PETROBRAS	TECHNICAL SPECIFICATION	Nº: I-ET-3010.00-1359-960-PY5-001	
	CLIENTE:		FOLHA: 1 de 47
	PROGRAMA:		
	ÁREA: OFFLOADING		
	TÍTULO: **OFFSHORE LOADING SYSTEM REQUIREMENTS**		GPP/MQP PÚBLICO

INDEX OF REVISIONS

REV.	DESCRIPTION AND/OR AFFECTED SHEETS
0	ORIGINAL
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
J	REVISION ITEM 1.4
K	REVISION ITEM 7.1
L	REVISION I-ET NUMBER
M	GENERAL REVISION
N	GENERAL REVISION
O	REVISION ITEM 6.5.3
P	GENERAL REVISION
Q	GENERAL REVISION
R	GENERAL REVISION – REF. GTD
S	REVISION ITEM 4.3, 4.4 AND 4.5
T	REVISION ITEM 6.6 AND 6.1.2
U	INDEX REVISION
V	GENERAL REVISION
X	REVISION ITEMS 4.6.3,5.1,5.3,6.2.1,6.6.2,6.6.3,6.7 AND 7. ADDED ITEM 8.

	REV. R	REV. S	REV T	REV U	REV V	REV. X
DATE	07/04/2022	13/04/2022	18/05/2022	26/05/2022	13/12/2022	14/03/25
	EAEP/MQP	EAEP/MQP	EAEP/MQP	EAEP/MQP	EAEP/MQP	EAEP/MQP
EXECUTION	FSC	FSC	FSC	FSC	FSC	EVHM
VERIFICATION	GBM	GBM	GBM	GBM	GBM	C5EQ
APPROVAL	FCLR	FCLR	FCLR	FCLR	FCLR	CQA6

INDEX

1. INTRODUCTION

1.1. GENERAL

The purpose of this document is to provide the basic technical requirements for inspection, maintenance, testing, 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.

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.

Table 1 - Types and location of the offloading systems

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

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

Remark:

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
CTV	Cargo Transfer Vessel
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
SLS	Side Load System
SPM	Single Point Mooring
OT	Oceanic Terminal
UPS	Uninterruptible Power Supply
WLL	Working Load Limit

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

SELLER - 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. SELLER´S DUTTIES

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

The SELLER shall submit the design of the offloading system to PETROBRAS approval. PETROBRAS may request changes to the arrangements, equipment and redundancies

proposed by the SELLER, in order to optimize the security and availability of the system during its life cycle.

SELLER'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 SELLER.

SELLER 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

Remarks:

1- 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 CONTRACTORSELLER procedure.

2- The equipment required to comply with PETROBRAS Offloading Guidelines are described in the I-ET-3010.00-1359-960-PY5-001Technical Specifications.

3- CONTRACTORSELLER shall submit the proposed design, operational procedures and technical specifications for PETROBRAS APPROVAL.

4- If the operational procedure is revised after the formal approval from Petrobras, it shall be submitted again for PETROBRAS APPROVAL.

5- Any modification in the platform or any recommendation from risk analysis that cause operational restrictions that must be submitted for PETROBRAS APPROVAL.

6- 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.

2. NORMATIVE AND NON-NORMATIVE REFENCES

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

Remark:

1- 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:

2- AWS D1.1: 2000 Structural Welding Code – Steel

3- AISC ASD latest edition (For shear, axial, bending strength, beam and column buckling of other than cylindrical members).

4- 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

For more details, refer to I-ET-3010.00-1359-940-P4X-001.

4.2. MOTIONS AND ACCELERATIONS

For more details, refer to I-ET-3010.00-1359-940-P4X-001.

4.3. OFFLOADING OPERATION TOTAL TIME AND FREQUENCY

The entire OFFLOADING SYSTEM shall be designed and manufactured for a minimum of 110 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:

1- 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 General Technical Description

4.5. DESIGN LIFE

The OFFLOADING SYSTEM shall have a design life identical to that of the F(P)SO. See 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

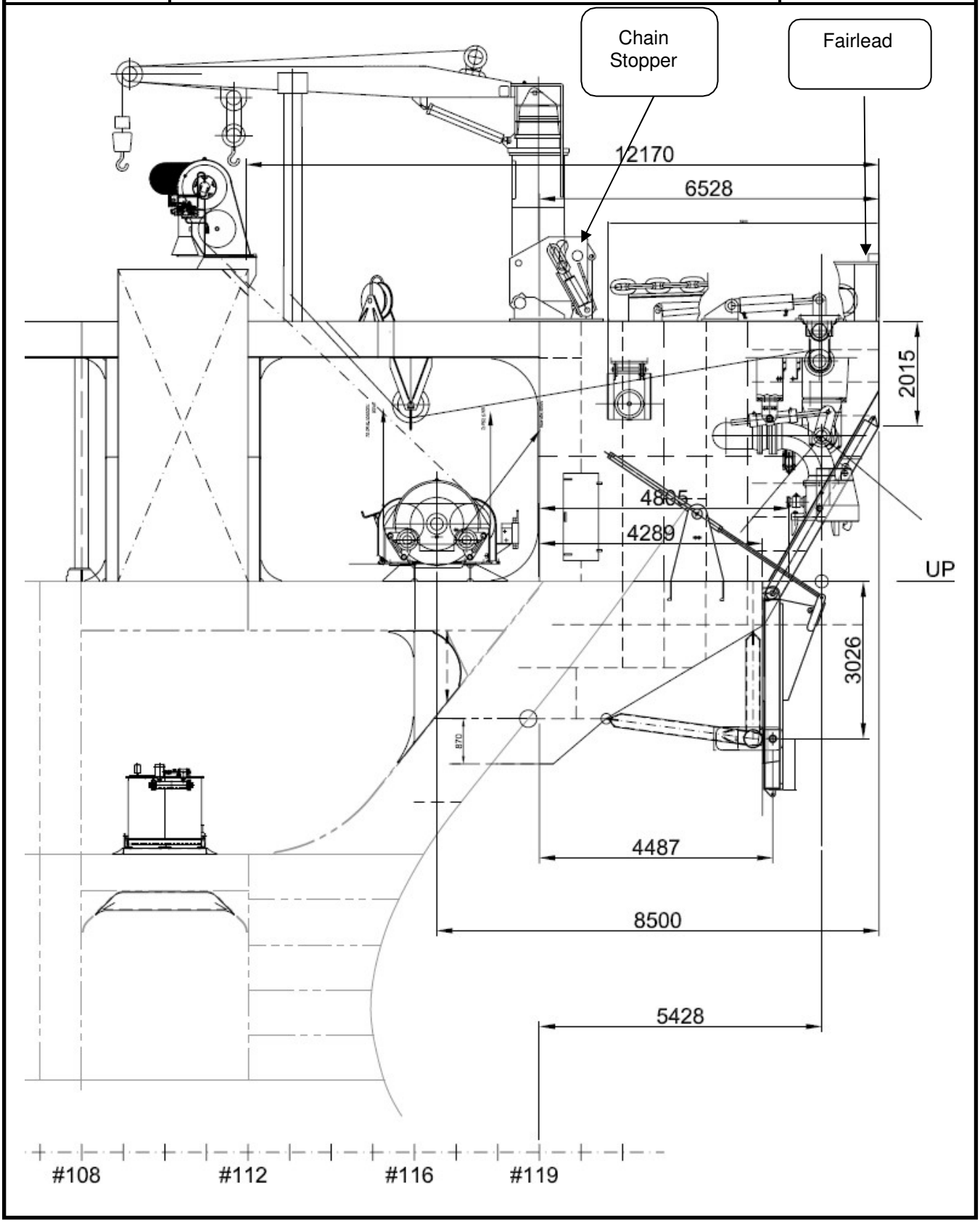
Chain Stopper
Fairlead
12170
6528
2015
4805
4289
UP
3026
870
4487
8500
5428
#108
#112
#116
#119

Figure 1 - Typical Suexmax layout

4.6.2. AFRAMAX SIZE

Length overall	246.00 m
Breadth	42.00 m
Draught in Ballast condition (Fwd/Aft)	8.50 / 12.90 m
Displacement (Ballast/Fully Loaded)	124.300 tones
BLS coupler elevation (at the bow)	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

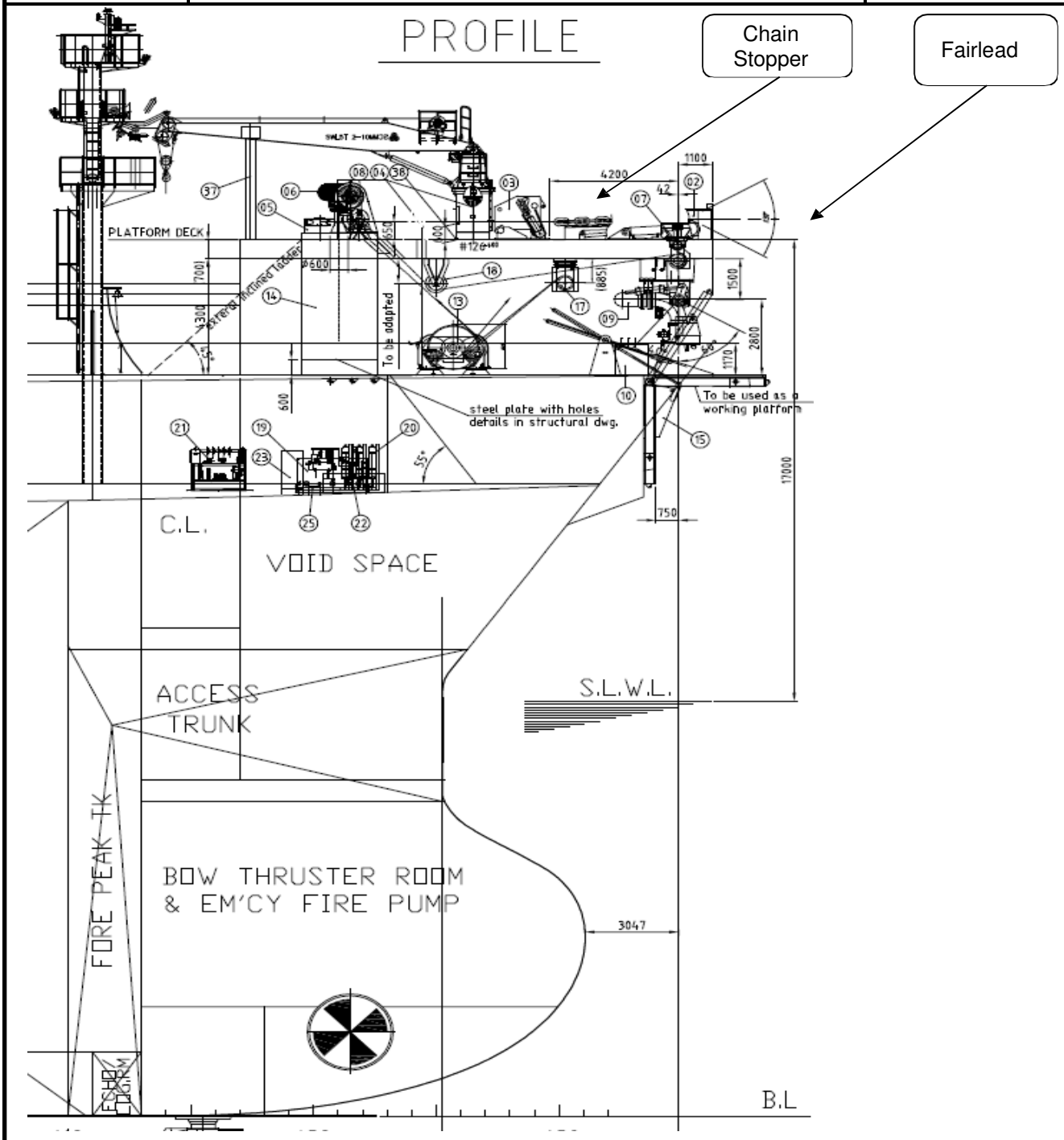

Figure 2 - Typical Aframax layout

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.

4.6.3. CTV DATA

The following main characteristics of the CTV that shall be considered for design purposes:

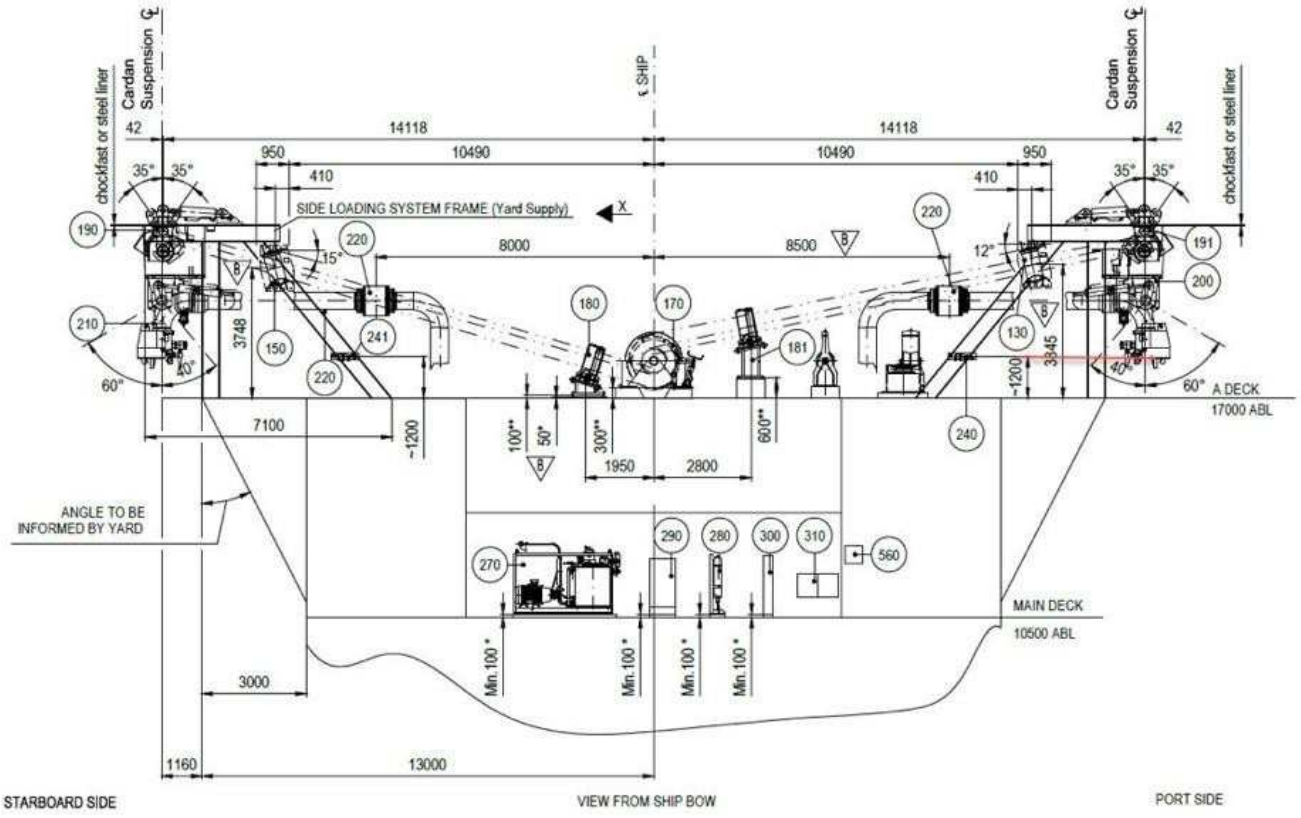

Figure 3 - Typical CTV layout

Remarks:

1- The CTV will work, in a tandem configuration together a conventional tanker (SUEZ or VLCC) and a tugboat as picture bellow;

2- The SLS works the same way as BLS of the DPST.

3- CTV is provided with 3 cargo booster pumps for pumping in higher flowrate, pressure loss to be considered the same as for operations with DPST.

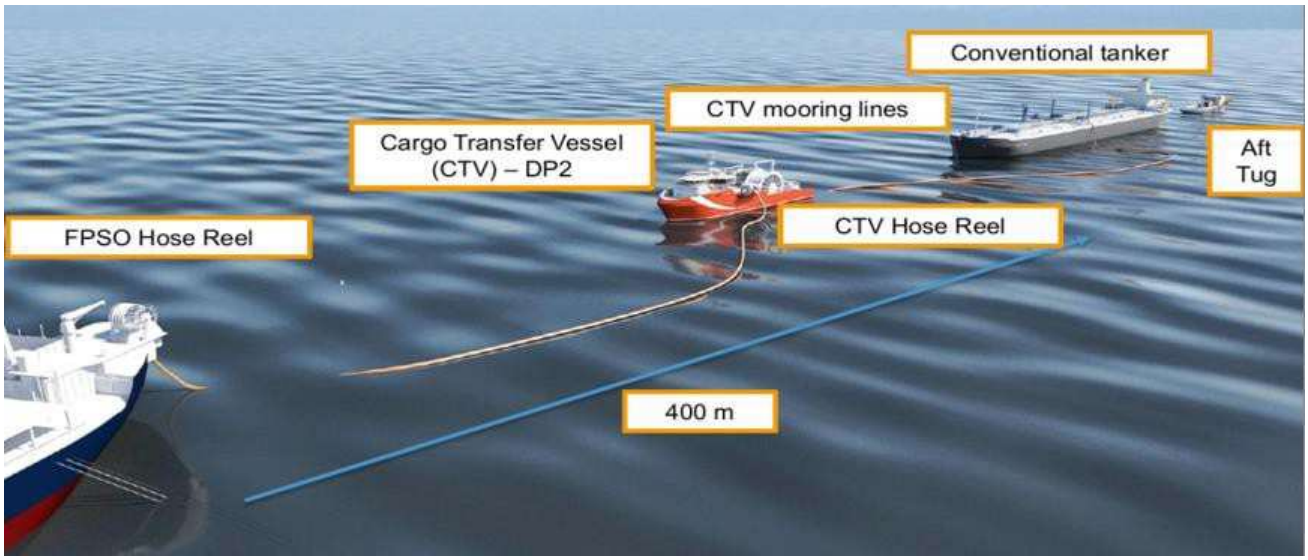

Figure 4 - Typical CTV convoy formation

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/CTV throughout the entire operating sector described below.

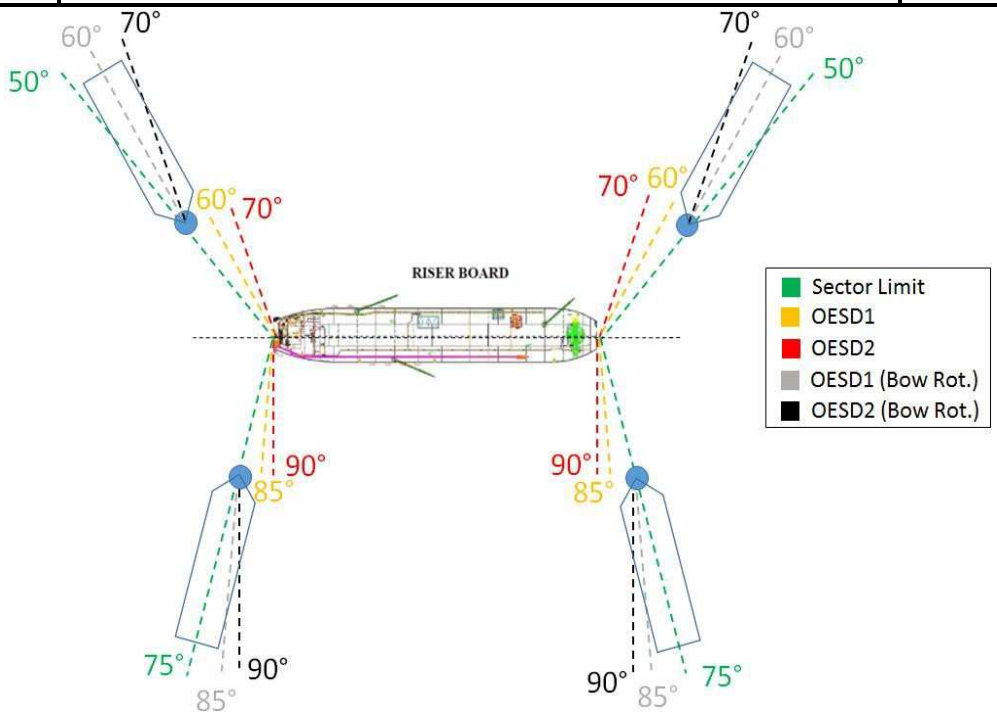

Figure 5 - Offloading sector for DPST

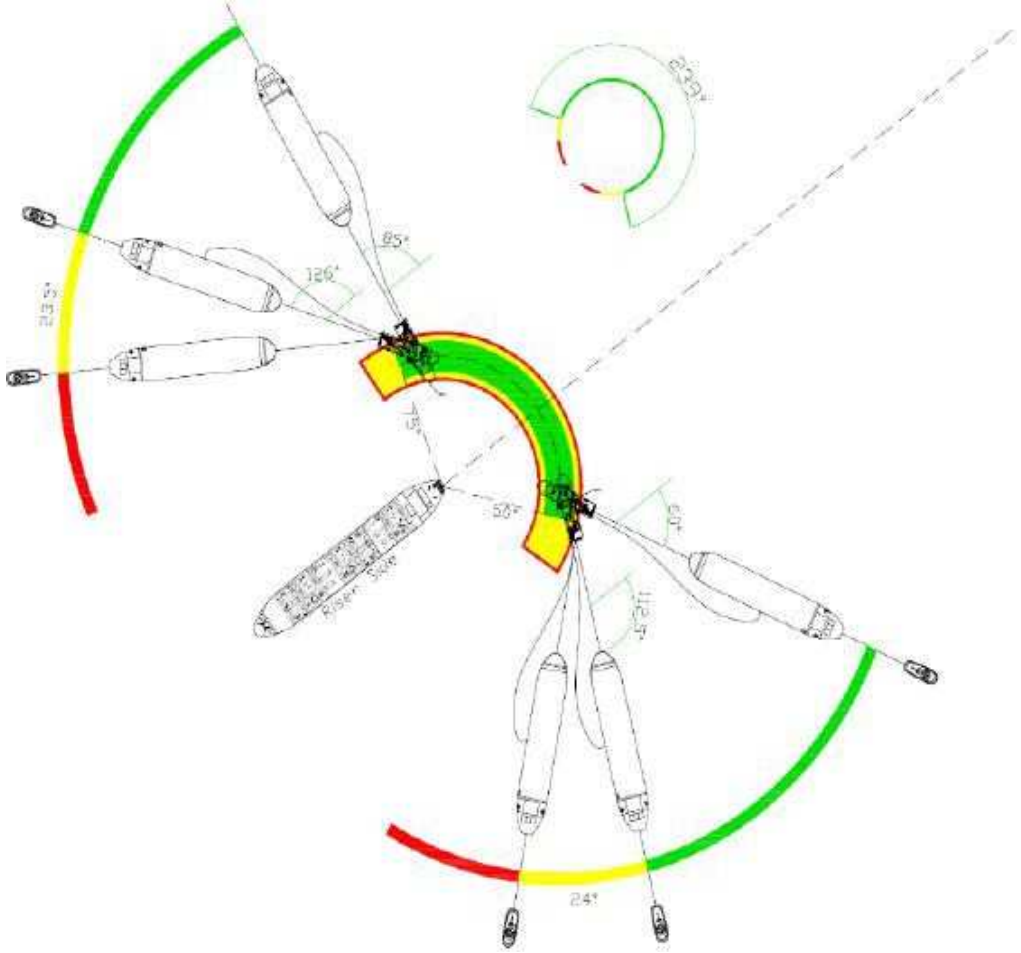

Figure 6 - Offloading sector for CTV convoy

Remarks:

1- Combined Operation Sector: Combining the operation sectors of both port and starboard SLS gives the following range for CTV and tanker. Figures are for illustration only;

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

Table 2 - Distance between DPST/CTV and FPSO

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	NORMAL OFFLOADING
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

On the F(P)SO side, the hawser will be permanently attached to a chain stopper, equipped with a load monitoring system.

The SELLER must provide a list of spare parts to be kept available, according to design, and submit it for Petrobras approval.

For more details, refer to I-ET-3010.00-1359-940-P4X-001

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:

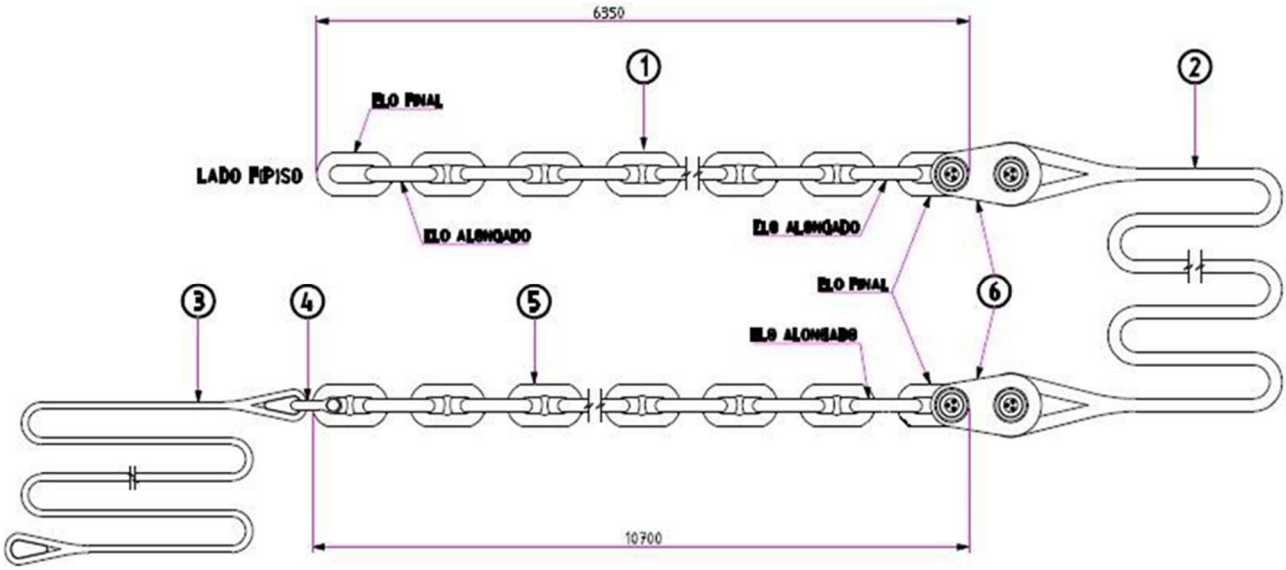

Figure 7 - Moorinf hawser

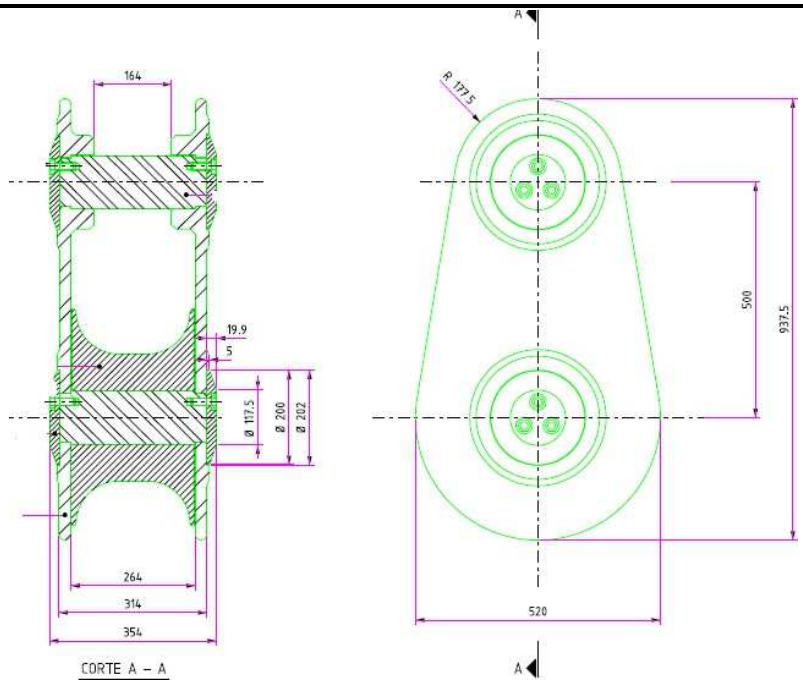

Figure 8 - Rope-chain coneector

Mooring Hawser layout:

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

Remarks:

1- As a primary mode, the messenger lines shall be launched using an air gun from the FPSO, to the shuttle tanker or to the CTV. Portable or similar system from the FPSO shall be made available when necessary. No support vessels shall be used for this objective. The air gun for the FPSO shall be provided by the CONTRACTORSELLER

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

Remarks:

5- Mooring Hawser must be permanently attached to the mooring hawser winch, no means of releasing the mooring hawser line must be implemented. All emergency release maneuvers are done from DPST/CTV side.

6- SELLER must provide space and pad-eyes for maintenance, replacement and inspection of the mooring hawser, according to vendor procedures.

5.4. MOORING HAWSER WINCH

For the mooring hawser winch requirements refer to I-ET-3010.00-1359-940-P4X-001. Maintenance:

- SELLER 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

The SELLER must provide a list of spare parts to be kept available, according to design, and submit it for Petrobras approval.

6.1. HOSE REEL

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.

6.2. ARRANGEMENT

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

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, …).

6.2.1. STRUCTURE

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

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 the goose neck flange. There must be a 15ton SWL padeye fixed to the internal structure and aligned with this open window on the drum, to bring the first section flange close to the goose neck flange.

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

A 20ton padeye must be installed on the deck for use in hose pull-in and pull-out operations. This padeye must be aligned with the hose connection flange on the reel and must be aft of the reel base, when dealing with the bow reel, and forward of the reel base when dealing with the stern reel. The SELLER must submit the drawing with the positioning of the padeyes, for analysis by Petrobras, before carrying out the installation.

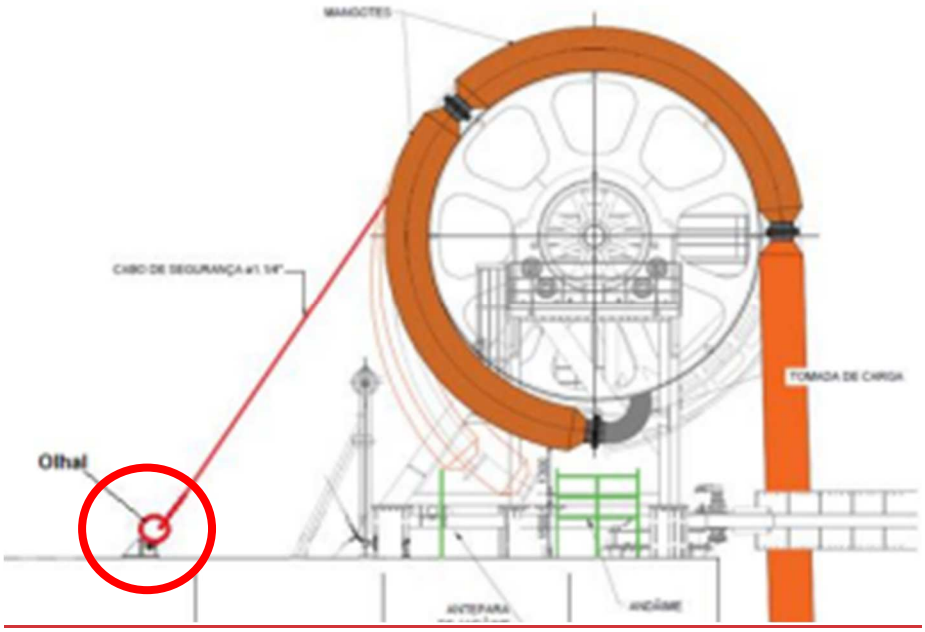

Figure 9 -Pull-in/Pull-out Pad-eye

6.2.2. CHARACTERISTICS

For additional design requirements refer to I-ET-3010.00-1359-940-P4X-001.

Maintenance:

- SELLER shall provide devices or mechanisms to allow adequate maintenance of the main parts of the reel with no crane assistance.

For more detail about hose reel requirements refer to I-ET-3010.00-1359-940-P4X-001.

6.3. CONTROL CONSOLE AND ACCESS PLATFORMS

For control console and access platforms requirements refer to I-ET-3010.00-1359-940-P4X-001.

6.4. SPECIAL DEVICES AND MECHANISMS

For Special Devices and Mechanisms requirements refer to I-ET-3010.00-1359-940-P4X-001.

6.4.1. 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;

6.5. REEL DRIVE UNIT

For reel drive unit requirements refer to I-ET-3010.00-1359-940-P4X-001.

6.6. OFFLOADING HOSE STRING

6.6.1. 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.

6.6.2. HOSE STRING CONFIGURATION

The recommend 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.

The position of the Negative Hose Segment of the offloading hose string from FPSO side shall be located at air/water transition zone considering maximum and minimum operational draft.

Note: 20” (twenty) nominal diameter is considered the minimum and most suitable specification for PETROBRAS. However, it is SELLER´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. SELLER 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.

7- At least once every six months the hose must be inspected.

6.6.3. 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, to be considered around 30-35 sec.

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.

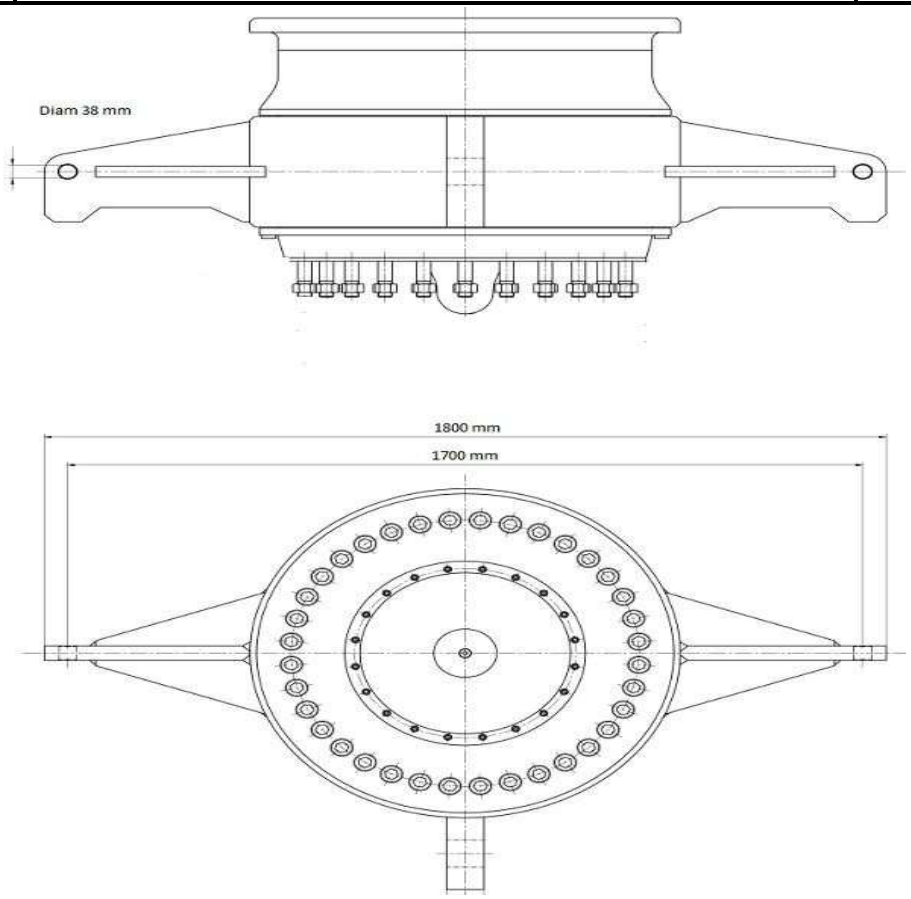

Figure 10 – NSV

SELLER 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:

- CO2 content: up to 5% mol (gas phase in equilibrium with water phase); H2S content: up to 200 mg/L (water phase);
- Chloride (Cl-): 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 H2S 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 H2S 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.

6.6.4. 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.

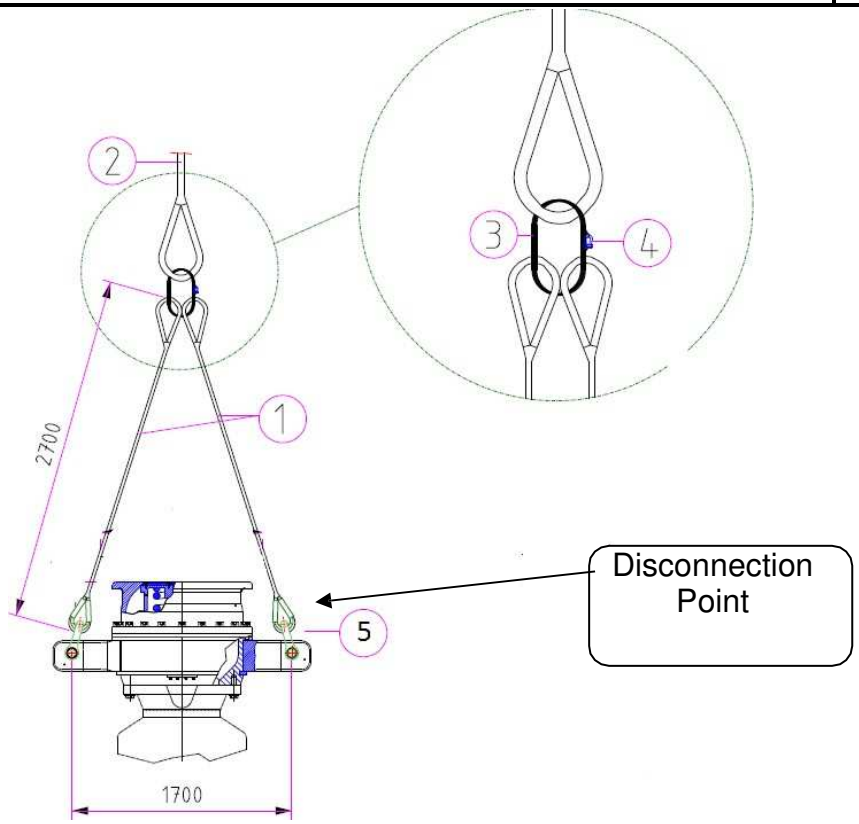

Figure 11 - Detachable hose bridle

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.
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)

6.7. EMERGENCY OFFLOADING ASSEMBLY

Two (02) connection coupler shall be provided for emergency situations (bow and stern), which will be used to connect an Emergency Offloading Assembly.

Offloading stations shall have bollards and chocks arranged in such way to allow the NSV stowage onboard the FPSO. This arrangement shall be submitted to PETROBRAS for appraisal.

For emergency offloading assembly refer to I-ET-3010.00-1359-940-P4X-001

6.8. 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:

For hose messenger line winch refer to I-ET-3010.00-1359-940-P4X-001

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, one for each offloading station, 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.

For each DARPS 900B, the minimum components to be installed on FPSO/FSU are specified in Table 3

Table 3 - DARPS 232 with telemetry components

ITEM
DARPS 232 module or higher
Cabinet 42U
Keyboard with roller-ball, 19" rack mount.
GPS/Glonass antenna
GNSS antenna mounting kit
DGPS IALA Beacon antenna
DARPS User Manual
DARPS Installation Manual
DARPS Site Manual
Interconnection cable, 1.5 m
Mains cable, 1.5 m
Antenna mounting rod
Seatex TDMA, 450 Transceiver Module
Connector, Low loss cable
UHF antenna
Dual TDMA programming/data cable
Industrial Display TFT, AC, 15" VGA Monitor
Keyboard with trackball

Monitor/keyboard switch
DARPS Network switch
DARPS 900BTelemetry controllers
Light control unit
Signal light-tower.
Alarm buzzer
Alarm Silencer button
Light test button
Telemetry UHF antennas
UHF TDMA Radio OMTS Units (Seagnal Radio)
Mains cable, 1.5 m
Connector

These quantities shall be confirmed by SELLER and by the system manufacturer.

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).

The following schematic diagram presents a typical arrangement of the proposed solution for spread moored units:

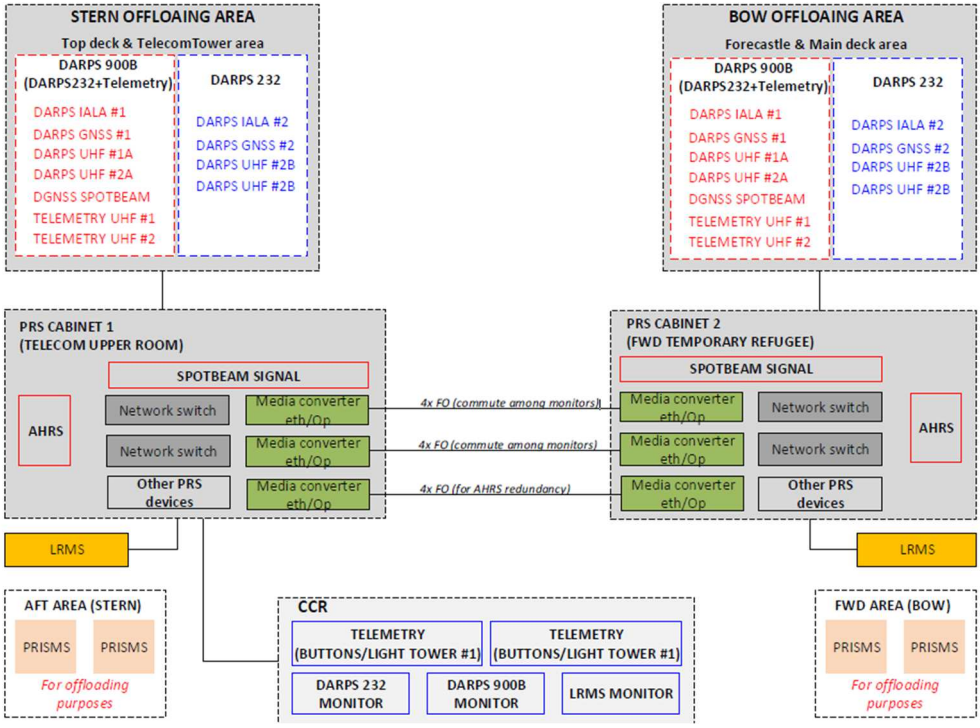

Figure 12 - DARPS overview proposal for spread units

Remarks:

1- Optical fiber solution will be need for transmit data from Forward side to CCR.
2- Any other part considered necessary to interface all DARPS with other systems must be provided and installed by the SELLER.
3- 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).
4- One (01) high accuracy Gyrocompass with serial outputs RS422 & NMEA 0183 must be provided.
5- The system must be according to the Tandem Mode Software.
6- All cables must be according to the maker' specification.
7- The antennas locations shall be according to maker's specification and submitted to Petrobras approval.

8- For all RF cables, before they ingress to radios consoles, it shall be protected by Coaxial RF Surge Protector/Arrestor.

7.2. RELATIVE POSITIONING REFERENCE SYSTEM

Additionally, the Unit must be fitted with:

7.2.1. LONG-RANGE MICROWAVE SYSTEM

A long-range microwave-based relative positioning system providing range and bearing must be installed according to the following

ITEM	SPM Turret	Spread Moored System
Long-range microwave-based relative positioning system	One (1) system for single offloading station	Two (2) systems, one per offloading station

The system must have a specified range of 5000 meters and installed a way that provides 250-degree coverage for spread-moored FPSO's, and 180 degree coverage for turret-moored FPSO's, with an accuracy of 1 meter.

Signal handling must be robust in all-weather condition without significantly degrade in performance.

Where distance from the fixed antenna location to the operator station exceeds 100 meters, either a high-quality low-loss copper cable (double-shielded of type ToughCAT-7 or better), or a fiber optic solution shall be used for data communication.

The microwave system shall be installed with best possible view towards the DPST, with sufficient height to reduce local shading/blocking. Operator station shall be located in the central control room, or as instructed by the client (Petrobras). The system must have an

easy to use and easy to operate display unit, visualizing bearing and distance to the DPST. User Manual must be provided by vendor.

The microwave-based relative positioning system shall (preferably) have power feed from an UPS. Installation of the system components according to vendors Installation Manual.

The system cannot have movable parts.

7.2.2. MULTI TARGET LASER-BASED SYSYTEM

An optical laser positioning system target comprising for offloading purposes:

- 02 (two) units: for Single Point Moored (Turret) Units an optical laser positioning system target comprising 01 (one) set of 02 (two) targets prismatic with 6-way prism cluster must be provided.
- 04 (four) units: for Spread Moored Units 02 (two) sets comprising 02 (two) targets prismatic with 6-way prism cluster.

Drawing showing the example of schematic for one CLUSTER:

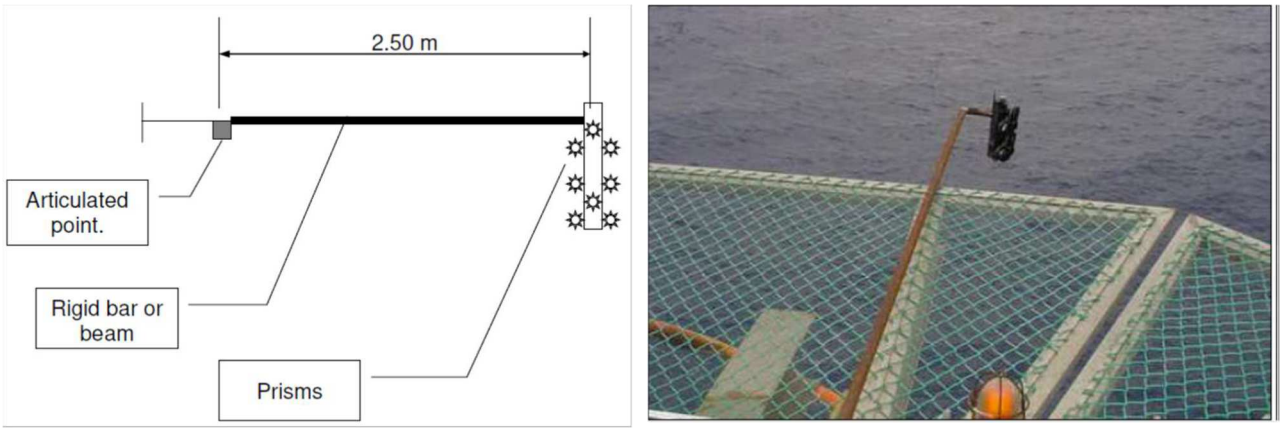

Figure 13 - Schematic for one cluster installation example

Each fixed set of prism unit shall be installed whenever possible at platform guard rail towards open sea, in a proper support easy to be man accessed and maintained without any ladder or scaffold.

7.3. UNINTERRUPTIBLE POWER SUPPLY SYSTEM (UPS)

The SELLER shall supply 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 powered by at least two different UPS units, ensuring that the operation is not impacted by the loss of one UPS

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

7.4. COMMISSIONING AND SET UP

The SELLER 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 during a DP operation together with a DP shuttle tanker. The SELLER with the assistance of the maker's representatives shall do this work.

Remarks:

1- 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.

2- Their antennas must be adequately positioned on the Unit as to provide maximum efficiency with minimum interference risk or possibility of “shadow” zones.

3- All set-up and tests will be performed with assistance from the maker representative.

4- PETROBRAS will perform an acceptance test for the PRSs.

5- The Dimensional Survey Report including the coordinates (X,Y,Z) of the position reference systems (GPS Antennas, Long Range Microwave, Muktitarget laser-based Prisms, MRUs) hose, hawser and offloading points, according to maker specification, shall be provided.

8. TECHNICAL REQUIREMENTS FOR THE POSITION REFERENCE SYSTEMS FOR SUPPORT AND SUPPLY VESSELS APPROACHING THE UNIT

8.1. MULTI TARGET LASER-BASED SYSTEM

For support/supply vessel safety approximation:

- 09 (nine) units: for Single Point Moored (Turret) Units it shall be supplied 09 (nine) prismatic targets to be installed, each of them being a 6-way prism cluster. Of these units, 03 (three) shall be on portside, 03 (three) on starboard, 02 (two) on turret tower, 01 (one) at end stern.
- 08 (eight) units: for Spread Point Moored Units it shall be supplied 08 (eight) prismatic targets to be installed, each of them being a 6-way prism cluster. Of these, 04 (four) shall be on portside and 04 (four) on starboard, all of these along platform sides and not equidistantly to each other.
- 08 (eight) units: for semi-submersible or fixed moored Units it shall be supplied 08 (eight) prismatic targets to be installed, each of them being a 6-way prism cluster. Of these, 04 (four) shall be on portside and 04 (four) on starboard, along platform sides and not equidistantly to each other.

- 02 (two) standalones: not mattering the type of Unit, it shall be additionally supplied 02 (two) standalone prismatic targets to be installed under operational demand, each of them being a 6-way prism. These additional prismatic targets shall be delivered inside suitable transport cases.

Figure 13 shows the example of schematic for one CLUSTER. Each fixed set of prism unit shall be installed whenever possible at platform guard rail towards open sea, in a proper support easy to be man-accessed and maintained without any ladder or scaffold.

8.2. MICROWAVE RADAR TRANSPONDER

For support/supply vessel safety approximation:

- 05 (five) fixed short range radar transponders for FPSO Spread Mooring type platforms, they shall be installed as follow: 03 (three) on port side (one further forward, another amidships and a third further aft) and 01 (one) on starboard near the cargo handling area and 01 (one) on starboard at amidships.
- 04 (four) fixed short range radar transponders for Turret FPSO type platforms they shall be installed as follow: 01 (one) on port side near the cargo handling area, 01 (one) on starboard near the cargo handling area and 02 (two) on the turret at diametrically opposite sides.
- 04 (four) fixed short range radar transponders for semi-sub or fixed platforms they shall be installed as follow: 01 (one) on each face (e.g. North; South; East; West).
- 01 (one) standalone short range radar transponder: not mattering the type of Unit, it shall be additionally supplied 01 (one) standalone transponder to be installed under operational demand, with the possibility of being installed along the entire platform perimeter at any side, which shall be delivered inside suitable transport case.

The proposed positions for the multi target and microwave transponders are illustrated below in Figure 14.

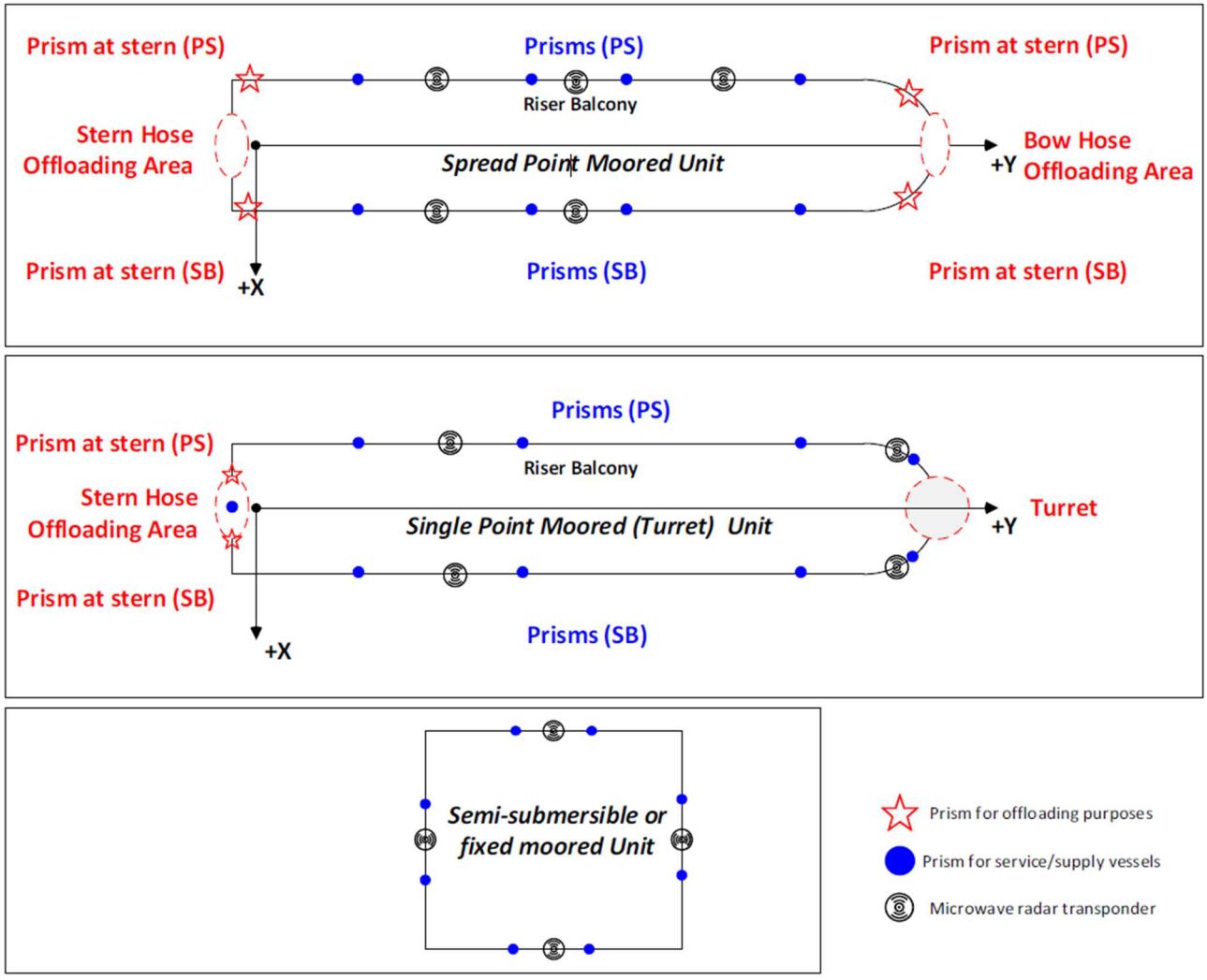

Figure 14 - Schematic prims and radar short range radar transponder's locations

9. MISCELLANEOUS

For Design testing and instruction manuals and technical documents refer to I-ET-3010.00-1359-940-P4X-001