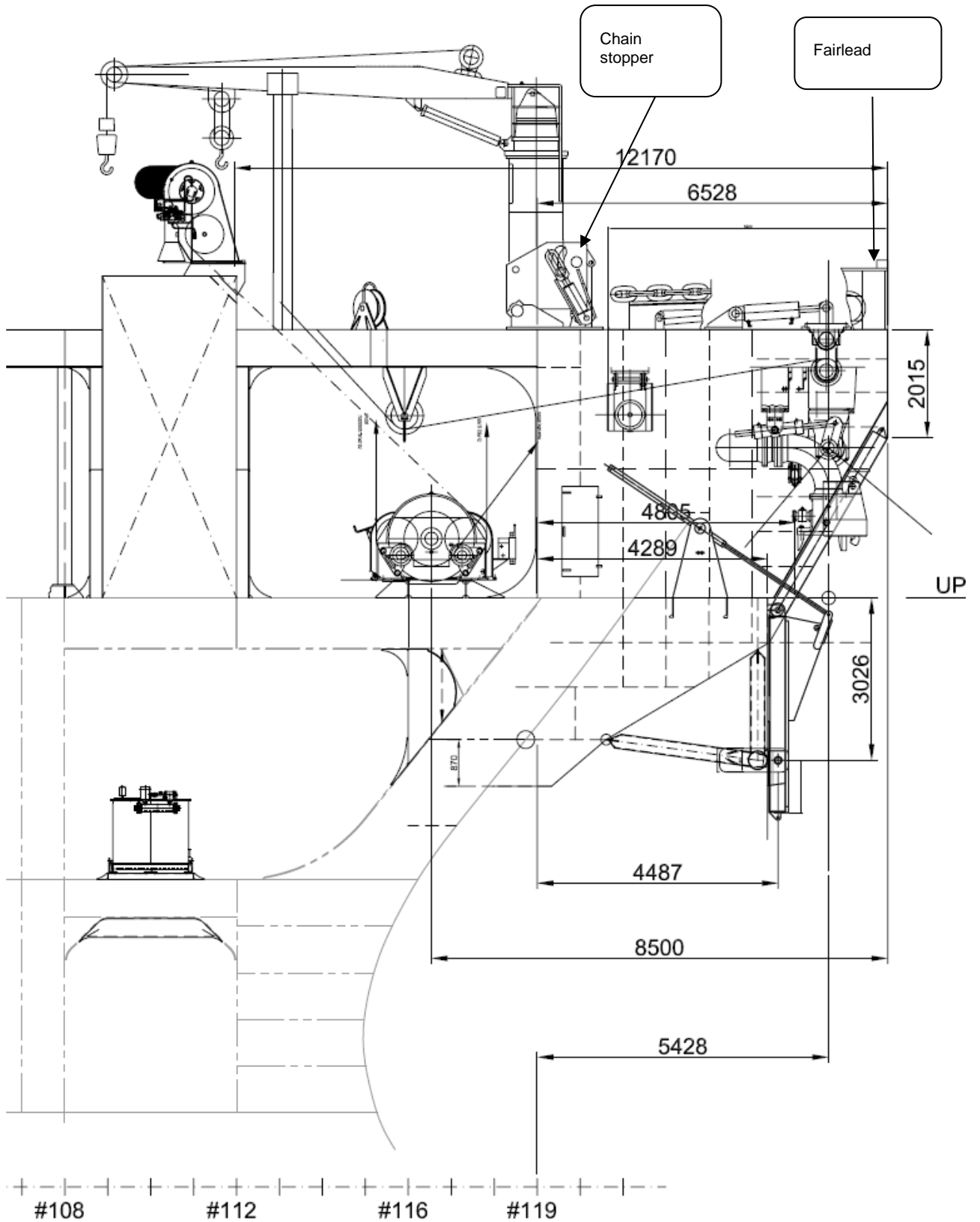
#### 4.6 - SHUTTLE TANKERS DATA

The following main characteristics of typical export tankers shall be considered for design purposes:

##### 4.6.1- SUEZMAX SIZE

- Length overall..... 269.00 m
- Breadth ..... 46.00 m
- Draught in Ballast condition (Fwd/Aft) ..... 7.10 / 9.20 m
- Draught in Fully Loaded condition..... 16.20 m
- Displacement (Ballast/Fully Loaded).....75.623 / 159.914 tones
- BLS coupler elevation (at the bow) ..... 27.00 m
- BLS chain stopper design load ..... 500 Ton
- BLS chain stopper SWL .....250 Ton
- Distance from chain stopper to fairlead ..... 6,2 m

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#### 4.6.2- AFRAMAX SIZE

- Length overall..... 246.00 m
- Breadth ..... 42.00 m
- Draught (Ballast/Fully Loaded)..... 8.50 / 12.90 m
- Displacement (Fully Loaded) .....124.300 tones
- Bow elevation (at the BLS coupler) ..... 24.00 m
- BLS chain stopper design load ..... 500 Ton
- BLS chain stopper SWL .....250 Ton
- Distance from chain stopper to fairlead ..... 6,2 m



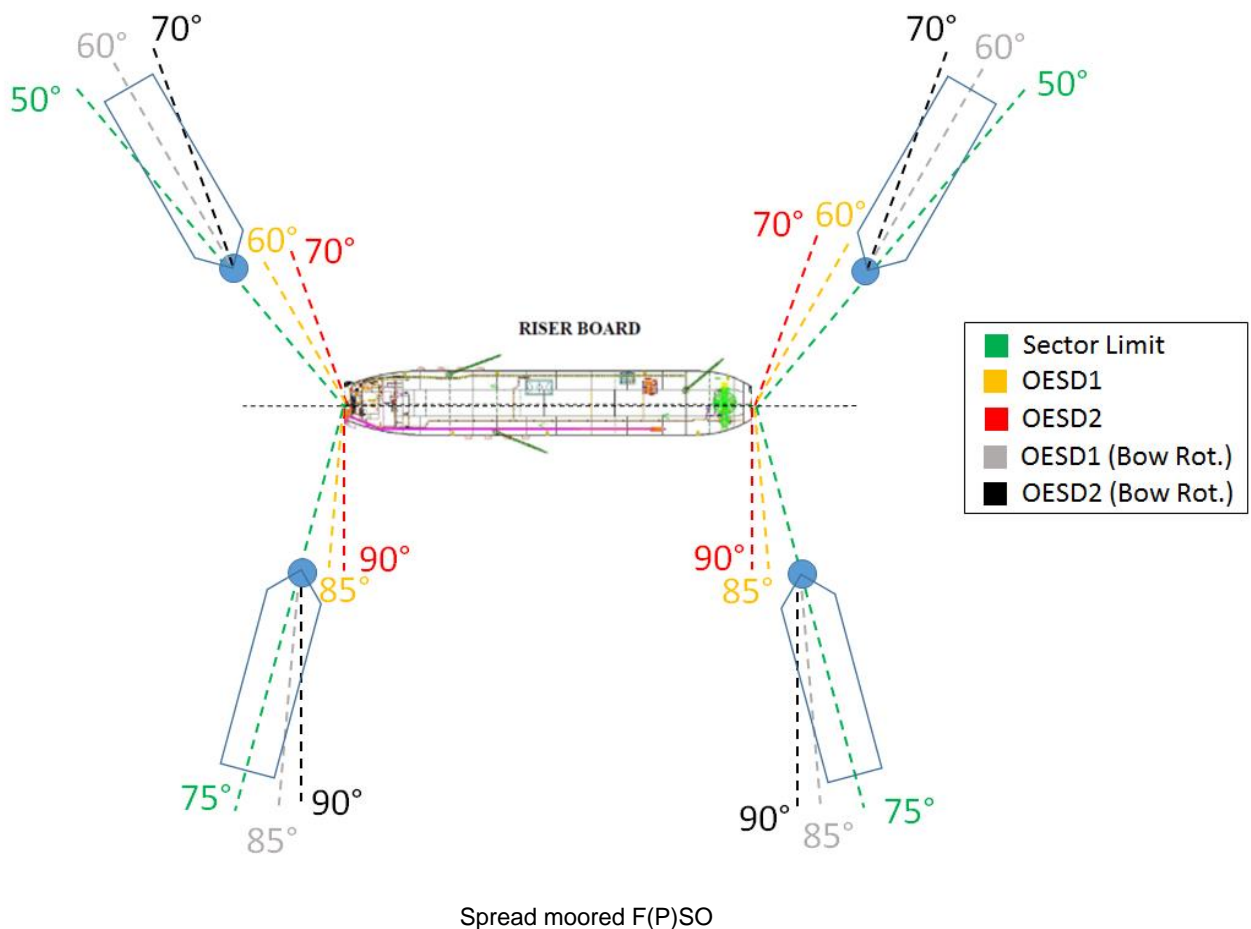
**Remarks:** 1- The shuttle tanker dimensions are molded dimensions;  
 2- The bow elevation is referred to the tanker's base line (keel);  
 3- For design purposes, the maximum distance between the DPST and the Unit shall be 170 (one hundred and seventy) meters.

**4.7 - UNIT'S STRUCTURES**

Concerning all operational modes and the design premises established herein, the deck structure under all equipment, winches and outfitting should be properly reinforced.

**4.8 - OFFLOADING OPERATIONAL SECTOR**

The design and installation of the hose reel and hawser line must ensure the safety and efficiency of the offloading operations between the F(P)SO and the DPST throughout the entire operating sector described below.



Distance between F(P)SO and DPST and hawser and tension limitations during offloading

RELATIVE DISTANCE DPST x FPSO (DP and Relative PRS)	HAWSER TENSION (tons)	ACTIONS
90 m OR LESS	---	RED ALARM NEAR ACTUATE "OESD-2" (Release Hose on BLS) RELEASE HAWSER
90 < L < 100 m	---	YELLOW ALARM NEAR STOP PUMPING ACTUATE "OESD-1" (Close Valves on BLS)
100 < L < 110 m	---	CONTACT FPSO PREPARE TO STOP PUMPING
110 < L < 120 m	---	PROXIMITY WARNING STAY ALERT
120 m	---	LOWER LIMIT FOR OFFLOADING
145 to 155 m	< 5 ton	<b>NORMAL OFFLOADING</b>
165 m	30 < T < 60 ton	STAY ALERT
	60 < T < 100 ton	CONTACT FPSO PREPARE TO STOP PUMPING
MORE THAN 170 m	T = 3 x 100 tons peaks per hour	YELLOW ALARM FAR STOP PUMPING ACTUATE "OESD-1" (Close Valves on BLS)
	TENSION OVER 100 ton	RED ALARM FAR ACTUATE "OESD-2" MANUALLY AND DISCONNECT HAWSER

## 5 - MOORING EQUIPMENT

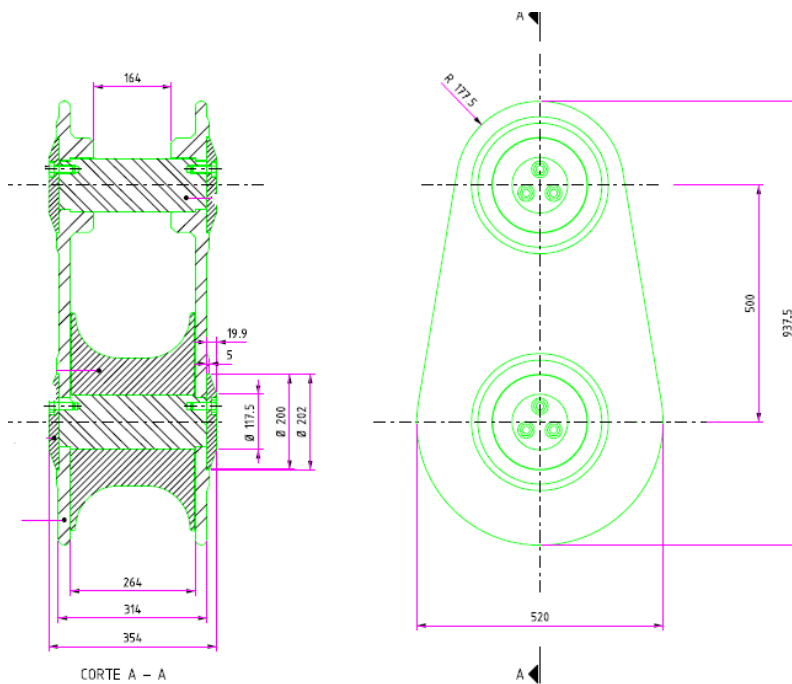
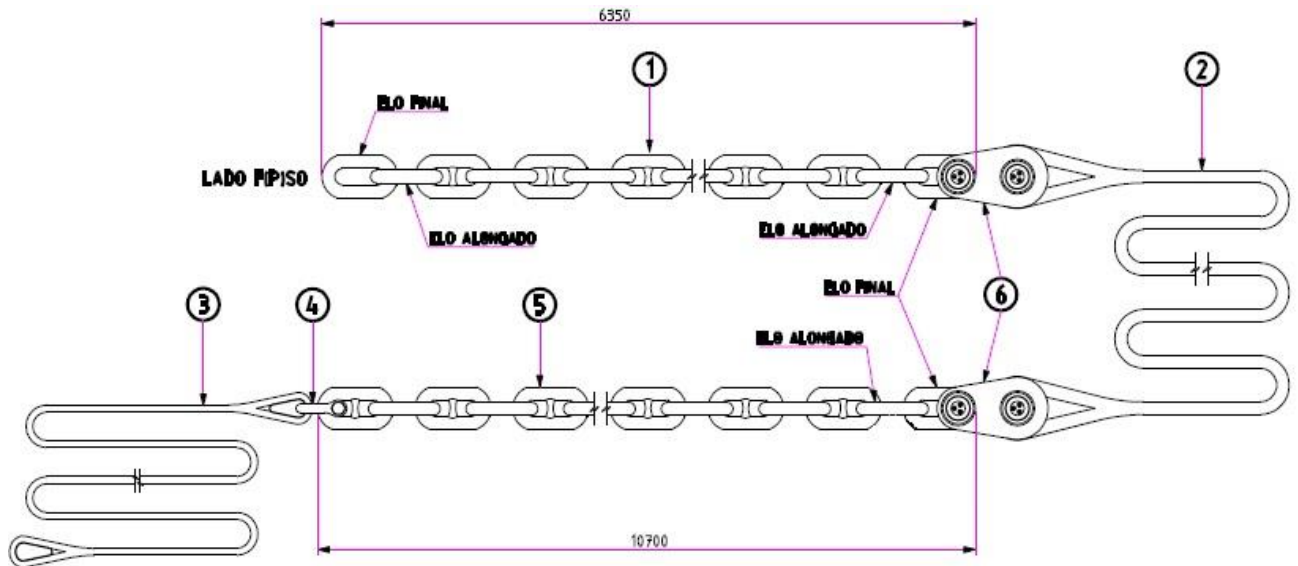
### 5.1 - GENERAL

The mooring system shall be supplied and installed by CONTRACTOR comprising of the hawser assembly, the hawser winch and related outfitting for each loading station, providing a complete arrangement with characteristics in accordance with these specifications.

On the F(P)SO side, the hawser will be permanently attached to a chain stopper, equipped with a load monitoring system. The load monitoring system shall be designed to monitor the hawser tension and set alarms for high tension at the hawser line, all the information should be available in the CCR. Since the hawser tension data will be stored in a computer, CONTRACTOR shall provide the necessary hardware such as cables, connectors and panels. This data shall be made available to the PETROBRAS onboard representatives on a regular basis.

### 5.2 - MOORING HAWSER ASSEMBLY

From the chafing chain part on hawser winch to the messenger line, the mooring hawser assembly comprises the following accessories:



Item 6 - Rope-chain connector





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- 1) Stud-link chain cable , ABNT NBR 13715-2, R4 , ND 76 mm, both terminals with enlarged end link
- 2) Fibre rope, ISO 9554, RN 168 mm, polyamide, higher-strength (hs) , double braided construction, MBF 5280 KN , length 150 m , eye splice plus polyurethane coating with RCS certificate of approval
- 3) Fibre rope, HMPE, ISO 10325, type C (covered), 12 strand, RN 38, MBF 909 KN, with eye splices, length 220 m
- 4) Bow shackle ABNT NBR 13545, grade 8S , bolt type pin with hexagon head, hexagon nut and AISI 316 split cotter pin, WLL 4o t ( body 46 mm, pin 52 mm, width between eyes 77 mm )
- 5) Stud-link cable, ABNT NBR 13715-2 , R4 , ND 76 mm , one terminal with enlarged and end link, other terminal with common link ; length 10 m
- 6) Thimble according to picture above

### **5.3 - MOORING HAWSER CHARACTERISTICS**

#### 5.3.1- MATERIAL

The polyamide fiber rope shall be in accordance with ISO 10554.

#### 5.3.2- LENGTH

The length of the hawser shall be 150 m after permanent stretch, and shall be in accordance with ISO 9554

### **5.4 - MOORING HAWSER WINCH**


The F(P)SO shall be equipped with a hydraulically driven winch at each loading station to launch, retrieve, spool and store the mooring hawser according to the following requirements:

#### 5.4.1- ARRANGEMENT

The hawser winch shall be installed on the main deck, near the centerline of the vessel and located at the deck extremity.

A Local Control Panel shall be installed adjacent to the hawser winch. The Control Console shall be provided the following functions:

- Hawser Winch Control
- HPU Control
- Control of the monitoring of hawser tension

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The control panel shall be installed in a place with a clear view of the offloading operational sector. For SMS F(P)SO two (02) control panels shall be provided, one for each offloading station.

The winch drum shall be horizontal or vertical type. No other arrangement will be accepted. If the drum is a horizontal type, it shall be split in two parts, one for the hawser rope and the other for the chafing chain. If the drum is a vertical type, the bottom plate of the drum must have a suitable diameter to accommodate all metal components of the mooring hawser assembly.

There must be a structure between the hawser spooling device and the opening in the balustrade to prevent chafe chain falling into this space.

It's not acceptable winch drum designed to retrieve hawser by the middle of cable.

The hydraulic power unit shall be designed for installation in a non- hazardous area.

Adequate lighting shall be provided over the deck at the offloading stations (consoles, work area, access, platforms, etc).

**5.4.2- STRUCTURE**

The hawser winch shall be of welded steel construction mounted on a raised skid base and installed on both ends (aft and forward) of the F(P)SO.

**5.4.3- OPERATIONAL CHARACTERISTICS**

Main Functions:

- Storage of complete mooring hawser arrangement;
- Hawser spooling mechanism;
- Hawser load monitoring.

Speeds:

- Minimum launching speed ..... 0.6 m/s
- Minimum retrieval speed ..... 0.3 m/s

Equipment:

- Drum capacity to store one hawser assembly including the chafe chains and the messenger lines.
- Hydraulically operated spooling device mounted on the frame of the winch.
- Load monitoring system (load cell range 0 - 5000 KN).
- Fail safe brake system automatically activated in case of hydraulic system failure;
- Driving system: electro-hydraulic driven with local (close to the winch) control and supervision panel.

**OFFSHORE LOADING SYSTEM REQUIREMENTS**

- Hydraulic System: Two (02) hydraulic pump sets, driven by electrical motor (one set running / one 100 % capacity set stand-by), with:
  - Emergency accumulator rack, for hawser quick release;
  - Oil cooler, adequate for seawater cooling;
  - Regular alarms (temperature, oil level etc);
  - Stainless steel (AISI 316L) for fittings, valves and tubing.
- Chafe chain installation and disconnection: it must be designed to provide safety operation without exposes people near tensioned lifting accessories.

**Maintenance:**

- CONTRACTOR shall provide devices or mechanisms to allow adequate maintenance of the hawser winch drum with no crane assistance;
- All equipment shall be provided with suitable marine treatment;
- To ensure the hawser winch will be full operational and available when required it is essential that the design takes inspection and maintenance activities into consideration;
- All grease nipples shall be located on the main deck to allow easy access and adequate lubrication of the hawser winch.

**6 - OFFLOADING EQUIPMENT****6.1 - HOSE REEL**

The F(P)SO shall be equipped with an all welded steel construction, hydraulically driven hose reel at each loading station, designed to handle and to store the offloading hose string according to the following requirements.

For design purposes the offloading hose string shall be considered full of seawater. The hose reel power unit shall be designed to recover the hose string fully filled with seawater, including all the friction loads and adding a 30 % allowance, to account for any difference in the weight of hoses.

In addition, the hose reel shall be designed to recover the hose string totally paid out and fully submerged. For this condition a retrieval speed less than required on item 6.1.3 will be accepted.

The design of the hose reel and its auxiliary equipment must provide for inspection and maintenance operations without exposing people to tensioned load accessories. Including hose string pull in and pull out operations.

### 6.1.1- ARRANGEMENT

The hose reel shall be installed on the main deck according to Table 1.

The maximum height of the bottom of the hose reel drum in relation to the deck must be 2.8 meters.

A control cabin shall be installed adjacent to the hose reel.

The reel shall be designed and placed for ease of operation and in order to launch, retrieve and spool the hose assembly properly.

Adequate lighting shall be provided over the deck at the offloading stations (consoles, work area, access, platforms, ...).

### 6.1.2- STRUCTURE

The hose reel shall be of welded steel construction mounted on both ends (aft and forward) of the Unit.

The reel shall be designed to store the hose string in one layer with no damage to the hose's cover and floating layers.

The reel shall be designed to store the hose string in one layer, and it must not contain sharp edges or any other part or structure that could damage the hose's cover.

The hose reel drum diameter should be equal or bigger than 8.0 meters.

There should be an open window on the hose reel drum surface immediately above the connection of the first hose to the cargo flange. There must be a 15ton SWL padeye fixed to the internal structure and aligned with this open window on the drum.

The reinforcement plates of the goose neck must not project laterally beyond the outer diameter of the flange. These reinforcement plates must not interfere with the passage of the pair of steel cables used to pull in the hose string.

The size and angle of the goose neck and flange assembly must allow the connection of first of reel hose with a 1m long spool.

The padeyes for connecting the cables must be embedded into the hose reel drum.

### 6.1.3- OPERATIONAL CHARACTERISTICS

Main Functions:

- Storage of complete hose string as specified herein;
- Hose spooling mechanism;

Speeds:

- Minimum launching/retrieval speed..... 0.3 m/s

Equipment:

- Minimum pulling force to handle the hose string;
- Redundant handling device to retrieve the hose string;
- Hydraulically locking device.

Maintenance:

- CONTRACTOR shall provide devices or mechanisms to allow adequate maintenance of the main parts of the reel with no crane assistance;
- All equipment shall be provided with suitable marine treatment;
- To ensure the hose reel will be operational and available when required it is essential that the design takes inspection and maintenance activities into consideration.

## 6.2 - CONTROL CONSOLE AND ACCESS PLATFORMS

A main console installed in a control cabin shall be provided for manual controls comprising the following main functions:

- The rotation speed of the reel
- The linear speed of the spooling device
- Emergency shut down switch (\*)
- Locking device switch
- Locking device position status (\*)

(\*) Functions or signals required on the CCR.

The control cabin shall be located in a platform providing a good and full visibility on the reeling of the hose. The reel design shall consider the equipment monitored, controlled and operated by only one person from the control cabin located near the reel.

An emergency shut down switch will also be provided for installation near the spooling device.

### **6.3 - SPECIAL DEVICES AND MECHANISMS**

#### **6.3.1- CRUDE OIL SWIVEL**

One 20" diam. ANSI B16.5 Class 300 crude oil swivel will be mounted on the drive side of the reel.

#### **6.3.2- LOCKING DEVICE**

- The locking device consists of a hydraulically operated pin or arm that engages locking holes mounted to the flange of the reel. In case of hydraulic system failure, the pin or arm shall be manually operated. This locking device should be able to lock hose reel in twelve symmetrical positions.

#### **6.3.3- SPOOLING DEVICE**

A hydraulically operated spooling device shall be mounted on the hose reel support structure. The device will assist in smooth spooling-on of the hose onto the reel.

The main structure of hose spooling device should not be positioned on deck below the hose reel.

#### **6.3.4- ARRANGEMENT FOR INSPECTION AND MAINTENANCE**

An arrangement should be designed to allow some inspection and maintenance tasks to be carried out by the F(P)SO crew. Some of the tasks that this arrangement should allow are:

- NSV inspection;
- Bridle and messenger line inspection and replacement;


### **6.4 - REEL DRIVE UNIT**

The hose reel will be operated by means of hydraulic drive units mounted on the reel support frame. Control of the drive is through the local control console. A monitoring panel shall be provided in the CCR.

A power unit, driven by electric power from the Unit's distribution board, shall generate the required hydraulic power.

The hose reel drive units shall be supplied with an integrated hydraulically operated fail-safe brake. The power pack will supply oil to the hose reel drive units and to the hawser winch drive units. For subsequent connection to the HPU, all hydraulic piping shall be provided on the hose reel assembly, ending in a manifold.

For emergency operation in case of failure of the drive units, the hose can be reeled on the drum by means of a redundant mechanism hydraulically driven.

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## 6.5 - OFFLOADING HOSE STRING

### 6.5.1- GENERAL

One (01) reinforced rubber offloading hose string, field proven type without failure tracking records (to be submitted to PETROBRAS analysis prior to equipment's purchase), for each hose reel, polyurethane elastomer covered, DOUBLE CARCASS type, approximately 230 m (two hundred and thirty meters) length, working pressure of 300 psi (21 bar), including sections with 10.7m length sections, end fittings flanged according to ANSI B16.5 Class 300 shall be provided and installed in accordance with the OCIMF guidelines as given in the *Guide to Purchasing, Manufacturing and Testing of Loading and Discharge Hoses for Offshore Moorings*, latest edition.

### 6.5.2- HOSE STRING CONFIGURATION

The offloading hose string configuration comprises the following:

- One (01) end section for the ST end, 20" nominal diameter, Tanker Rail type, 40% net buoyancy, considering one outboard hose termination piece fitted (North Sea Valve);
- One (01) segment, 20" nominal diameter, Regular Floating Hoses (35%);
- One (01) segment, 20" nominal diameter, Negative Floating Hose (-10%);
- Intermediate segments, 20" nominal diameter, Regular Floating Hoses (35%);
- Two (02) segments, 20" nominal diameter, Negative Floating Hose (-10%);
- One (01) segment, 20" nominal diameter, Regular Floating Hose (35%);
- One (01) segment, 20" nominal diameter, Reinforced first off reel type, submarine hose.

Note: 20" (twenty) nominal diameter is considered the minimum and most suitable specification for PETROBRAS. However, it is CONTRACTOR's responsibility to verify if this minimum diameter fulfills the requirement to offload one (01) million barrels of crude oil to the ST in not more than 24 (twenty-four) hours. CONTRACTOR shall advise PETROBRAS about the need to modify the hose string minimum diameter if necessary.

The following components and accessories shall be included in the offloading hose:

- One (01) outboard hose termination piece (flanges ANSI B16.5 Class 300);
- One (01) detachable hose bridle;
- One (01) hose messenger line.

**Remarks:**

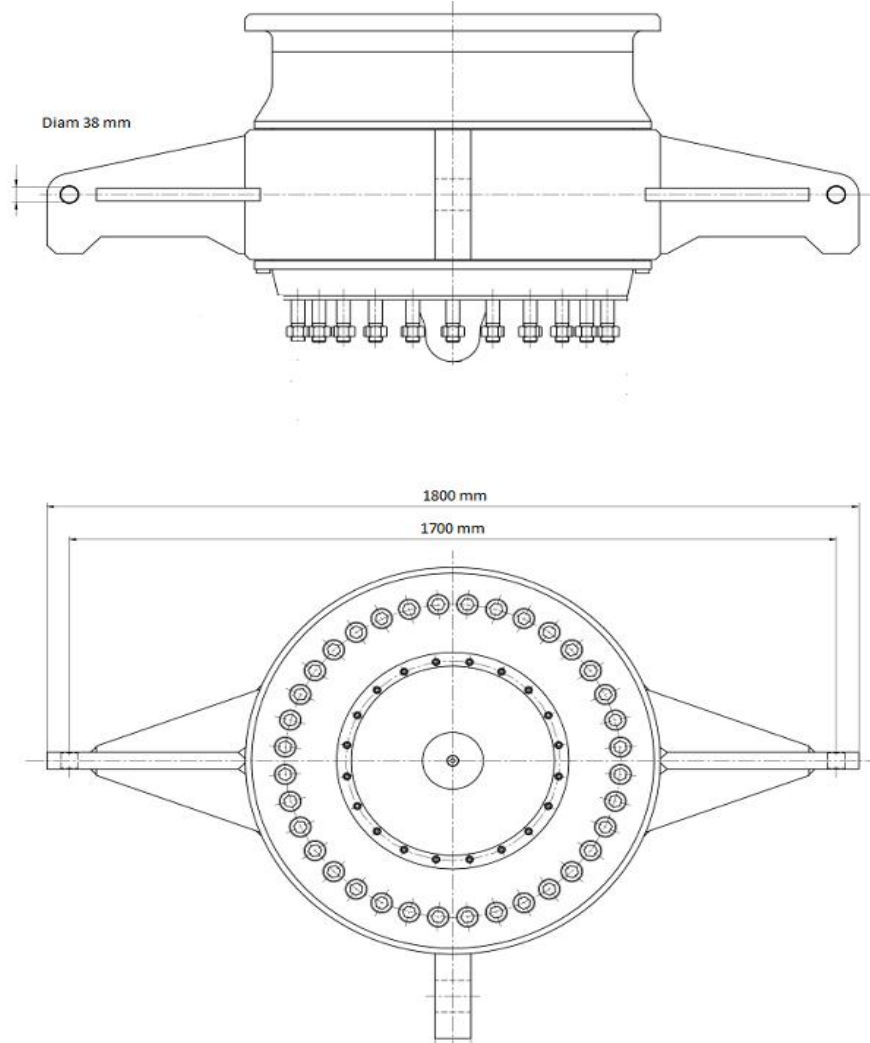
1. The tanker rail hose shall come with additional integrated buoyancy in DPST side, in order to provide buoyancy to the outboard hose termination piece during hose transferring;
2. Two (02) hose intermediate segments and one (01) hose end section shall be furnished as spares for the offloading hose string;
3. Stainless steel bolts (ASTM A193 Grade B8M Class 1) and nuts (ASTM A194 Grade 8M – AISI-316) shall be provided to make up the flanged connections;
4. The electrical continuity of the hose string should be according to OCIMF guidelines and the requirements from the Classification Society.
5. No marine breakaway coupling or similar devices will be accepted as a component of the hose string.
6. The internal lining of the hoses must be designed to work with oil with a 50% aromatic content.

**6.5.3- OUTBOARD HOSE TERMINATION PIECE ( NORTH SEA VALVE )**

The outboard hose termination piece shall consist mainly of one valve DN 20" x 300 psi (21 bar) with body, disc, and a spring. The North Sea Valve shall be of proper dimension and design to connect at the BLS of the DPST. 4.1.2 The valve spring keeps the hose closed between the loading operations, and it automatically closes the hose in an emergency situation. A built-in time delay function prevents pressure surge in the system.

The outboard hose termination piece shall be designed with the minimum possible pressure drop. The hose termination piece should have a suitable swivel ring to which the hose bridle is connected. It is important that the swivel works properly, and is easy to rotate because when the launch is pulling the hose from the Unit to the ST, twists in the hose messenger may occur.





CONTRACTOR shall provide:

1. Two flushing covers with hydraulic jacks to allow the opening of the hose termination piece, proper flushing and pressure test of the hose string line.
2. Means to store the NSV within FPSO boundaries in order to avoid of oil spills overboard

The valve shall be designed to operate in an offshore environment CX according to ISO12944-2 and eventual Im1 environment. The collar shall receive an anticorrosive coating.

Materials specification for the valve shall be carried out based on the following inlet fluids characteristics and normal operating conditions:

CO<sub>2</sub> content: up to 5% mol (gas phase in equilibrium with water phase);

H<sub>2</sub>S content: up to 200 mg/L (water phase);

Chloride (Cl<sup>-</sup>): up to 170,000 ppm (water phase);

Minimum pH: 4.0 (water phase).

NSV shall be in accordance with ISO 15156 for the lowest anticipated pH and the highest H<sub>2</sub>S partial pressure.

NOTE: The permitted exclusions listed at Table 1 of ISO15156-1 are not applicable to this valve.

NSV shall be able to handle BETX, as applicable.

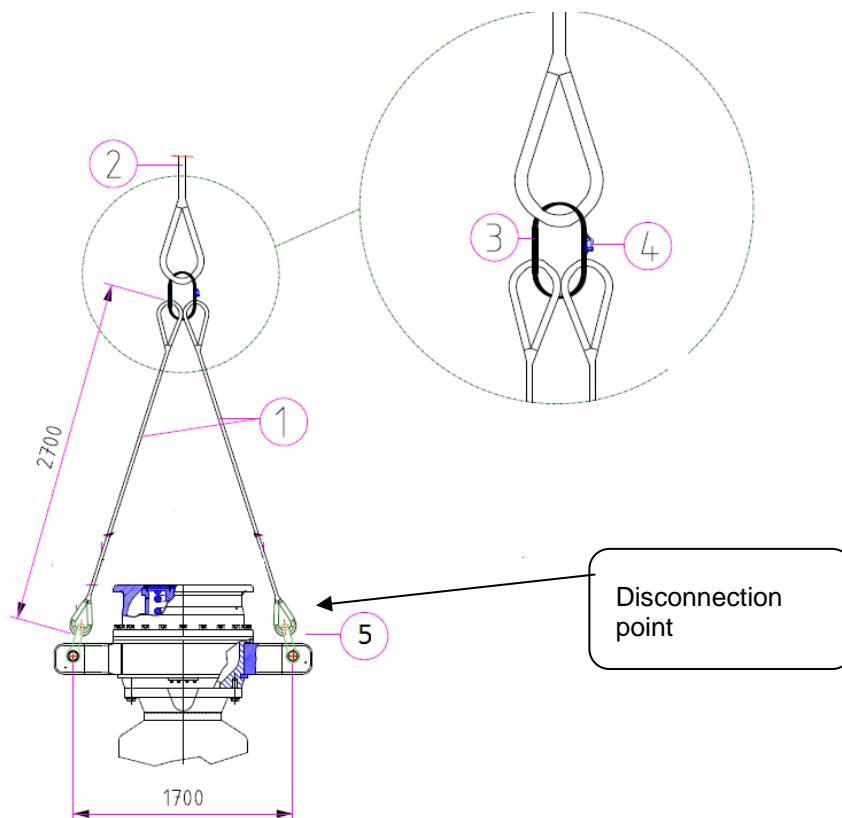
NSV shall also be able to handle seawater as a service fluid.

In addition, the project should provide resources to ensure the control of the H<sub>2</sub>S content of slop tanks below 5.0 mg / L (aqueous phase) and, in case of levels above this value before offloading, seawater shall be used for flushing operation.


#### 6.5.4- DETACHABLE HOSE BRIDLE

The hose bridle between the hose termination piece and the hose messenger line should be connected to the hose messenger line using a shackle.

It is extremely important from a safety point of view, that when the outboard hose termination piece is connected to the BLS on the DPST, the hose bridle must be disconnected to the hose line.



1. Fibre rope, HMPE, ISO 10325, type T (12-strand), RN 28, MBF 610 KN, with eye splices, one thimble in one splice
2. Fibre rope, HMPE, ISO 10325, type C (covered), (12-strand), RN 38, MBF 909 KN, with eye splices.
3. Fibre rope, HMPE, ISO 10325, type T (12-strand), RN 28, MBF 610 KN, with eye splices, length 1,5 m.

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4. Bow Shackle ABNT NBR 13545, grade 6, bolt type pin with hexagon head, hexagon nut and split cotter pin, WLL 5 t (Shackle ABNT NBR 13545-6-BX 5t)
5. Bow Shackle ABNT NBR 13545, grade 6, bolt type pin with hexagon head, hexagon nut and split cotter pin, WLL 12,5/13,5 t (Shackle ABNT NBR 13545-6-BX 12,5/13,5 t)

## 6.6 - EMERGENCY OFFLOADING ASSEMBLY

One Two (02) connection coupler shall be provided for emergency situations, which will be used to connect an **Emergency Offloading Assembly**. The 1<sup>st</sup> hose section over the connection coupler platform is a submersible hose without location collars. The 2<sup>nd</sup> and 3<sup>rd</sup> hose sections off the connection coupler platform are submersible hoses with location collars and buoys or reinforced floating hoses. The rest of the Emergency String is similar to a regular 20"x300# floating hose string.

PETROBRAS shall supply the **Emergency Hose String**, if and when it is required. CONTRACTOR shall design and install only the standing part (piping, valves, controls) of the emergency offloading line (20", ANSI 300# class) and also the means to install the hose string offshore (winches, sheaves, wire ropes, work platforms, slip way).

CONTRACTOR shall provide means to isolate the main offloading station from the emergency offloading stations (e.g. by installing a valve).

Platform connecting points shall be located at both the bow and the stern of the FPSO and as close to the edge as possible in such a way that clearance to the hose from the FPSO hull is provided.

An oil spillage tray under the Emergency Offloading Assembly connection flange shall be provided, with its drain connected to the slop tank.

## 6.7 - HOSE MESSENGER LINE WINCH

The F(P)SO shall be equipped with a hydraulically driven winch at each loading station to launch, retrieve, spool and store the hose messenger line according to the following requirements:

Pull in capacity / minimum speed: 20 TONS / 20 m/min.

This winch must be alignment with cargo flange of hose reel to support hose string pull in and pull out operations. There should be no obstacles between winch and hose reel.

The drum of messenger line winch should be able to work with synthetic ropes and steel wire cable. The dimensions of this drum must be compatible to contain up to 400m of synthetic ropes of 96mm diameter.

A 20 ton SWL padeye should be installed on deck, between hose messenger line winch and hose reel. This padeye should be alignment to goose neck and be welded near messenger line winch structure base.

## 7 - TECHNICAL REQUIREMENTS AND COMPONENTS

### 7.1 - ABSOLUTE, RELATIVE POSITIONING REFERENCE AND TELEMETRY SYSTEM

The Unit must have a DARPS 900B Differential Absolute and Relative Positioning System with telemetry by Kongsberg Maritime, compatible with the existing systems installed on DPSTs. The DARPS system must receive GPS/GLONASS satellite signals. The receptors must have their antenna properly located according to maker's specification. The DARPS system must receive signals from at least one GYROCOMPASS.

The DARPS 900B components to be installed on FPSO/FSU are specified in Table 2.

ITEM	SPM Turret	Spread Moored System
DARPS 232 module or higher (*)	One (01)	Two (02) (*)
Cabinet 12U	One (01)	One (01)
Keyboard with roller-ball, 19" rack mount.	One (01)	One (01)
GPS/Glonass antenna	One (01)	Two (02)
DGPS IALA Beacon antenna	One (01)	One (01)
DARPS User Manual	One (01)	One (01)
DARPS Installation Manual	One (01)	One (01)
DARPS Site Manual	One (01)	One (01)
Interconnection cable, 1.5 m	Four (04)	Four (04)
Mains cable, 1.5 m	Three (03)	Three (03)
Antenna mounting rod	One (01)	Two (02) (*)
Seatex TDMA, 450 Transceiver Module	Two (02)	Four (04) (*)
Connector, Low loss cable	Eight(08)	Eight(08)
UHF antenna	Two (02)	Four (04)
Dual TDMA programming/data cable	One (01)	Two (02)
Industrial Display TFT, AC, 15" VGA Monitor	One (01)	One (01)
Keyboard with trackball	One (01)	One (01)
Monitor/keyboard switch	-	One (01)
DARPS Network switch	One (01)	Two (02)
DARPS 900B Telemetry controllers	Two (02)	Two (02)
Light control unit	One (01)	One (01)
Signal light-tower.	One (01)	One (01)
Alarm buzzer	One (01)	One (01)
Alarm Silencer button	One (01)	One (01)
Light test button	One (01)	One (01)
UHF antennas	Two (02)	Two (02)
Mains cable, 1.5 m	Three (03)	Three (03)
Connector	Four (04) (*)	Four (04) (*)

Table 2 – DARPS 900B components

(\*) These quantities need to be confirmed by the maker.



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Additionally, the following items shall be provided:

- Antenna cable for the GPS, IALA and UHF antennas;
- Serial cable (gyro signal to All DARPS);
- Power cable to all DARPS (from UPS).

**Remarks:**

a) Any other part considered necessary to interface the all DARPS with other systems must be provided and installed by the CONTRACTOR.

b) Unit's radios and protocols: TDMA (Time Division Multiple Access) radios and protocols allowing more than one transmitter to use the same frequency without interference and a distribution of data from one to several users (Units).

c) One (01) high accuracy Gyrocompass with serial outputs RS422 & NMEA 0183 must be provided.

d) The system must be according to the Tandem Mode Software.

e) All cables must be according to the maker' specification.



**7.2 - RELATIVE POSITIONING REFERENCE SYSTEM**

Additionally, the Unit must be fitted with:

**7.2.1- ARTEMIS**

A microwave radio positioning system of “range-bearing” type, ARTEMIS Mark V or higher version, fixed station.

ITEM	SPM Turret	Spread Moored System
ARTEMIS Fixed Station: - Artemis Fixed Antena Unit - Artemis Scanner (antenna) - Standard cables - Manuals	One (01)	Two (02)
Micro Cos 128 MB computer w/ power supply	One (01)	One (01)
Keyboard and Mouse	One (01)	One (01)
VGA Monitor-Industrial 15".	One (01)	One (01)
Power cable to Artemis (from UPS) Length defined from the Pre-Survey	One (01)	Two (02)
Maker: THALES GEOSOLUTIONS BV - Netherlands		

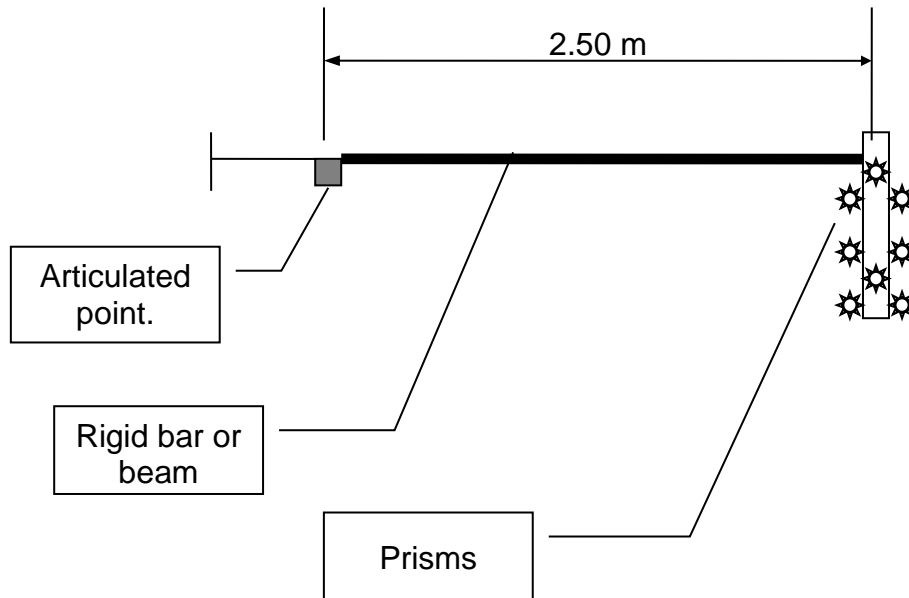
Note: Where distance from the Fixed Antenna Unit to Micro Cos Computer greater than 100 meters, a Fibre Optic solution should be used for data communication:


Fibre optic Junction Box with media converter for installation near Fixed Antena	As required	As required
Fibre optic Junction Box with media converter for installation near Fixed Antena	As required	As required
Fibre optic cable and connectors	As required	As required

7.2.1- FANBEAM

An optical laser positioning system target comprising one (01) set of two (02) FANBEAM 6 prism cluster must be provided for Single Point Moored Units. For Spread Moored Units two (02) sets comprising two (02) FANBEAM 6 prism cluster must be provided and installed on each offloading station (forward and aft).

Drawing showing the schematic for one CLUSTER:



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**7.3 - UNINTERRUPTIBLE POWER SUPPLY SYSTEM (UPS)**

The CONTRACTOR shall supply and install at least two redundant Uninterruptible Power Supply System (UPS) for the Position Reference Systems, (2x100% capacity) and batteries.

The UPSs must have a by-pass switch; batteries with enough storage for at least 30 minutes worth of operations after an interruption in the primary power supply and alarm functions, showing in the DP console, in case of failure.

Each PRS consumer must be connected to a different UPS, not being acceptable a configuration with more than one PRS connected to the same UPS.

The load distribution must be configured to avoid the loss of more than one PRS, in case of failure of any one of the UPSs.

**7.4 - COMMISSIONING AND SET UP**


The CONTRACTOR with the assistance of the maker’s representatives shall do the initial commissioning and set up of the PRS system in the Yard.

The final commissioning and set up of the PRS system shall be done in the FPSO final location in Campos Basin during a DP operation together with a DP shuttle tanker. The CONTRACTOR with the assistance of the maker’s representatives shall do this work.

**Remarks:**

- a) The electrical power supply to the systems must not be from the same UPS in order to assure redundancy to the PRSs, in case of a failure.
- b) Their antennas must be adequately positioned on the Unit as to provide maximum efficiency with minimum interference risk or possibility of “shadow” zones.
- c) All set-up and tests will be performed with assistance from the maker representative.
- d) PETROBRAS will perform an acceptance test for the PRSs.



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## 8 - MISCELLANEOUS

### 8.1 - WELDING (APPLICABLE CODES AND STANDARDS)

Workmanship, technique, qualification and inspection of all steelwork will be in accordance with AWS D.1.1.- "American Welding Society Structural Welding Code for Steel".

### 8.2 - SPARE PARTS

All spares parts shall be according to the OCIMF guidelines. All spares have to be packed separately with clear identification and delivered in packing suitable for long-term storage.

### 8.3 - SPECIAL TOOLS

CONTRACTOR shall supply all special tools required for installing, commissioning, operation and maintenance of all equipment specified herein.

### 8.4 - INSPECTION AND TESTING

#### 8.4.1- HOSE REEL TESTING

##### Rotation Test

A complete 360-degree rotation of the reel shall be made in both the clockwise and counter-clockwise direction and the torque required to start and turn the reel shall be recorded.

##### Speed Test

A set of tests shall be performed to confirm the operational speeds.

##### Load Test

The reel will be locked and a capacity test of the drive unit will be performed. The maximum torque shall be recorded.

##### Spooling Device Test

A set of tests shall be performed to confirm the functionality of the hose spooling device.

##### **Remark:**

- 1- At least once every six months the hose must be inspected.
- 2- All tests shall be carried out with the hose string stored on the reel and full of water.

#### 8.4.2- HAWSER WINCH TESTING

##### Rotation Test

A set of rotations of the winch drum shall be performed in both the clockwise and counter-clockwise direction and the torque required to start and turn the drum shall be recorded.

##### Speed Test

A set of tests shall be performed to confirm the operational speeds.

##### Load Test

The winch drum will be locked and a capacity test of the drive unit will be performed. The maximum torque shall be recorded.

##### Spooling Device Test

A set of tests shall be performed to confirm the functionality of the hawser spooling device.

**Remark:** All tests shall be carried out with the hawser stored on the drum.

#### 8.4.3- PRESSURE TEST OF HOSES AND PIPING ON REEL

The piping on the drum, including the swivel shall be pressure tested to 300 psi for a minimum of six (06) hours.

The offloading hose string shall be spooled out and pressure tested according OCIMF. During the test, a visual inspection shall be carried out in order to detect any leakage or deformation.

### 8.5 - INSTRUCTION MANUALS AND TECHNICAL DOCUMENTS

All instructions related to the operation, maintenance, inspection of the OFFLOADING SYSTEM should be detailed in a specific manual in order to ensure that they will be performed in safe and suitable manner.

The following information should be available in the OFFLOADING SYSTEM MANUALS:

- Offloading System General Arrangement;
- Installation Procedures;
- As-built drawings of all steel construction parts and main hydraulic diagrams;
- Technical specification, drawings and functional description of all parts;
- Weight Control Report;
- Detailed periodic maintenance instructions;
- Detailed maintenance instructions for the operational situations;
- Regular inspections, calibrations, tests (including pressure tests) and checks (including the related data sheets, tables and charts);
- Check-lists and procedures for all the operational modes;



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- Instructions for emergency situations;
- Procedures for offshore replacement of the hawser and the hose sections;
- Factory Acceptance Tests (FAT) for the main components;
- Fabrication certificates, including the hoses;
- Tests/Inspections Report (Test Certificates, Visual inspections, Welding inspection, Non-destructive Testing).