
	TECHNICAL SPECIFICATION					I-ET-3000.00-5529-850-PEK-001					
	CLIENT	PETROBRAS						SHEET	1	of	17
	JOB	RIGID RISER SYSTEMS									
	AREA	-									
SUB	TITLE	RIGID RISER MONITORING SYSTEM (RRMS) – FPU SCOPE						 SUB/ES/EECE/ECE			
REVISION INDEX											
REV	DESCRIPTION AND/OR REVISED SHEETS										
.											
0	Original - This document is based on the previous technical specification for RHMS: I-ET-3000.00-5529-850-P6B-001=C										
A	Changes in power supply of RRMS system.										
	REV. 0	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H		
DATE	27/03/2020	22/04/2020									
DESIGN	AIRES / RENATO	RENATO									
EXECUTION	RENATO	RENATO									
CHECK	AIRES	AIRES									
APPROVAL	ALAN	ALAN									
THE INFORMATION CONTAINED IN THIS DOCUMENT IS PETROBRAS PROPERTY AND MAY NOT BE USED FOR PURPOSES OTHER THAN THOSE SPECIFICALLY INDICATED HEREIN.											
THIS FORM IS PART OF PETROBRAS N-0381 REV. L											



TECHNICAL SPECIFICATION	Nº I-ET-3000.00-5529-850-PEK-001	REV. 0
JOB	RIGID RISER SYSTEMS	SHEET 2 of 17
TITLE	RIGID RISER MONITORING SYSTEM (RRMS) – FPU SCOPE	

TABLE OF CONTENTS

1	SUBJECT	3
2	ABBREVIATION	4
3	REFERENCE DOCUMENTS, CODES AND STANDARDS	4
4	DEFINITIONS	5
5	TECHNICAL CHARACTERISTICS	5
5.1	DESIGN AND FABRICATION	5
5.2	QUALIFICATION	5
6	TECHNICAL REQUIREMENTS	6
6.1	SYSTEM OVERVIEW	6
6.2	GENERAL REQUIREMENTS	6
6.3	RRMS CABINETS	8
6.4	RISER DECK CABLING	9
6.5	FPU HULL CABLING AND CONNECTORS	10
7	SCOPE OF SUPPLY	15
8	INSTALLATION AND COMMISSIONING REQUIREMENTS	16
9	DOCUMENTATION REQUIREMENTS	16

1 SUBJECT

This document presents the Technical Specification of the FPU (floating production unit) scope of an integrity monitoring system applicable for rigid steel risers. This Technical Specification is applicable only for spread mooring FPU.

1.1 Riser Systems

This informative section presents an overview of the riser configurations covered by this monitoring system specification.

1.1.1 Steel Lazy Wave Riser (SLWR)

A Steel Lazy Wave Riser (SLWR) consists of a steel riser with an intermediary section lifted by buoyancy modules. An illustration is presented in Figure 1.

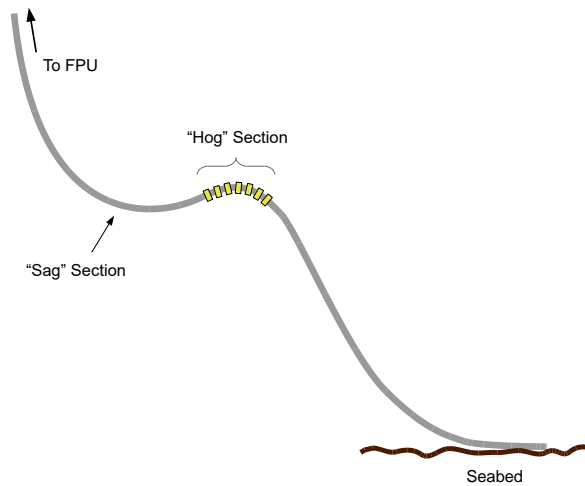


Figure 1 — SLWR illustration

1.1.2 Steel Catenary Riser (SCR)

A Steel Catenary Riser (SCR) is a steel riser that hangs from the FPU in a free single-catenary configuration. This concept is illustrated in Figure 2.

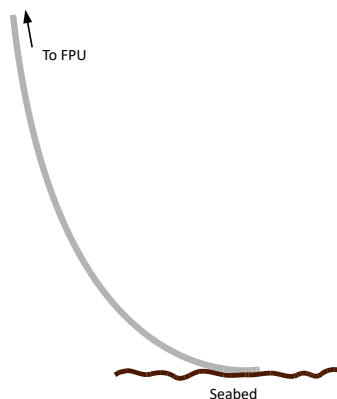


Figure 2 — SCR illustration

2 ABBREVIATION

AHRS	Attitude and Heading Reference System
FO	Fiber Optic
FPSO	Floating Production, Storage and Offloading
FPU	Floating Production Unit
GPS	Global Positioning System
IMU	Inertial Measurement Unit
IP	Ingress Protection
JB	Junction Box
PSU	Power Supply Unit
RDCS	Riser Data Collection System
RRMS	Rigid Riser Monitoring System
SCR	Steel Catenary Riser
SLWR	Steel Lazy Wave Riser
TSP	Twisted Shielded Pair
UPS	Uninterruptible Power Supply

3 REFERENCE DOCUMENTS, CODES AND STANDARDS

This section lists standards and external documents applicable to the design of the monitoring system.

API 17F	Standard for Subsea Production Control Systems
API 17Q	Recommended Practice on Subsea Equipment Qualification
ASME B16.5:2013	Pipe Flanges and Flanged Fittings
ASTM A320:2015	Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service
DNVGL-RP-B401:2017	Cathodic Protection Design
IEC 60079 (latest revision)	Series Explosive Atmosphere Standards
IEC 60092 (latest revision)	Electrical installations in ships - ALL PARTS
IEC 60502-1 (latest revision)	Power cables with extruded insulation and their accessories for rated voltages from 1 kV ($U_m = 1,2$ kV) up to 30 kV ($U_m = 36$ kV) – Part 1: Cables for rated voltages of 1 kV ($U_m = 1,2$ kV) and 3 kV ($U_m = 3,6$ kV);
IEC 60529 (latest revision)	Degrees of Protection Provided by Enclosures (IP Code)
IEC 61892-6	Mobile and fixed offshore units – Electrical installations – Part 6: Installation
ISO 13628-6:2006	Design and Operation of Subsea Production Systems – Subsea Production Systems
NMEA 0183 V 4.10	Standard for Interfacing Marine Electronics Devices

4 DEFINITIONS

RISER CONTRACTOR	The company contracted by PETROBRAS to design, supply and install the risers, including the monitoring system (focus of this technical specification)
FPU CONTRACTOR	The company contracted by PETROBRAS to construct the Floating Production Unit
DIVING TEAM	The party responsible for execution of diving-related tasks, to be defined during the bidding phase.
MAY	Is used when alternatives are equally acceptable
SHOULD	Is used when a provision is not mandatory, but is recommended as a good practice
SHALL	Is used when a provision is mandatory
WET-MATE [CONNECTOR]	Connector designed for plugging/mating in underwater environments
COVERAGE INTERVAL	Interval containing the set of true values of a measured quantity with a stated probability, based on the information available
COVERAGE PROBABILITY	Probability that the set of true values of a measured quantity is contained within a specified COVERAGE INTERVAL

5 TECHNICAL CHARACTERISTICS

5.1 DESIGN AND FABRICATION

- 5.1.1 All subsea equipment shall be designed in accordance with 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 riser.
- 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).
- 5.1.5 Electrical and communication analyses shall be performed, including simulations considering the parameters of specified cable types (for deck, hull and subsea cables).

5.2 QUALIFICATION

- 5.2.1 All subsea equipment shall be qualified in accordance with API 17Q or ISO 13628-6:2006.

6 TECHNICAL REQUIREMENTS

6.1 SYSTEM OVERVIEW

6.1.1 Figure 1 presents a general diagram of the riser monitoring system.

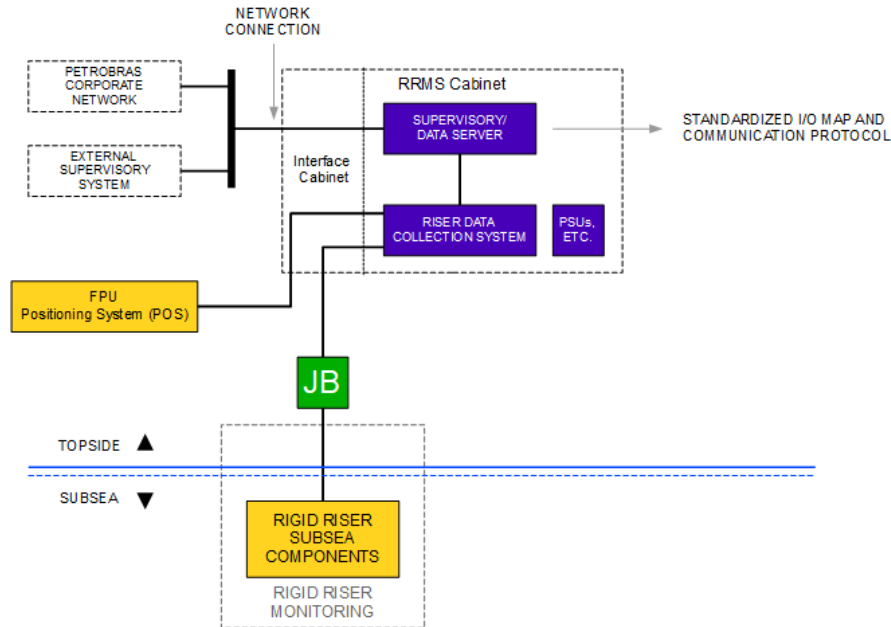


Figure 1 — General system diagram

6.1.2 The system is composed of a topside processing system which communicates with sensors and equipment installed on subsea riser structures and FPU Positioning System (POS).

6.2 GENERAL REQUIREMENTS

6.2.1 This section describes FPU provisions which are specific for monitored rigid risers (RRMS). In case PETROBRAS requests that provisions be made for future rigid risers at given locations, the scope presented in this section shall be executed accordingly.

6.2.2 Cabling shall be designed in accordance with international standards. In no occasion shall the design or installation of any item described herein infringe norms or standards in force at the FPU.

6.2.3 Connectors/terminations shall be properly protected from exposure before final assembly to junction boxes and other equipment.

6.2.4 All junction boxes/cabinets shall be properly identified with visible tags.

6.2.5 All cabling (at dry area) shall be properly identified with visible tags.

6.2.6 Individual conductors within a bundle (multi-cable) shall be properly identified on

both ends, through tags or color coding.

6.2.7 Cabling shall conform to the IEC 60502-1 standard.

6.2.8 The Figure 2 presents the general topology of the system.

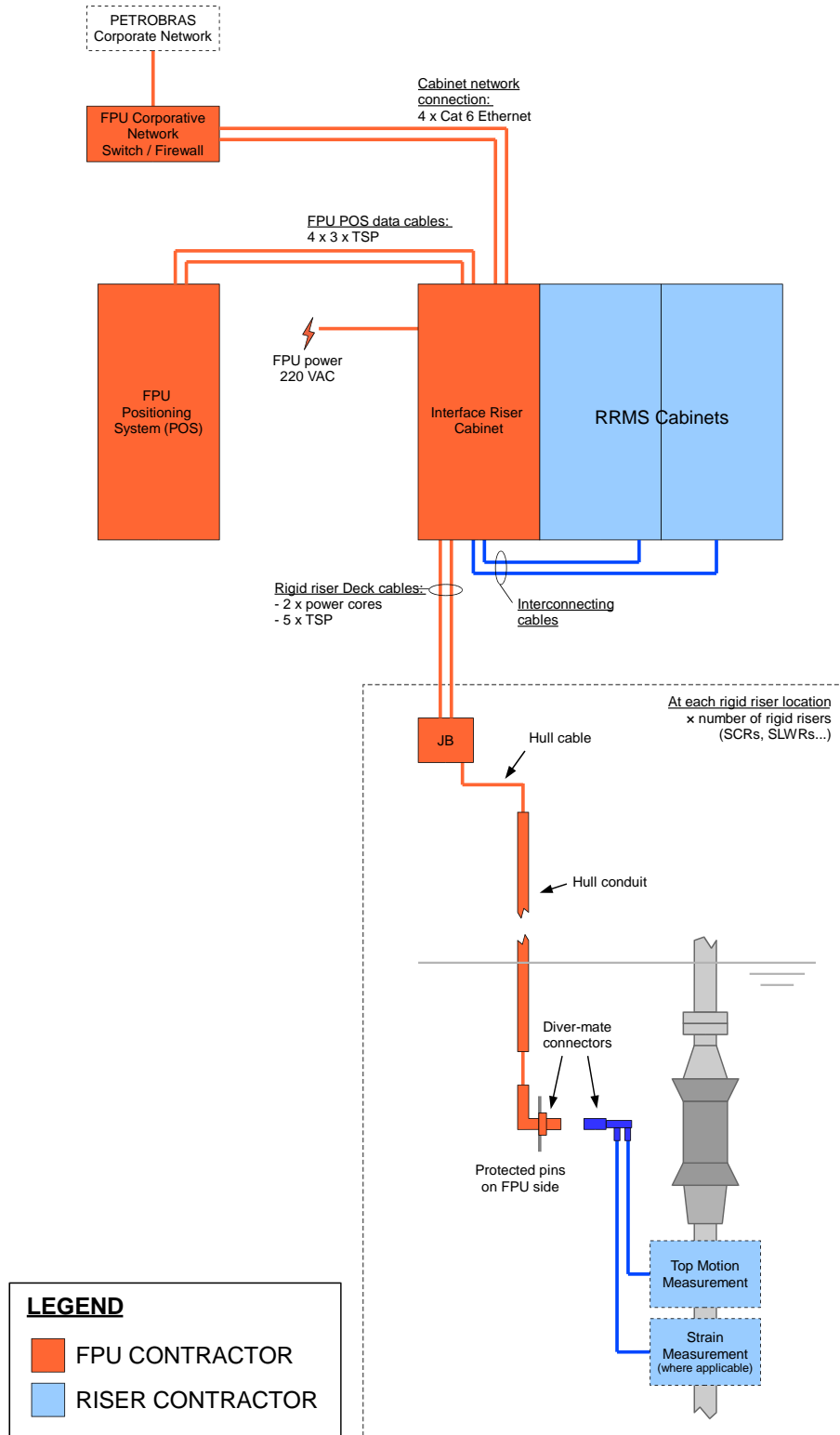



Figure 2 — General topology – RRMS System



6.3 RRMS CABINETS

- 6.3.1** FPU CONTRACTOR shall supply and install one cabinet (named as RRMS Interface Cabinet) in Electrical Module, where shall be terminated all cabling from Risers (Deck Cables), FPU Positioning system and PETROBRAS Corporative Network;
- 6.3.2** The Interface Cabinet shall have the minimum dimension of 800mm x 800mm x 2000mm. All cables shall be terminated in properly terminals (see Table 1), in order to provide interface to RRMS cabinets that will be installed and commissioned by RISER CONTRACTOR;
- 6.3.3** FPU CONTRACTOR shall provide power supply to RRMS system from FPU normal bus. FPU CONTRACTOR shall install two local UPS in RRMS Interface Cabinet in order to power supply each RRMS Cabinet. FPU CONTRACTOR shall consider consumption of 3000W and voltage of 220VAC 50/60Hz for each RRMS cabinet. The UPS shall feed each RRMS cabinet during 30 minutes at least, in case of feeding fail.
- 6.3.4** In case of solution proposed in item 6.3.3 is not possible, FPU CONTRACTOR shall present alternative solution for PETROBRAS approval.
- 6.3.5** FPU CONTRACTOR shall provide inside Interface Cabinet two surge protectors connected to FPU grounding system for each future RRMS Cabinets.
- 6.3.6** The supply of RRMS Cabinets and its internal equipment is scope of RISER CONTRACTOR. However, FPU CONTRACTOR shall provide the infrastructure to install onshore or offshore this equipment as described in this section. FPU CONTRACTOR shall provide a proper lifting/handling system and access of RRMS Cabinets at Electrical Module.
- 6.3.7** FPU CONTRACTOR shall provide space and foundation to install two cabinets in Electrical Module with the following dimensions 800mm X 800mm X 2000mm. General arrangement of these cabinets can be requested to PETROBRAS during the engineering design. The space designated to these cabinets shall be sided by RRMS Interface Cabinet.
- 6.3.8** FPU CONTRACTOR shall provide bottom cable access between Interface Cabinet and RRMS Cabinets. RISER CONTRACTOR shall supply/install this cabling.
- 6.3.9** FPU CONTRACTOR shall provide assistance to all activities to be performed by the RISER CONTRACTOR aboard the FPU, including crane operation, transportation of loads (cabinets, etc.), heavy mechanical installations (such as cabinets, etc.) and issuance of work permits when needed.
- 6.3.10** Interface Cabinet shall be connected to FPU Positioning System (POS) and PETROBRAS corporative network as detailed in table 1.

Cable Specification	No. of Runs	From/To	Termination	Intended Function
Shielded CAT-6 Ethernet cable	4	Interface Cabinet to FPU PETROBRAS network switch	Standard RJ-45 female patch panel inside Interface Cabinet.	PETROBRAS corporative network

	TECHNICAL SPECIFICATION		Nº I-ET-3000.00-5529-850-PEK-001	REV. 0
	JOB RIGID RISER SYSTEMS			SHEET 9 of 17
	TITLE RIGID RISER MONITORING SYSTEM (RRMS) – FPU SCOPE			

Signal – 4 TSPs 1.5 mm ²	4	Interface Cabinet to FPU Positioning System	SAK Terminals inside Interface Cabinet	FPU Positioning System (POS)
--	---	---	---	------------------------------------

Table 1 — Common topside cabling interfaces

6.3.11 FPU CONTRACTOR shall provide GPS & AHRS data from Positioning System (POS) in full & half-duplex RS-485 standards at the Interface Riser Cabinet. If necessary, FPU CONTRACTOR shall supply and install protocol data converters with PSUs at the Interface Riser Cabinet.

6.3.12 FPU CONTRACTOR shall provide GPS & AHRS data from Positioning System (POS). The POS system shall broadcast FPU position to the Interface Riser Cabinet by means of three (3) data connection loops (supplied in two sets, one for each future RRMS Cabinet):

- **GPS NMEA 0183 link:** GGA and ZDA messages.
- **AHRS TSS1 link:** FPU attitude in TSS1 protocol.
- **AHRS NMEA 0183 link:** HDT message.

6.4 RISER DECK CABLING

6.4.1 Riser deck cabling means the electrical cables between the Interface Cabinet and RRMS junction boxes.


6.4.2 FPU CONTRACTOR shall provide RRMS junction boxes in order to make the transition between Deck and Hull cabling. One JB can be used to connect one or more risers Hull Cabling.

6.4.3 Riser Junction Boxes shall be installed in places with easy access, in maximum high of 2 meters and where is dismiss the use of safety harness for high work.

6.4.4 Riser Junction Boxes shall be sealed against dust and powerful water jets (protection degree IP-66).

6.4.5 Riser Junction Boxes and cable glandes specification/installation shall be in accordance with its corresponding area classification.

6.4.6 For each monitored rigid riser, the following minimum cabling interfaces shall be available between Interface Cabinet and Riser Junction Box.

	TECHNICAL SPECIFICATION	Nº I-ET-3000.00-5529-850-PEK-001	REV. 0
	JOB	RIGID RISER SYSTEMS	
	TITLE	RIGID RISER MONITORING SYSTEM (RRMS) – FPU SCOPE	
		SHEET 10	of 17

Cable Specification	No. of Runs	From/To	Termination	Intended Function
Power – 2 cores 4 mm ² 0.6/1 kV rating	1	Interface Cabinet to junction with each subsea cable	Connected to corresponding subsea cable, on area end	Power for rigid riser monitoring equipment
Signal – 5 TSPs 1.5 mm ² 250 V rating	1	Interface Cabinet to junction with each subsea cable	Connected to corresponding subsea cable, on area end	Communications to rigid riser monitoring equipment

Table 2 — Topside cabling interfaces for rigid risers

- 6.4.7** Each deck cable meant for a rigid riser shall be connected, in a conductor-by-conductor basis, to the corresponding hull cable at a convenient junction box, as shown in Figure 3.
- 6.4.8** All corresponding shields belonging to each cable (deck vs. subsea) shall also be interconnected at the junction point.

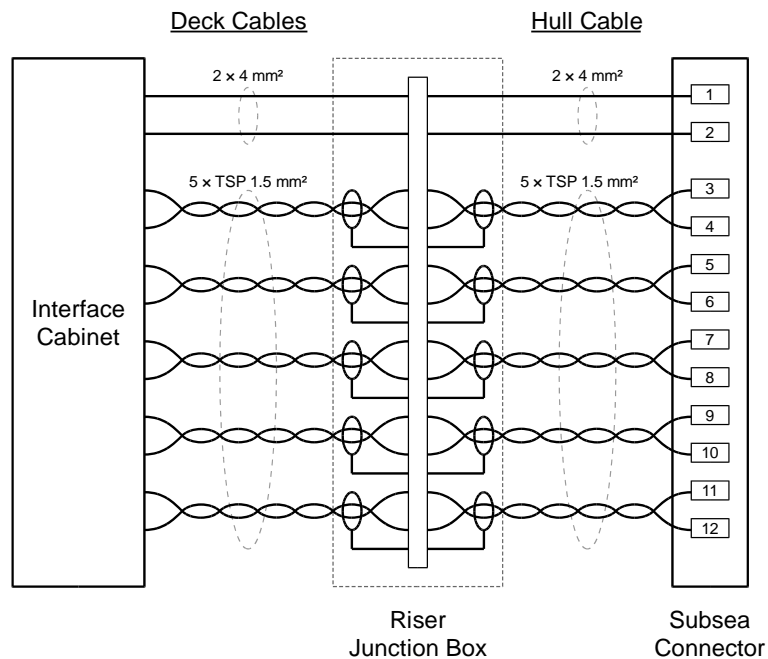


Figure 3 — Connection diagram for rigid riser cabling

6.5 FPU HULL CABLING AND CONNECTORS

- 6.5.1** By Hull Cabling means the cables between Riser Junction Boxes and Diver Mate connectors supplied and installed by FPU CONTRACTOR in Lower Riser Balcony.
- 6.5.2** The structure described in this section shall be implemented for each rigid riser foreseen in FPU.

6.5.3 A subsea-graded cable and wet mate connector shall be provided on the FPU hull for connecting monitoring units attached to each rigid riser. The connection scheme is illustrated in Figure 4.

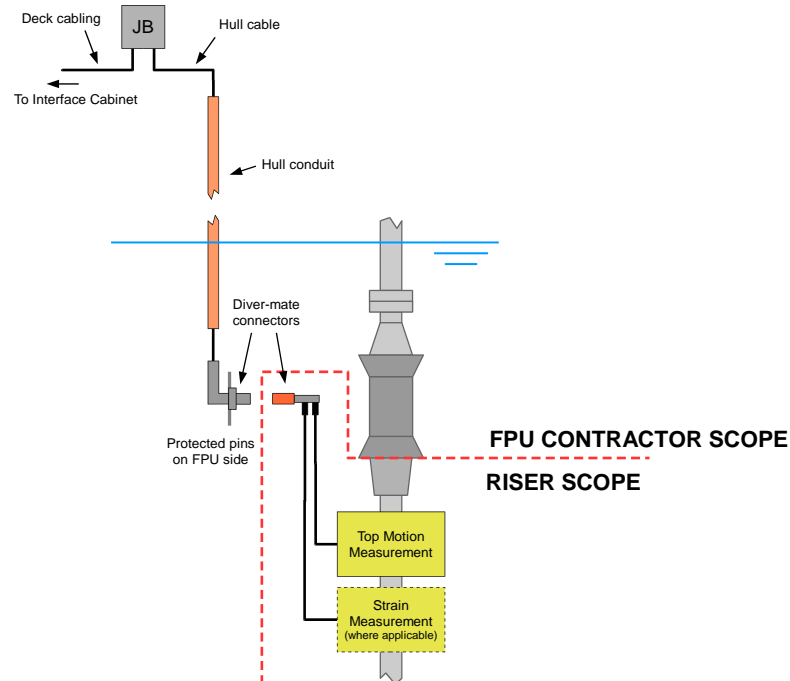


Figure 4 — Rigid riser connection scheme

- 6.5.4** One subsea hull cable shall be run to each rigid riser support location.
- 6.5.5** Each hull subsea cable shall be run individually through an appropriate closed conduit. The conduit shall be designed to provide mechanical protection to the cable throughout the FPU design life.
- 6.5.6** FPU CONTRACTOR shall design/supply/install the hull conduits from upper riser balcony to the lower elevation of the lower riser balcony.
- 6.5.7** FPU CONTRACTOR shall use flanged pipes to connect sections of the hull conduit.
- 6.5.8** Hull conduit shall be fixed at the hull-side and lower riser balcony by mechanical supports welded at double plates.
- 6.5.9** This conduit shall terminate as close as possible of wet-mate connector.
- 6.5.10** Conduit inner diameter and path shall be chosen to allow free passage of the cable during installation (without the risk of tearing or rupturing), respecting the minimum bending radius (MBR) and mechanical resistance of the cable.
- 6.5.11** Both ends of the cable shall be firmly held by centering elements at the exits of the conduit pipe (upper and lower balconies), in order to avoid damage to the cables due to friction against pipe borders. See next an example photo from a previous project.

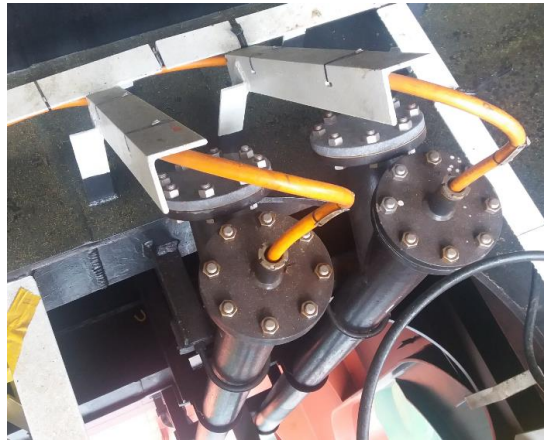


Figure 5 – Ending of conduit pipe

6.5.12 FPU CONTRACTOR shall analyze the inclusion of aluminum anodes to guarantee cathodic protection for the hull conduit and supports during transit from shipyard to final location. Once in operation, hull conduit and supports shall be protected by the FPU impressed current system.

6.5.13 Each hull-side subsea cable shall meet the following minimum specifications:

- 2 x 4 mm² cross-section power conductors, 0.6/1 kV rating
- 5 x TSPs of 1.5 mm² cross-section for communications, 250 V rating
- Enclosed in PBOF-type hose; other solutions may be proposed and subjected to PETROBRAS approval

6.5.14 The subsea end of the cable shall be terminated in a wet-mate connector with protected (non-exposed) electrical contacts, of a type suitable for proper termination of the subsea cable. The connector model shall be chosen during the construction phase in formal consultation with PETROBRAS.

6.5.15 The connector model shall conform to the following requirements: be diver-operated; be suitable for operation in the foreseen environment, with a maximum operating depth of at least 3000 m; be able to withstand at least 100 connection/disconnection cycles; have a design life of at least 25 years.

The models listed next are known to fulfill these requirements; other models that meet or exceed the required performance may be proposed and subjected to PETROBRAS approval:

- 12-way Tronic DigiTRON+ Diver Connector Plug
- 12-way ODI Nautilus Manual-Mate Receptacle
- 12-way Seacon CM 2000 Diver Mate Connector (non-exposed pins)

6.5.16 Each connector shall be fitted with a dummy connector for protection from the subsea environment until its corresponding jumper is connected. For cable integrity

testing purposes, the dummy shall internally connect each pair of pins with a resistor as specified in Table .

- 6.5.17 The body of each subsea connector shall be electrically connected to the FPU cathodic protection system.
- 6.5.18 Each Hull-subsea connector shall be fastened to an appropriate supporting plate welded/bolted to the FPU hull.
- 6.5.19 FPU CONTRACTOR shall provide a support to fasten the subsea cable from RISER CONTRACTOR, close to subsea wet mate connector, avoiding mechanical stress in cable and connector. Example is given in figure 5 and 6.

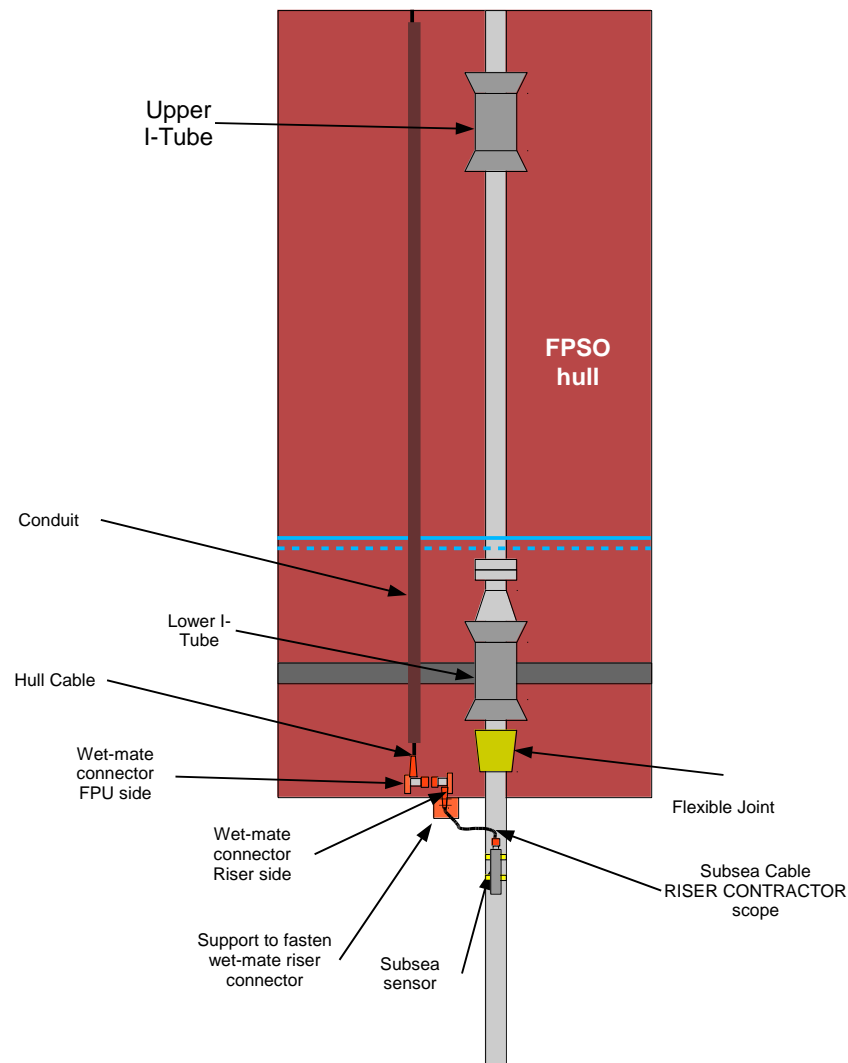


Figure 5 – Hull cable and wet-mate connector;

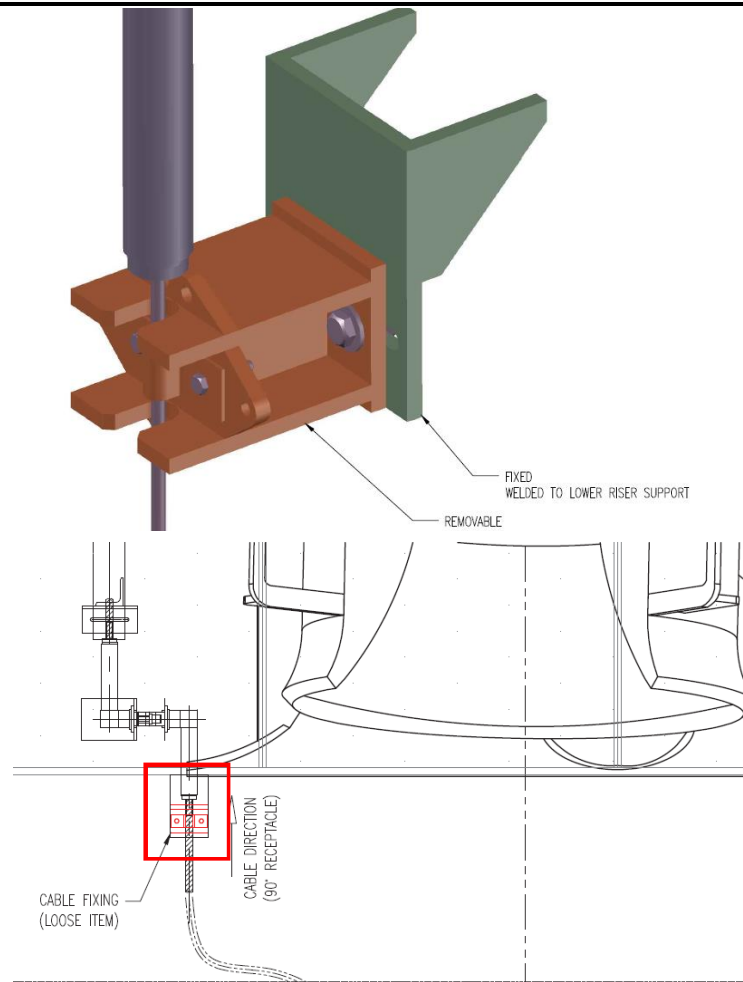


Figure 6 – Example of support to wet-mate connector from riser

6.5.20 In case of FPU CONTRACTOR cannot attend the Petrobras recommendation to connector's position at lower elevation of Lower Riser Balcony, an alternative solution shall be submitted for PETROBRAS approval. In this solution shall be observed:

- Wet mate connector (from FPU CONTRACTOR supply) support shall be properly fixed (welded/bolted) at this final position;
- Wet mate connector (from FPU CONTRACTOR supply) support final position shall be designed in a minimum limit of 10 meters water depth in order to make feasible for diving activities offshore;
- FPU CONTRACTOR shall design/supply proper protection/fixation for RISER CONTRACTOR subsea cabling/wet mate connector in order to guarantee its integrity for the full projects design life (i.e. avoid abrasion damage from lower balcony/hull structures).

6.5.21 FPU CONTRACTOR shall design this lower balcony infrastructure for proper diving accessibility for installation offshore.

6.5.22 Connections between subsea connector pins and hull cable conductors, for all connector types, shall be as specified in Table 3.

Connector Pin Number	Hull Cable Assignment	Dummy Resistance Value
1	Power cable	10 kΩ
2		
3	Signal cable TSP 1	15 kΩ
4		
5	Signal cable TSP 2	22 kΩ
6		
7	Signal cable TSP 3	33 kΩ
8		
9	Signal cable TSP 4	47 kΩ
10		
11	Signal cable TSP 5	56 kΩ
12		

Table 3 — Hull connector pin assignment for rigid riser slots

6.5.23 On the topside, each hull-side subsea cable shall be connected to the corresponding deck cables.

7 SCOPE OF SUPPLY

7.1.1 Supply, install and interconnect Interface Cabinet as described in § 6.3.1, § 6.3.2, § 6.3.3 and § 6.3.4.

7.1.2 Provide space and facilities (infrastructure) for the RRMS Cabinets, considering the requirements described in § 6.3.5, § 6.3.6, § 6.3.7 and § 6.3.8.

7.1.3 Provide transmission of FPU positioning system data to the riser monitoring system as specified in item § 6.3.10 and § 6.3.11, including cable connections to the FPU POS cabinet (Item 6.3.9).

7.1.4 Provide a network connection to the RRMS Cabinet, considering the requirements in § 6.3.9.

7.1.5 Provide assistance to all activities to be performed by the RISER CONTRACTOR aboard the FPU, including crane operation, transportation of loads (cabinets, junction boxes, etc.), heavy mechanical installations (such as of junction boxes, cabinets, etc.) and issuance of work permits when needed.

7.1.6 Supply and run all deck cabling, including termination, required in accordance with the requirements presented in § 6.4.

7.1.7 Design, Supply and install Riser Junction Boxes, providing connections between deck cables and hull/subsea cables for rigid risers, as described in § 6.4.

7.1.8 Supply and run all Hull Cables, including infrastructure, termination and wet-mate

connectors, required in accordance with the requirements presented in § 6.5, for each rigid riser position.

- 7.1.9** Provide documentation with all information needed for the design of the monitoring system, including but not limited to: cabling information, wiring diagrams, area classification, mechanical, electrical interfaces and diving accessibility report.

8 INSTALLATION AND COMMISSIONING REQUIREMENTS

- 8.1.1** 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.

- 8.1.2** 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.

- 8.1.3** All equipment shall be tested onshore before deployment at sea. Testing and interventions on equipment shall not be planned or performed during offshore deployment (on deck), save for emergency occasions, in which case approval shall be explicitly given by PETROBRAS.

- 8.1.4** The fully commissioning of RRMS system is in RISER CONTRACTOR scope, however, FPU CONTRACTOR, shall commission all infrastructure in its scope.

- 8.1.5** In terms of Acceptance Test, the FPU CONTRACTOR shall evidence, at least:

- Cabling and power supply in **RRMS Interface Cabinet**;
- Certification of all network cables related to RRMS System;
- Checking the receiving data from Positioning System;
- Fully testing of each riser cable (end-to-end, from RRMS cabinet to Dummy conector), using the loop in Dummy connector to verify the resistance of each pair;
- **UPS discharge test.**

- 8.1.6** FPU CONTRACTOR shall provide all infrastructure for RISER CONTRACTOR, in order to allow it to complete the fully commissioning of RRMS system, including access to installation, power supply and information related the system.

9 DOCUMENTATION REQUIREMENTS

- 9.1.1** Documentation shall be issued in compliance with agreed standards and formal processes.



9.1.2 The RRMS documentation shall include at least the following:

- One Line diagram;
- Interconnection Diagram;
- General arrangement of cabinet installation;
- General arrangement of all external installation, including cable routing and mechanical details;
- Typical detail of installation at each riser showing at least junction box, conduits, cable tray (if applicable) connector, and fixation;
- Diving accessibly report.

9.1.3 During de executive design shall be issued to PETROBRAS approval a Technical Proposal of the FPU CONTRACTOR scope, including Datasheets, manuals and certificates for all equipment or cable supplied by FPU CONTRACTOR.