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A	Revised Hydraulic actuator Top Cone support hydraulic functions.										
B	Revised for PACXe Design.										
C	Change of Hydraulic Supply										
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1 SUBJECT

This document presents the Technical Specification of hullside umbilical for risers systems.

2 ABBREVIATION

BSDL-SI	Diverless Bell Mouth - Standard Interface (Portuguese acronym)
DL	Diverless
FAT	Factory Acceptance Test
FPU	Floating Production Unit
HPU	Hydraulic Power Unit
RRMS	Rigid Riser Monitoring System
RSMS	Riser Support Monitoring System
TSUDL	Unified Diverless Support Tube (Portuguese acronym)

3 REFERENCE DOCUMENTS, CODES AND STANDARDS

This section lists standards and documents applicable to the design hullside umbilical:

3.1 International Standards and Patents

- [1] API 6A - Specification for Wellhead and Christmas Tree Equipment
- [2] API 17E – Specification for Subsea Umbilicals
- [3] API 17F - Standard for Subsea Production Control Systems
- [4] API 17Q - Recommended Practice on Subsea Equipment Qualification
- [5] ASME B16.5:2013 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service
- [6] ASME B16.5:2013 - Pipe Flanges and Flanged Fittings
- [7] DNVGL-RP-B401:2017 - Cathodic Protection Design
- [8] IEC 60529 (latest revision) - Degrees of Protection Provided by Enclosures (IP Code)
- [9] ISO 13628-6:2006 - ISO 13628-6:2006
- [10] BR 10 2021 017362-9 – Patent: “SISTEMA DE ATUAÇÃO HIDRÁULICA PARA BOCA DE SINO”

3.2 Petrobras documents

- [11] I-ET-3010.00-1300-850-PEK-001 - Control and Monitoring System for Riser Supports
- [12] I-DE-3010.00-1300-850-PEK-001 - Riser Supports P&ID
- [13] I-DE-3010.00-1300-279-PEK-003 - Lateral Support Module
- [14] I-LI-3010.00-1300-279-PPC-350 – BSDL-SI PART LIST
- [15] I-ET-3010.00-1300-279-PPC-350 - DIVERLESS BELL MOUTH STANDARD INTERFACE SUPPLY SPECIFICATION

[16] I-ET-3000.00-5529-850-PEK-005 - RIGID RISER MONITORING SYSTEM (RRMS) - Umbilical Hullside Solution

[17] I-ET-3010.00-1300-279-PEK-002 - 5K HYDRAULIC ACTUATOR FOR BSDL /DIVERLESS BELL MOUTH

[18] I-DE-3010.00-1300-279-PEK-003 - 5K HYDRAULIC ACTUATOR ASSEMBLY FOR BSDL

[19] I-DE-3000.00-5520-850-PEK-001 - BLOCK DIAGRAM – SUBSEA MONITORING SYSTEMS

4 DEFINITIONS

FPU CONTRACTOR	The company contracted by PETROBRAS to construct the FPU
MAY	It is used when alternatives are equally acceptable
RISER SUPPORT	General reference for lower balcony risers support. Comprising BSDL-SI, TSUDL and Receptacle.
SHOULD	It is used when a provision is not mandatory, but is recommended as a good practice
SHALL	It is used when a provision is mandatory
SUBCONTRACTOR	Company contracted by FPU CONTRACTOR, to supply hullside umbilical.

5 TECHNICAL CHARACTERISTICS

5.1 Design and fabrication

- 5.1.1 All subsea control components shall be designed in accordance with API 17E and API 17F.
- 5.1.2 Selection of materials for all subsea structures shall be in accordance with DNVGL-RP-B401:2017 item 5.5, and be designed for the same design life as the FPU.
- 5.1.3 All enclosures and equipment to be placed in hazardous areas shall comply and be certificated according IEC 60079 (latest revision).
- 5.1.4 All enclosures with a required degree of ingress protection shall comply with IEC 60529 (latest revision).

5.2 Qualification

- 5.2.1 All subsea equipment shall be qualified in accordance with API 17Q or ISO 13628-6:2006.
- 5.2.2 All subsea control components shall be qualified in accordance with API 17E.
- 5.2.3 FPU CONTRACTOR shall consider SUBCONTRACTORS with experience in subsea umbilical.

6 GENERAL TECHNICAL REQUIREMENTS

6.1 System overview

6.1.1 The hullside umbilical is a multipurpose structure that has the function to provide an interconnection between lower and upper riser balcony, through electrical, optical and hydraulic circuits. These circuits shall attend:

- TSUDL actuation system (Top Cone, Lateral Support modules and Integrated BSDL);
- TSUDL monitoring system (End course and Corrosion monitoring);
- BSDL actuation system;
- BSDL monitoring system (End course and Corrosion monitoring);
- Rigid Riser Monitoring System (See Ref. [16]).

6.1.2 A general sketch of hull side umbilical is illustrated in figure 1.

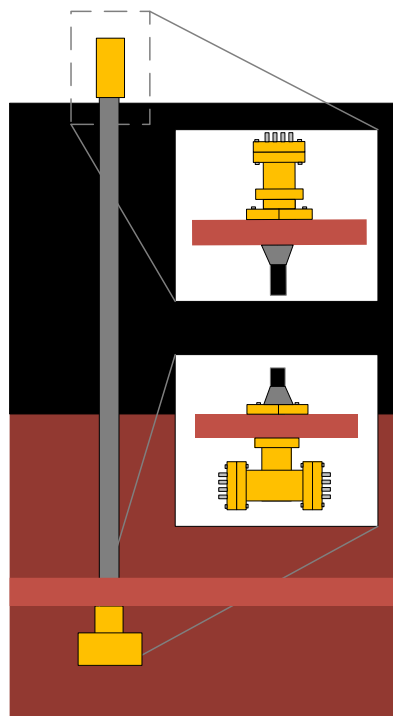


Figure 1 – Hull side umbilical (sketch)

6.2 Umbilical Minimum Requirements

6.2.1 FPU CONTRACTOR shall provide umbilical with the minimum requirements detailed as follow:

6.2.1.1 When TSUDL is in FPSO scope:

- a) 16 thermoplastic hydraulic hoses, in order to attend a minimum of 4 TSUDL;
- b) 28 electrical twisted shielded pairs, in order to attend a minimum of 4 TSUDL;

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- c) 20 single mode optical fibers, in order to attend a minimum of 5 rigid riser slots with optical RRMS Connector.

6.2.1.2 When TSUDL is not in FPSO scope:

- d) 5 thermoplastic hydraulic hoses, in order to attend a minimum of 5 BSDL-SI;
- e) 20 electrical twisted shielded pairs, in order to attend a minimum of 5 BSDL-SI (end course and corrosion monitoring) plus to attend a minimum of 5 rigid risers slots with electrical RRMS Connector ;
- f) 20 single mode optical fibers (10 pairs), in order to attend a minimum of 5 rigid risers slots with optical RRMS Connector.

6.2.1.3 FPU CONTRACTOR may propose umbilical configuration optimization to Petrobras approval, observing the functionality required in this specification.

6.2.2 Thermoplastic Hydraulic hoses shall observe the minimum requirements:

6.2.2.1 The thermoplastic hydraulic hoses shall have internal diameter of 3/8 inch.

6.2.2.2 The thermoplastic hydraulic hoses shall be compatible with the following hydraulic control fluids standardized by PETROBRAS: MacDermid HW443, HW525 P and Castrol Transaqua DW.

6.2.2.3 FPU CONTRACTOR shall provide a compatibility analysis for the hydraulic control fluid adopted in PUPS design with all materials used that shall contact with such fluid.

6.2.2.4 All thermoplastic hoses shall be supplied from umbilical factory filled with the hydraulic fluid defined by the PUPS CONTRACTOR (MacDermid HW443; MacDermid HW525P or Castrol Transaqua DW) and plugged with hydraulic hose caps at both ends.

6.2.2.5 All thermoplastic hoses shall be flushed in order to guarantee supply of water-glycol based hydraulic control fluid with cleanliness class according to Norm ISO 4406 CLASS 17/15/12. (Equivalent to class 6 from the old Norm NAS1638 Cleanliness Requirements used in Hydraulic Systems) and ensure no air bubbles inside.

6.2.2.6 The umbilical lines shall be supplied with all accessories to protect both ends (for example: armor pots, bend stiffener etc) for umbilical line handling and fixation at riser balconies.

6.2.2.7 All hydraulic pigtailed not used shall be filled with the hydraulic fluid and closed with caps at both ends

6.2.2.8 All hydraulic pigtailed shall have individual identification. Identification may be numbers, letters and/or insulation color. Identification shall withstand handling and installation of hydraulic lines and umbilical system.

6.2.3 The electrical cables shall observe the minimum requirements:

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6.2.3.1 Conductor cross-sectional area of 2,5 mm².

6.2.3.2 0,6/1kV Class.

6.2.3.3 All electric cables construction materials shall be selected considering environmental resistance for the specified umbilical system service life. Environmental conditions includes, at least, seawater, marine growth, UV radiation and hydrogen generated in electric cables and/or umbilical armoring and/or umbilical cathodic protection.

6.2.3.4 The electric cables design shall minimize gap and voids between layers to reduce air and gas accumulation in electric cable.

6.2.3.5 Fillers, if used, shall be of polymeric material.

6.2.3.6 The electric cables shall have at least two barriers to protect conductors against seawater. The electric cable outer sheath shall not be considered as a barrier.

6.2.3.7 The conductors shall have a longitudinal water blocking material (within strands) to minimize water migration in case of conductors flooding.

6.2.3.8 The conductors shall have individual identification. Identification may be numbers, letters and/or insulation color. Identification shall withstand handling and installation of electric cables and umbilical system.

6.2.4 The optical fibers shall observe the minimum requirements:

6.2.4.1 Single mode (ITU-T G.652 standard);

6.2.4.2 The optical fibers shall be suitably arranged "loose" with a defined over-length within a watertight metal tube (stainless steel). The metal tube shall be welded, filled with a water blocking and hydrogen-absorbing compound, and sheathed. The umbilical supplier shall mention in its technical proposal how those features are going to be addressed in the cable design and manufacture.

6.2.4.3 Metal tube splices design shall be mechanically suitable and watertight. The metal tube sheath shall provide corrosion protection for the metal tube, mechanical protection during manufacturing and installation (offshore splicing)

6.2.4.4 All optical cables construction materials shall be selected considering environmental resistance for the specified umbilical system service life. Environmental conditions includes, at least, seawater, marine growth, UV radiation and hydrogen generated in electric cables and/or umbilical armoring and/or umbilical cathodic protection.

6.2.5 This umbilical shall not contain layers of wire from the steel tensile reinforcement, only aramid reinforcement half the thickness of the outer sheat layer;

6.2.6 Umbilical Outer Sheat material: Polyurethane or HDPE (High Density Polyethylene)

6.2.7 The construction materials to be used in the umbilical and its functional

components, hoses, electrical cables and optical fibers and terminations, must withstand all types of degradation arising from the exposure of these components in a marine environment or atmosphere. This includes, but is not limited to, the following agents:

- Sea water, microorganisms and marine life, considering the functional components and their terminations, when sea water penetrates through the interstices between umbilical components. It should also be considered that the materials that make up the functional components shall not suffer degradation due to the phenomenon of hydrolysis;
- Ultra-violet radiation, as the ends of the functional components will be exposed to sunlight during transport, storage and operation of the umbilical.
- High temperatures: resulting from sun exposure during the transport, storage and operation of the umbilical;
- Specified hydraulic fluid.

6.3 Termination Requirements

6.3.1 Both ends of hull side umbilical shall be supplied with pull-in heads designed to handle umbilical lines installation at dry dock.

6.3.2 FPU CONTRACTOR shall provide biparted hangoff structures to fix both ends of the umbilical lines at the upper & lower riser balconies.

6.3.3 The umbilical lines shall be terminated in plates at both sides.

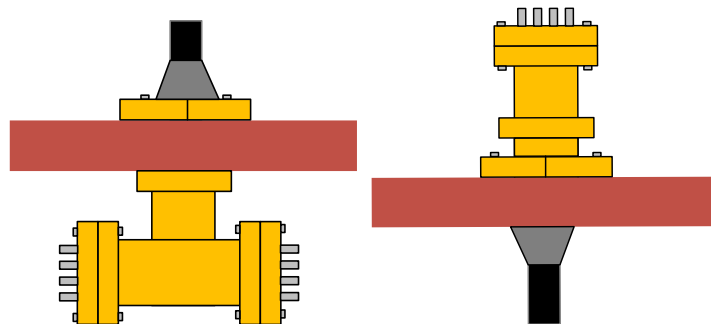


Figure 2 – Umbilical lower and upper terminations examples

6.3.4 In terminations design, FPU CONTRACTOR shall observe:

- 6.3.4.1 Thermoplastic hoses need a minimum 400mm of straight section after terminal connector.
- 6.3.4.2 Thermoplastic hoses need a minimum bend radius of 150 mm;
- 6.3.4.3 Cathodic protection to JIC, electrical and optical connectors (if applicable);
- 6.3.4.4 Steel tubing routing at lower and upper balcony
- 6.3.4.5 All pig tails (hydraulic, Optical and electrical) shall be housed internally of umbilical termination in order to protect from UV radiation and mechanical impacts.

6.3.5 The lower termination shall have:

6.3.5.1 Hydraulic Connector, to connect each pigtailed thermoplastic hoses in a steel tubing (for BSDL and TSUDL hydraulic actuation), shall observe the following requirements

- Type: JIC 37 9/16" 18 UNF
- Stainless Steel material (AISI 316L)
- Fast connectors in both sides.

6.3.5.2 Electrical dry-mate connectors (or penetrators) with the following requirements:

- 14 ways (minimum)
- Be housing made with stainless steel material (AISI 316L);
- Be qualified according to API-17F (shall present evidences);
- Have a design life of at least 25 years.

6.3.5.3 Optical flange penetrators with the minimum requirements:

- Be housing made with stainless steel material (AISI 316L);
- Be suitable for operation at temperature range of -20°C to +70°C;
- Be suitable for operation in the foreseen environment;
- Be qualified according to API-17F (shall present evidences);
- Have a design life of at least 25 years.

6.3.6 The quantity of JIC, Optical and Electrical connectors/penetrators of each riser shall observe the systems attended by it, where:

6.3.6.1 Each TSUDL shall demand:

One electrical connector (three pairs for RRMS and four pairs to TSUDL monitoring) - See Ref. [11] and [16].

- Four JIC connectors for hydraulic actuators.
- One Optical connector for RRMS system (See Ref. [16]).

6.3.6.2 Each BSDL shall demand (See Ref. [11]):

- One JIC Connector for hydraulic actuators.
- Two electrical pairs (one pair to end course detectors and one pair for corrosion monitoring). Up to three BSDL can share the same electrical connector at umbilical termination.

6.3.6.3 Each receptacle shall demand:

- Three electrical pairs for RRMS System. Up to two receptacle can share the same electrical connector at umbilical termination (See Ref. [16]).



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- One optical connector for RRMS system (See Ref. [16]).

6.3.7 FPU CONTRACTOR may use more electrical connectors (with less conductors) rather than split subsea cable after electrical connector.

6.3.8 A configuration example (block diagram) to one umbilical lower termination is presented in Figure 3

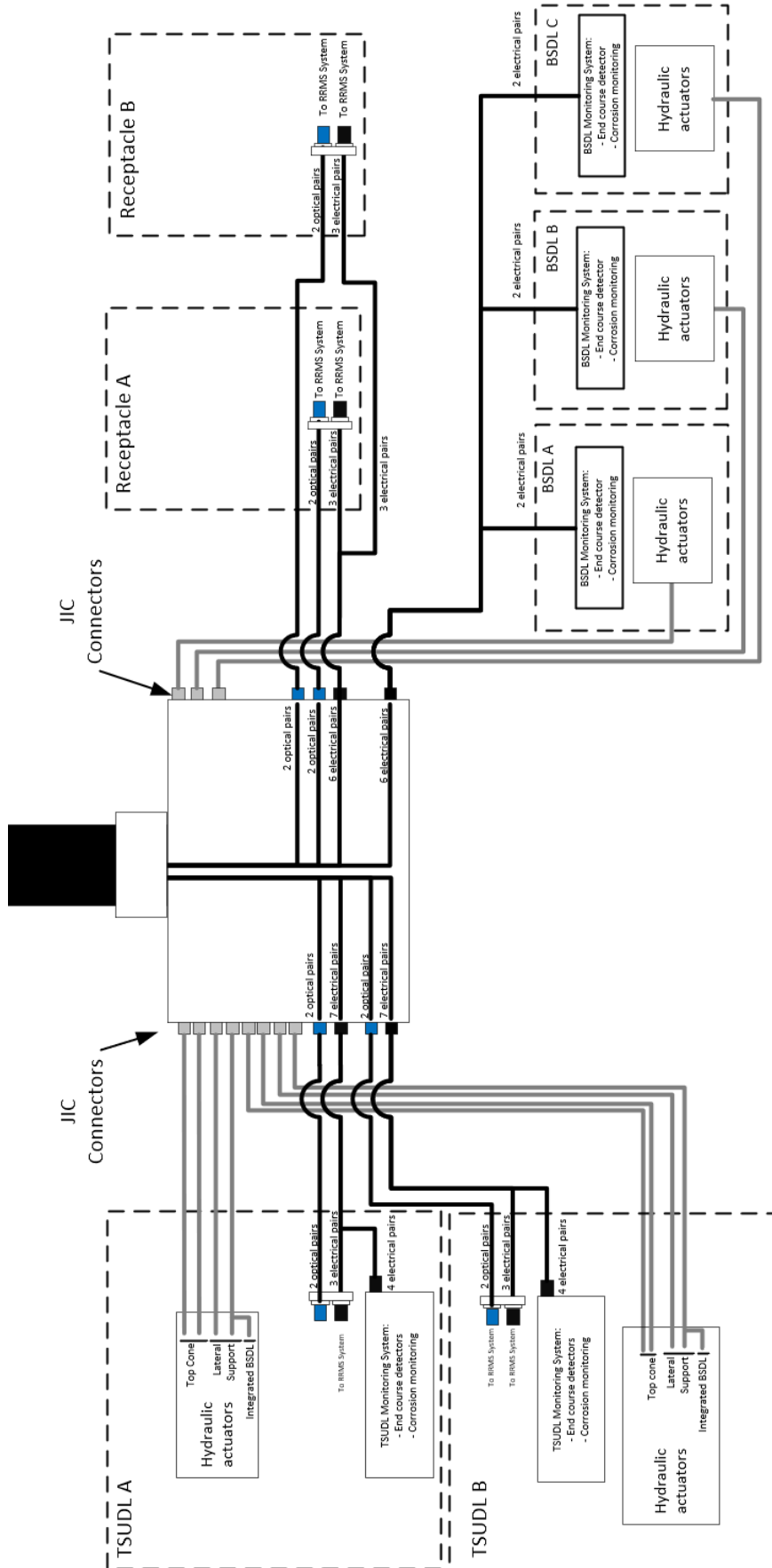


Figure 3 – Umbilical Lower Termination example

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6.3.9 The lower umbilical termination shall be fixed in lower riser balcony area, with terminal plate sided to bellow area.

6.3.10 The upper termination shall observe the following requirements:

6.3.10.1 FPU CONTRACTOR shall provide JIC SAE 37° tube fitting to connect each pigtails thermoplastic hoses in a steel tubing (for local panel interface);

6.3.10.2 FPU CONTRACTOR shall guarantee that any thermoplastic hose will not be exposed to solar UV light to avoid upper balcony pigtails degradation.

6.3.10.3 Electrical and optical cables shall interface to Riser Junction Box. FPU CONTRACTOR shall provide this connection (by spare length or jumpers).

6.3.10.4 Shall be fixed in upper riser balcony area with free access to terminal plate in order to allow future maintenance.

6.4 Umbilical installation

6.4.1 The umbilical body shall be fixed along the hull side of FPSO by welded fixing/clamp supports at double plates. The fixing/clamp supports quantity, mechanical details and welded locations shall be submitted to PETROBRAS approval. A fixation concept example is in Figure 4.

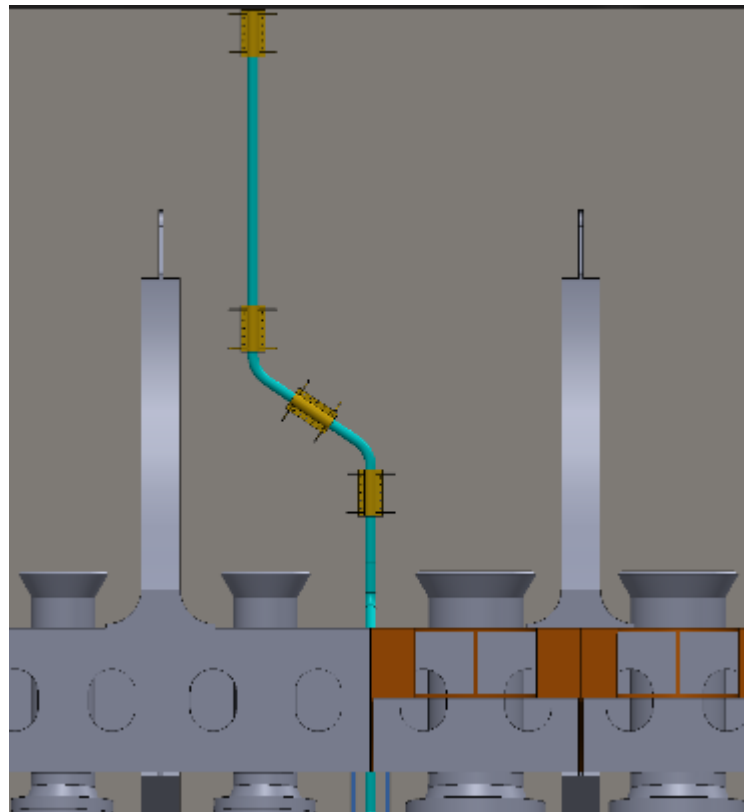


Figure 4 – Umbilical Fixation

6.4.2 The installation positions for umbilical lines for BSDL hydraulic actuation system shall not use any riser slot in balcony reserved to subsea riser arrangement. See example in Figure 5.

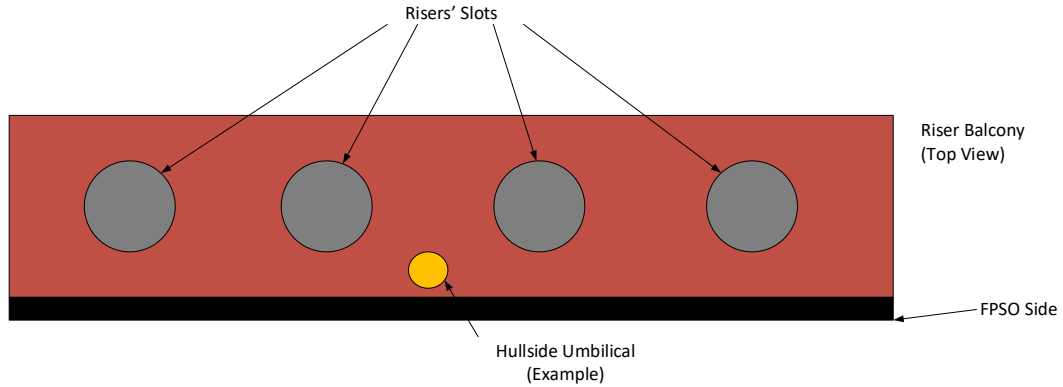


Figure 5 – Position of umbilical

6.4.3 All Steel tubing and jumpers used to connect to risers supports, shall be properly fixed and routed bellow lower riser balcony. The routing shall prioritize protected areas in order to avoid mechanical damage.

7 TESTS, INSTALLATION AND COMMISSIONING REQUIREMENTS

7.1.1 The requirements presented in this section shall be met regarding commissioning activities. Planning of installation and commissioning activities shall be developed and submitted for PETROBRAS approval.

7.1.2 Commissioning is understood, in this context, as the process of placing the system (or parts thereof related to a particular monitored structure) in a fully functional state, without any pending issues.

7.1.3 All equipment (Connectors and umbilical terminations) shall be tested onshore before deployment at FPSO.

7.1.4 Once, the hullside umbilical is a structure to support another systems, the commissioning of this structure shall be done in two steps:

7.1.4.1 Isolated: All circuits (hydraulic, electrical and optical) shall be tested individually.

7.1.4.2 Integrated: Functional tests with the systems evolved: BSDL, TSUDL and RRMS.

8 DOCUMENTATION REQUIREMENTS

8.1.1 Documentation shall be issued in compliance with agreed standards and formal processes.

8.1.2 The documentation shall include at least the following:

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- Block diagram;
- General arrangement hullside umbilical;
- General arrangement of umbilical termination (upper and lower)
- Typical details of all umbilical installation;
- Factory Acceptance Test Procedure/Reports;
- Acceptance and Performance test (TAP) Procedure/Reports;
- Operational procedure for hullside umbilical maintenance and operations;

8.1.3 During de executive design shall be issued to PETROBRAS approval a Technical Proposal of the hullside umbilical, including the following information:

- Datasheet of each component of the system;
- Detail of each material used in the system;
- Evidences of SUBCONTRACTOR experience (items 11.1.1 and 11.1.2);

9 SCOPE OF SUPPLY

9.1.1 FPU CONTRACTOR shall design, supply and install, hullside umbilicals with all accessories in quantity enough to attend all risers supports: BSDL, TSUDL and receptacles.

9.1.2 FPU CONTRACTOR shall supply all the hull side fixation supports welded at double plates required to protect the umbilical body.

10 SCOPE OF WORK**10.1 Executive Design**

10.1.1 FPU CONTRACTOR shall design and detail umbilical line system including accessories.

10.1.2 FPU CONTRACTOR shall design and detail the fixation structure.

10.1.3 FPU CONTRACTOR shall design and detail umbilical termination.

10.2 Factory acceptance tests

10.2.1 FPU CONTRACTOR shall perform factory tests to confirm acceptance for all umbilical lines and accessories.

10.3 Installation/Commissioning at dry dock

10.3.1 FPU CONTRACTOR shall install at dry dock all umbilical lines with installation accessories.

10.3.2 FPU CONTRACTOR shall install at dry dock all hydraulic tubings connecting all risers supports to umbilical lines.

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- 10.3.3** FPU CONTRACTOR shall install at dry dock all hydraulic tubings connecting Local Panels to umbilical lines
- 10.3.4** FPU CONTRACTOR shall fill and flush all hydraulic circuit with PUPS water-glycol based hydraulic control fluid with cleanliness class according to Norm ISO 4406 CLASS 17/15/12. (Equivalent to class 6 from the old Norm NAS1638 Cleanliness Requirements used in Hydraulic Systems) and ensure no air bubbles inside.
- 10.3.5** FPU CONTRACTOR shall perform commissioning of the complete system at dry dock.

11 SUBCONTRACTOR REQUIREMENTS

- 11.1.1** To design and supply the umbilical lines and accessories for the project, FPU CONTRACTOR shall chose umbilical manufacturer with experience (track record) with PETROBRAS.
- 11.1.2** During de executive design FPU CONTRACTOR shall submit to PETROBRAS approval a Technical Proposal of the hullside umbilical with all accessories.