PETROBRAS	**TECHNICAL SPECIFICATION**	Nº I-ET-3000.00-1510-800-PEK-002	
	CLIENT PETROBRAS		SHEET 1 of 34
	JOB		
	AREA –		
SUB	TITLE **UMBILICAL TERMINATION ASSEMBLY (UTA) CONTROL SYSTEM – FOR SUBMARINE EXPORT SYSTEMS**		***PUBLIC***
			SUB/ES/EECE/ECE

REVISION INDEX

REV.	DESCRIPTION AND/OR REVISED SHEETS
0	Original
A	Revisions marked in yellow.

	REV. 0	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE	28/01/2021	09/08/2023							
DESIGN	ECE	ECE							
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CHECK	Y5UJ	DVHV / B8WL							
APPROVAL	UR6A	CXF0							

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1 INTRODUCTION

This document presents the Technical Specification and functional requirements for the electro-hydraulic control system of UTA for the subsea import/export system of PETROBRAS production fields (to connect to a SESDV).

2 ABBREVIATIONS

AC - *Alternating Current* ;

ABNT - Brazilian Association of Technical Standards;

AFM - Material Supply Authorization;

ANP - National Agency of Petroleum, Natural Gas and Biofuels;

CLM - Material Release Communication;

DC - *Direct Current* ;

DIV – *Diver*;

SESDV - Subsea *Emergency Shutdown Valve*;

ET - Technical Specification;

FAT - *Factory Acceptance Test* ;

FLDF - *Flying Leads Deployment Frame* ;

HCR - *High Collapse Resistant;*

HS – *Hot Stab*;

IEC - *International Electrotechnical Commission*;

IEEE - *Institute of Electrical and Electronics Engineers*;

MTTF - *Mean Time to Failure* ;

MQC – *Multi-Port Quick Connection;*

NC – Not Connected pin;

PVT - *Performance Verification Test* ;

ROV - *Remotely Operated Vehicle*;

RM - Material Requisition;

RMS - *Root Mean Square*;

SESDV – Subsea Emergency Shut-Down Valve

UEH - Electro-Hydraulic Umbilical ;

UEP - Stationary Production Unit ;

UTA - *Umbilical Termination Assembly*;

UTH - *Umbilical Termination Head*;

SIT - *Site Integration Test;*

WC – *Wet mate Connector* .

3 REFERENCE DOCUMMENTS, CODES AND STANDARDS

This section lists standards and documents applicable to the design of the control and monitoring system:

3.1 International standards

[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] DNV-RP-H103 - Modelling and Analysis of Marine Operations;

[10] ISO 13628-6:2006 - ISO 13628-6:2006 (**Note:** The cleaning classification for hydraulic fluids of the old NAS 1638 standard (“Cleanliness Requirements used in Hydraulic Systems”) is cited in this specification as a reference best known by the Industry. The most current standard is SAE AS 4059 (“Cleanliness Classification for Hydraulic Fluids”)

3.2 PETROBRAS documents

[11] I-ET-3000.00-1500-823-PEK-001 Qualification of Wet-Mate Electrical Connectors and Accessories

[12] I-ET-3000.00-1510-854-PEK-001- MONITORING SYSTEM FOR SUBSEA EMERGENCY SHUT-DOWN VALVE (SESDV)

[13] DE-3500.00-1514-273-PPC-101 - Dual Hot Stab (PETROBRAS Standard)

[14] PETROBRAS N-858 Construção, Montagem e Condicionamento de Instrumentação

[15] ET-3000.00-1500-600-PEK-006 - REQUISITOS GERAIS DE EQUIPAMENTOS SUBMARINOS.

[16] PETROBRAS N-1710 – Coding of Technical Engineering Documents

[17] PETROBRAS N-0381 – Engineering Technical Documents Templates

4 DEFINITIONS

UTA CONTRACTOR	The company contracted by PETROBRAS to design, construct and supply the UTA and its accessories (e.g., CONTROL SYSTEM)
UMBILICAL CONTRACTOR	The company contracted by PETROBRAS to design, construct, supply and install the umbilical line and its accessories.
SESDV CONTRACTOR	The company contracted by PETROBRAS to design, construct, supply and install the SESDV and its accessories.
FPU CONTRACTOR	The company contracted by PETROBRAS to design, construct and supply the FPU topside infrastructure of SESDV SYSTEM
SUPPLIER	Company hired by UTA CONTRACTOR, to supply components from UTA CONTROL SYSTEM.
MAY	It is used when alternatives are equally acceptable
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
AVAILABILITY	Probability that the system will remain operating under the conditions specified in the project during its useful life.
EQUIPMENT	Set of components and parts composing an architecture to meet the requirements of this ET.
RECOMMENDED PRACTICE	Best Practice established in Technical Standard, but which admits the possibility of a more adequate alternative to the specific application.
TECHNICAL PROPOSAL	Set of technical premises that the UTA CONTRACTOR undertakes to follow in the design of the Equipment.
SYSTEM	Set of elementary systems, integrated within the premises and operational availability established in the RM to which this ET refers.
UTH	Sub-module of the UTA, in which all the components residing in the UTA of the CONTROL SYSTEM are assembled, including the ELECTRIC SYSTEM.
MALE CONNECTOR	Electrical wet mate connector solution with the electrical pins non-exposed to sea water.
FEMALE CONNECTOR	Electrical wet mate connector solution with the electrical pins exposed to sea water.

5 TECHNICAL CARACTERISTICS

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 CONTROL SYSTEM.

5.1.3 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 UTA CONTRACTOR shall consider SUPPLIERS with experience in subsea electro-hydraulic control system.

6 GENERAL TECHNICAL REQUIREMENTS

6.1 System overview

6.1.1 The CONTROL SYSTEM shall be compatible with the following environmental conditions:

6.1.1.1 Operating water depth: up to 2500 m;

6.1.1.2 Maximum storage temperature: 50ºC;

6.1.1.3 Submarine average temperature: 4ºC;

6.1.1.4 Maximum environmental temperature during tests: 45ºC;

6.1.1.5 Maximum relative air humidity: 85%;

6.1.1.6 CONTROL SYSTEM design life: 30 years.

6.1.2 UTA CONTRACTOR shall previously identify, in the phase of submission of the TECHNICAL PROPOSAL, all subsea equipment that needs maintenance during the lifetime of the CONTROL SYSTEM's operation, as well as presenting a list of recommended spare parts in the RM document. If it is not listed in the RM, the amount of spare parts in the present document shall be considered.

6.1.3 UTA CONTRACTOR shall design and build the UTA structure according to [15].

6.1.4 UTA shall include in the ROV Pannels from UTA and FLDF a subsea QR Code as described in [15].

6.1.5 All components from CONTROL SYSTEM (except FLDF) shall be protected by the cathodic protection from UTA [7]. If a component could not be protected, the equipment shall be made of a corrosion resistant material and submitted for PETROBRAS technical approval.

6.1.6 All equipment of the CONTROL SYSTEM shall be protected against crevice corrosion.

6.1.7 All subsea components from CONTROL SYSTEM shall be designed, manufactured, and tested according to ISO13628-6, API-6A, API-17D and API17F.

6.1.8 UTA CONTRACTOR shall present a reliability study based on standard MIL-STD-217F for the CONTROL SYSTEM components. If any critical components should be

found, technical solutions shall be pointed out to satisfy the equipment's operational design life.

6.1.9 All recoverable subsea components shall be able to withstand the inherent impacts from subsea installation and recovery operations. SUPPLIER shall present in the TECHNICAL PROPOSAL the parameters of maximum acceleration in all axes and allowable vibrations of each subsea equipment to be installed and/or recovered.

6.1.10 The design of the CONTROL SYSTEM shall ensure that its components are prepared to resist efforts during subsea offshore installations and recovery of UTA structure or flying lead jumpers set.

6.1.11 CONTROL SYSTEM project, including the UTA mechanical structure, shall be compatible with a subsea layout according to Figure 1.

6.1.12 The monitoring and hydraulic actuation systems can follow two arrangement options:

- One umbilical connects FPU to just one SESDV (Option 1 – Figure 1).
- One umbilical connects FPU to more than one SESDV, through a SDU (Option 2 - Figure 1).

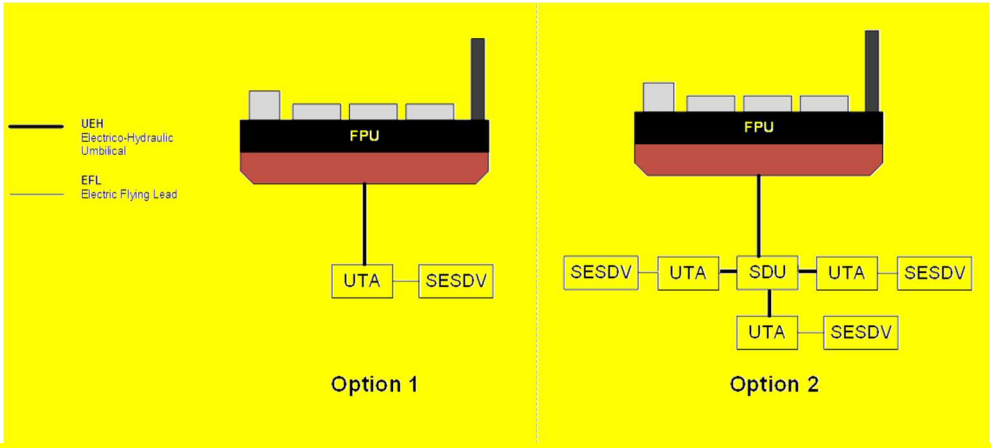

Figure 1 – General schematic of the subsea layout with SESDV Monitoring System (two options)

6.1.13 The minimum length of each flying lead (EFL and HFL) of the flying lead jumpers set shall be 50 meters long.

6.1.14 The maximum distance between UTA and SESDV structures shall be 30 meters.

6.1.15 UTA CONTRACTOR and SESDV CONTRACTOR shall both submit a ROV accessibility report study for interconnection between UTA and SESDV to demonstrate compliance with such premises.

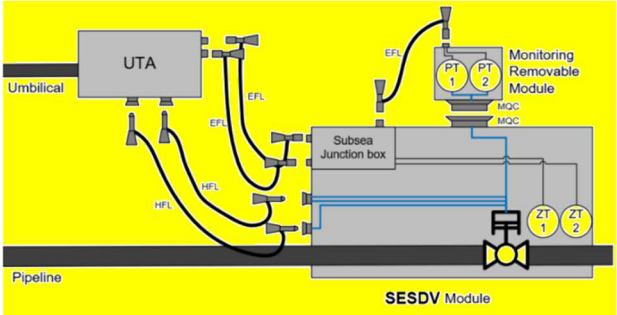

Figure 2 – SESDV MONITORING SYSTEM subsea general schematic

6.2 Electrical components requirements

6.2.1 The requirements from Section 6.2 (and its sub-items) shall be applicable to all electrical components from CONTROL SYSTEM, including the UTA's resident ELECTRICAL SYSTEM, the EFLs set and the Flying Leads Deployment Frame.

6.2.2 The following requirements are valid for all electrical components of the CONTROL SYSTEM:

6.2.3 Nominal voltage (as defined in standard IEC 60502-1): 0.6 / 1 (1.2) kV;

6.2.4 Rated current: 10A RMS AC.

6.2.5 All PBOF hoses used in electrical distribution from CONTROL SYSTEM shall be provided terminated with connector assembly JIC 37° male ¾" - 16UNF (SIZE 8) for electrical connectors.

6.2.6 All electrical connectors shall be supplied with JIC 37º male ¾" - 16UNF (SIZE 8) for interconnection of PBOF hoses.

6.2.7 The electrical distribution shall be made with ½" hoses, filled with silicone oil.

6.2.8 The electrical conductors shall be arranged with twisted shielded pairs.

6.2.9 PBOF hoses shall be supplied with internal pressure as specified by the manufacturer. PBOF hoses shall be qualified for projects subsea application. The results of the qualification tests shall be submitted for PETROBRAS approval.

6.2.10 Bend stiffeners shall be provided at the interface between the PBOF hoses with the wet mate connectors or the subsea junction box. These bend stiffeners shall ensure that the PBOF hose shall not exceed the minimum radius of curvature and minimize the possibility of crevice corrosion.

6.2.11 During the project detailing phase, CONTRACTOR shall present to PETROBRAS evaluation and approval the angle of the orientation keys of all the ROV-operable electrical connectors of the CONTROL SYSTEM.

6.2.12 The electrical wet mate connectors (ROV-mate & diver-mate) shall have the following characteristics:

6.2.12.1 It shall be able to remain firm after coupling with another connector;

6.2.12.2 It shall be able to be connected and disconnected in sea water at the required depth;

6.2.12.3 It shall have electrical contacts protected from sea water during the coupling. The contacts shall be designed in a controlled environmental compartment, pressure compensated and filled with oil or dielectric gel during mating and demating;

6.2.12.4 It shall have a double barrier against the ingress of sea water to the contacts, both for the part of the connection, and for the cable-connector interface at its rear;

6.2.12.5 It shall be able to maintain its mechanical and electrical integrity after 100 (one hundred) operations (mate/demate);

6.2.12.6 It shall have a reduced size body, allowing easy handling by the ROV manipulator;

6.2.12.7 It shall have an insulation resistance (after 100 operations) greater than 1 GΩ @ 500 VDC @ environmental temperature;

6.2.12.8 It shall allow the MALE CONNECTOR (model with non-exposed pins) to be kept energized even when disconnected.

6.2.13 Each electrical connector shall have a respective complete protective dummy connector to prevent the pins (MALE and FEMALE) from being exposed to sea water.

6.2.14 All subsea electrical ROV connectors shall be suitable for single ROV operation.

6.2.15 The subsea junction box inside UTA shall be made of corrosion resistant material and shall also be equipped with a double barrier against the penetration of sea water.

6.2.16 All types of subsea electrical connectors of the CONTROL SYSTEM shall be subjected to PVT-type tests, including connection cycling and disconnection in a hyperbaric chamber, according to test procedures approved by PETROBRAS. The samples used in these tests shall be chosen randomly from those manufactured for the CONTROL SYSTEM and cannot be reused as part of the Submarine Equipment after the tests.

6.2.17 All subsea electrical hoses, including flying leads, shall have at least two barriers against seawater penetration in electrical contacts.

6.2.18 The flying leads shall be of the type where the electrical wires are wrapped inside a hose filled with dielectric oil as a barrier for pressure compensation (PBOF).

6.2.19 The routing of all electrical hoses shall be submitted to PETROBRAS in the project detailing phase.

6.2.20 All electrical components that are subject to fungal attacks and humidity shall be tropicalized to inhibit these issues.

6.2.21 UTA CONTRACTOR shall use EFLs with electrical connectors from the same SUPPLIER model, except in cases indicated at project's RM. During UTA detailing design phase, UTA CONTRACTOR shall make a formal consultation to PETROBRAS for the definition of ROV CONNECTOR SESDV MODEL before placement of the AFM.

6.3 Hydraulic components requirements

6.3.1 The requirements of Section 6.3 (and its sub-items) are applicable to all hydraulic components of the CONTROL SYSTEM, which covers the UTA resident HYDRAULIC SYSTEM, the JUMPERS ASSEMBLY HFLs and the FLDF.

Figure 3 – Hot-stab (PETROBRAS standard)

6.3.2 Working pressure of the hydraulic components of the control system: 5.000 psi.

6.3.3 Internal diameter of the hydraulic control lines of the CONTROL SYSTEM: 1/2".

6.3.4 The hydraulic components of the control system (including chemical injection circuit) shall comply with the cleaning class standard SAE AS4059: 6B to 6F classes.

6.3.5 The CONTROL SYSTEM shall be compatible with the following hydraulic control fluids standardized by PETROBRAS: *MacDermid HW443*, *MacDermid HW525P* and *Castrol Transaqua DW*.

6.3.6 After placement of the AFM, the UTA CONTRACTOR shall provide the compatibility analysis showing that hydraulic control fluid adopted in the project is compatible with all materials used in the CONTROL SYSTEM that will be in contact with such control fluid.

6.3.7 All HYDRAULIC SYSTEM piping shall be stainless steel and welded.

6.3.8 For the delivery of the equipment to PETROBRAS, all hydraulic control circuits of the CONTROL SYSTEM shall be filled with the control fluid with corrosion protection in the vapor phase, standardized by the COMPANY.

6.3.9 UTA CONTRACTOR shall fill and flush all hydraulic circuit with HPU 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.

6.3.10 The hydraulic fluid shall be defined by PETROBRAS by a formal consultation during detailing phase based on 6.3.5. The hydraulic fluid shall be the same from SESDV, UTA and topside HPU.

6.3.11 Thermoplastic hoses used in HFLs shall be designed and shall have the respective operational procedures developed by the SUPPLIER in such a way as to ensure the integrity of its components during its underwater installation, including to ensure that they do not collapse. The use of HCR-type thermoplastic hoses shall not be permitted.

7 CONTROL SYSTEM COMPONENTS

7.1 Electrical system

7.1.1 ELECTRICAL SYSTEM shall comprise the supply from UTA internal electrical components for the UEH with 4 pairs except in cases indicated at project's RM. All ELECTRICAL SYSTEM (except parking places) shall be supplied in dedicated transportation "IP-65" boxes for the offshore installation.

7.1.2 The default case, all channels shall be terminated in the electrical ROV wet mate bulkhead connectors mounted at ROV panel from UTA to interface with the EFLs JUMPER SET.

7.1.3 The ROV wet mate connectors shall be a non-exposed pins model, MALE CONNECTOR, with 7-ways electrical connector compatible with the EFLs of the JUMPERS SET.

7.1.4 The pairs of UTH electrical cables shall be terminated: pair ID-1 (Connector 1: pins #1 and #2), pair ID-2 (Connector 1: pins #3 and #4) and pair ID-3 (Connector 2: pins #1 and #2) and pair ID-4 (Connector 2: pins #3 and #4) of the electrical connectors of the ROV panel (see Figure 4)

7.1.5 The subsea cables to connect the subsea junction box shall be PBOF hoses with JIC8 interface for mounting with the FEMALE diver connectors supplied from UMBILICAL CONTRACTOR.

7.1.6 UMBILICAL CONTRACTOR shall be responsible for the supply of diver wet mate connectors with male JIC-8 interface (including all mounting accessories) and UTA CONTRACTOR shall be responsible for the PBOF hoses with electrical cables terminated in a female JIC-8 interface (see Figure 4).

7.1.7 UTA CONTRACTOR shall supply the required silicon oil for this cable mounting. These subsea cable mounting shall be executed by UMBILICAL CONTRACTOR and/or UTA CONTRACTOR.

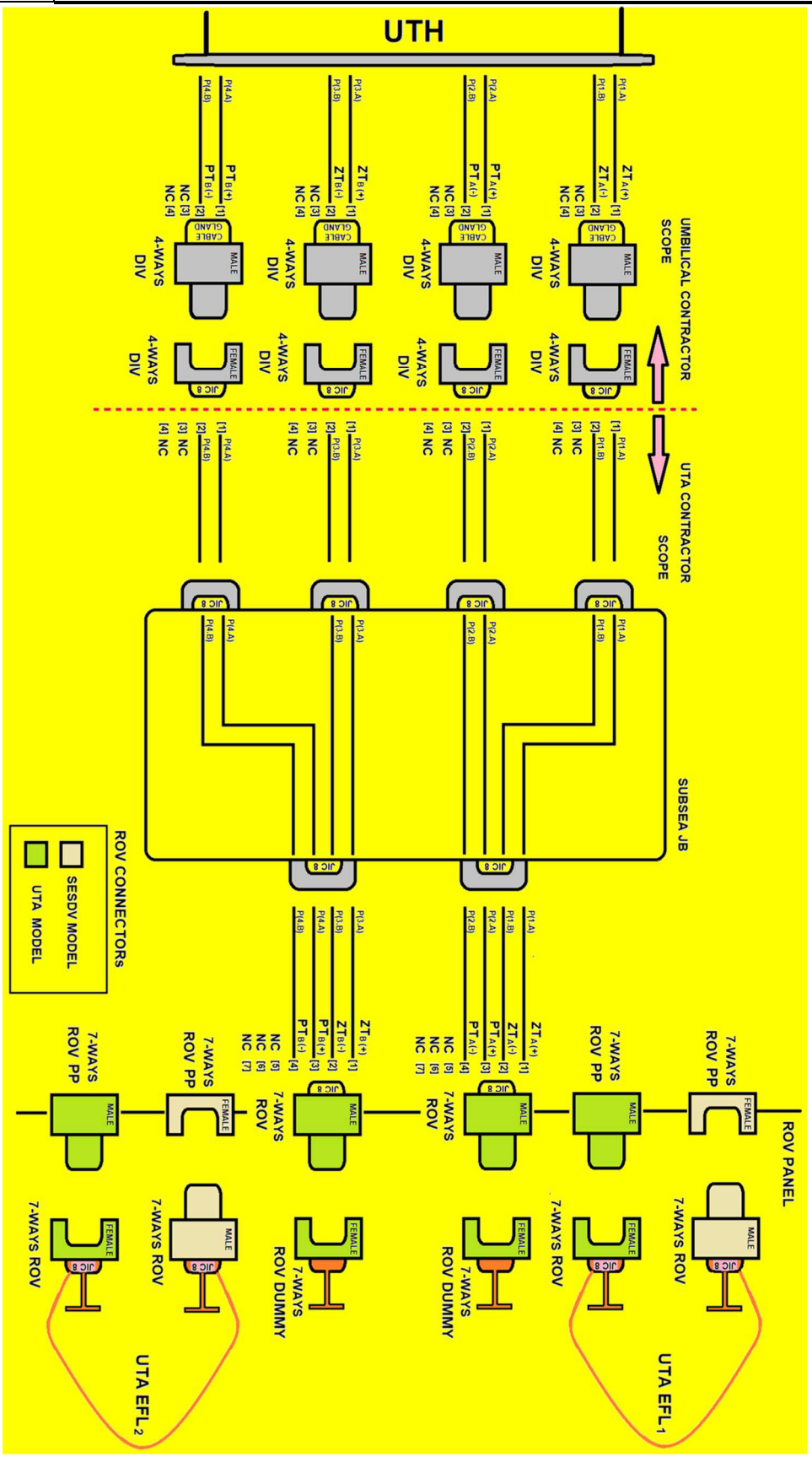

Figure 4 – ELECTRICAL SYSTEM wiring diagram from standard export UTA

7.1.8 If UEH supplied with only 3 pairs indicated in project's RM, UTA CONTRACTOR shall supply a subsea junction in the electrical arrangement as indicated in Figure 5.

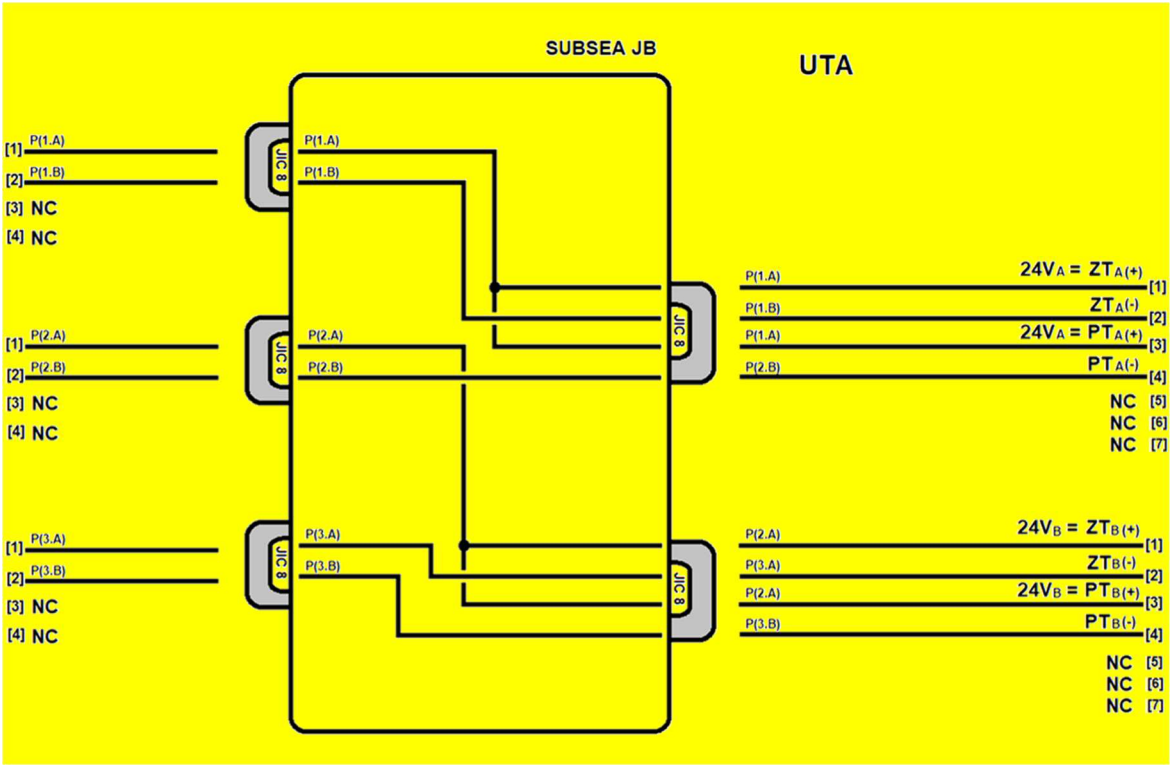

Figure 5 – Subsea junction box wiring diagram from UEH with 3 pairs

7.1.9 UTA CONTRACTOR shall provide 2 (two) protective ROV dummy connectors (FEMALE – UTA MODEL), operated by ROV to protect wet mate bulkhead connectors and/or EFL connector to be mounted in the ROV panel for offshore operation. Both shall be looped, i.e., have the pairs of pins short circuited, to support the umbilical line integrity monitoring during pipelay installation.

7.1.10 UTA CONTRACTOR shall provide 4 (four) connectors parking places (2 FEMALE – SESDV MODEL and 2 MALE– UTA MODEL), mounted on ROV panel compatible with the EFL JUMPER SET terminations.

7.1.11 All the electrical connectors (including parking places) shall be identified in the ROV panel by TAGs, for viewing by ROV. The identification shall adopt abbreviations that shall be defined by PETROBRAS during the detailing phase of the project.

7.1.12 UTA CONTRACTOR shall provide 2 (two) test connectors kit for ROV wet mate connectors (SESDV MODEL and UTA MODEL) for supporting UTA ELECTRICAL SYSTEM mounting/testing.

7.1.13 The electrical crossover (diver wet mate connectors as indicated in Figure 3) that interfaces with umbilical line is not scope of supply of the UTA CONTRACTOR.

7.1.14 UTA CONTRACTOR shall request to PETROBRAS, in the project's detailing phase, the models of SESDV ROV wet mate connector models with which SESDV ELECTRICAL SYSTEM and the UTA ELECTRICAL SYSTEM shall be compatible. See the SESDV & UTA ELECTRICAL SYSTEM interface schematic drawing in Figure 6.

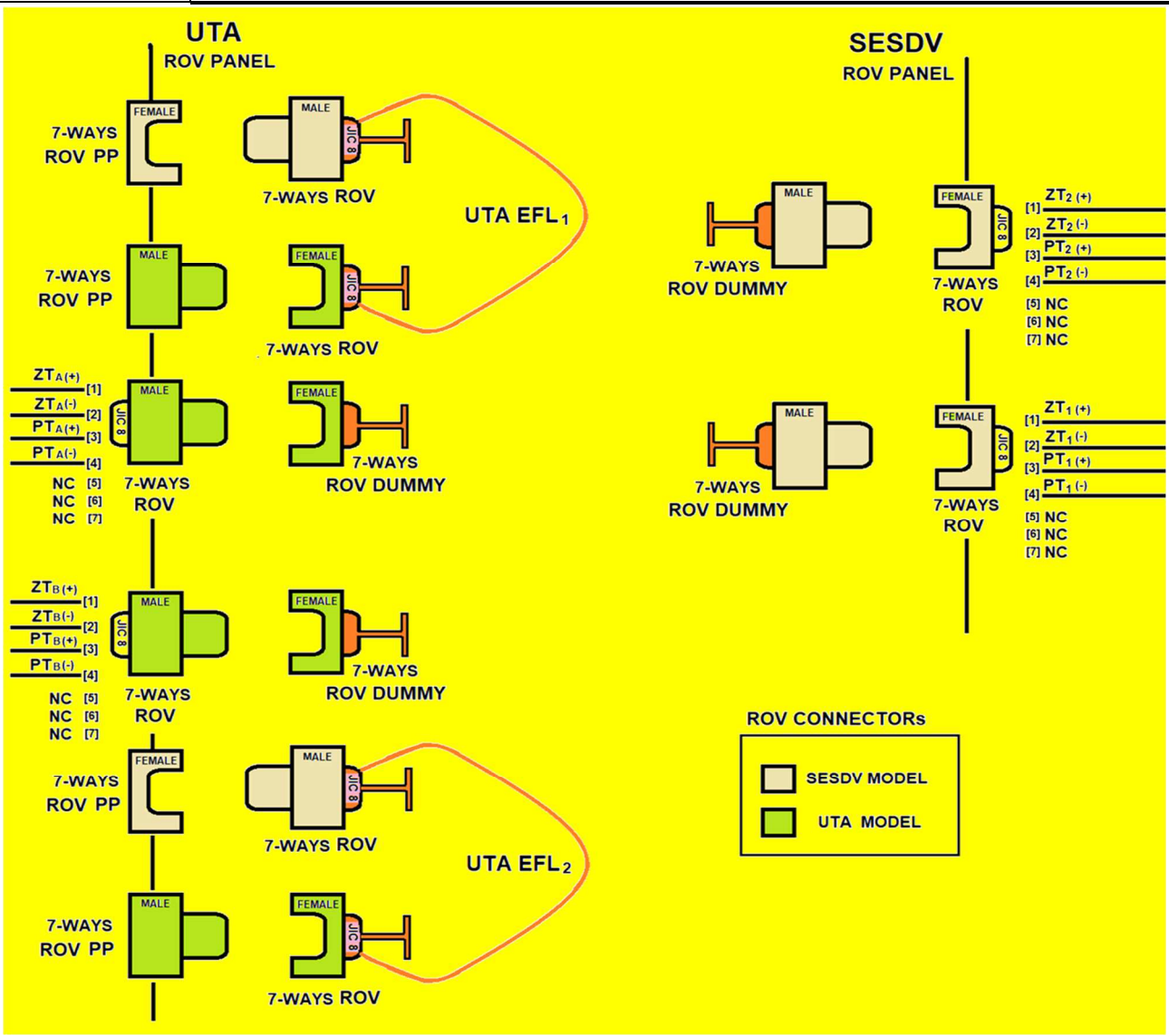

Figure 6 – SESDV & UTA ELECTRICAL SYSTEM interface schematic drawing

7.1.15 The installation of the electrical bulkhead connectors in ROV panel shall be in accordance with the dimensions shown in Figure 7.

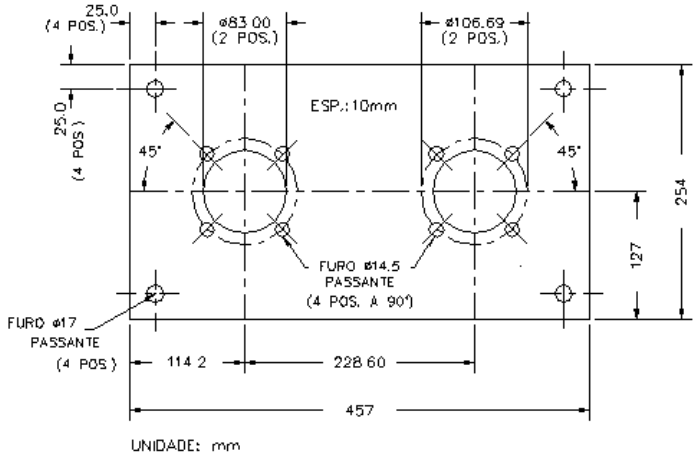

Figure 7 – Standardization of electrical connector housing for ROV panel

7.2 Hydraulic system

7.2.1 HYDRAULIC SYSTEM shall carry out the distribution of the hydraulic control lines according to the arrangement to Figure 8.

7.2.2 For the distribution of hydraulic control, HYDRAULIC SYSTEM shall consist of 4 (four) main lines and 1(one) spare line, without communication between each other inside the UTA.

7.2.3 All 5 (five) shall be intended for the control of SESDV and shall be steel tubings made of stainless steel S31600 with requirements established in ISO 15156-3:2009. The steel tubing shall have internal diameter of ½ inches.

7.2.4 The 4 (four) main hydraulic control lines of the SESDV are arranged in 2 (two) terminations of the type “dual hot stab receptacle”, according to the following distribution: 2 (two) lines in the first termination (HS1) and 2 (two) lines in the second termination (HS2) (see Figure 5).

7.2.5 The 1 (one) spare hydraulic control line of the SESDV is arranged in the termination of the type “dual hot stab receptacle” (HSS) with the channels A & B interconnected (see Figure 5).

7.2.6 The other terminations of the 5 (five) hydraulic control lines shall be placed in a hydraulic plate with hydraulic male JIC SAE 37° SIZE-8 tube fitting to connect offshore with the hydraulic pigtails from UTH (see Figure 5). UMBILICAL CONTRACTOR shall supply hydraulic quick couplers connectors for all 5 (five) hydraulic pigtails from UTH.

7.2.7 At UTA Hydraulic plate all JIC connections shall be tagged to support hydraulic channels identification.

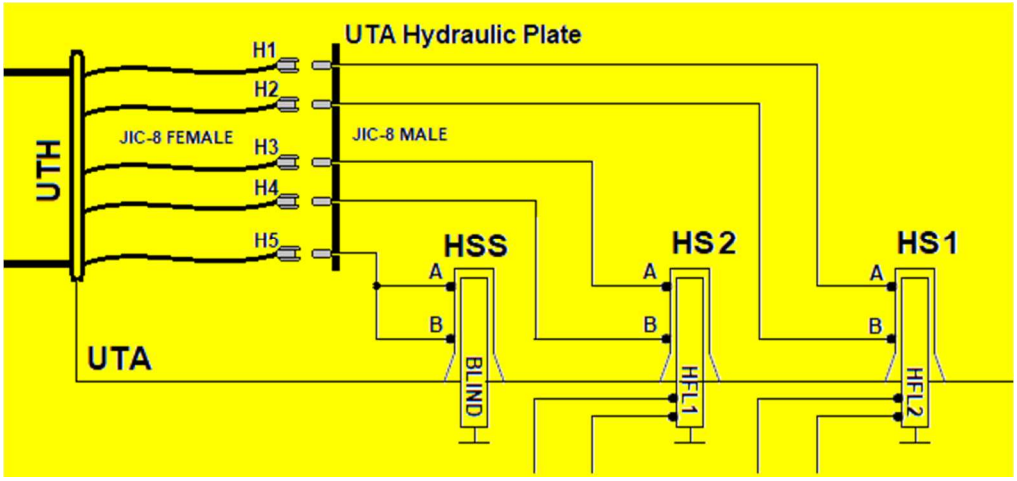

Figure 8 – Distribution of the hydraulic control lines

7.2.8 The hydraulic connector "receptacle dual hot stab” shall be compatible with the “dual hot stab” hydraulic connectors, operable by ROV, of the HFLs of the ASSEMBLY OF JUMPERS.

7.2.9 UTA CONTRACTOR shall provide 5 (five) hydraulic connectors of the type “blind hot stab”, operable by ROV. These connectors shall be designed according to PETROBRAS standard hot-stab and shall be connectable in the hydraulic terminations of type "receptacle dual hot stab" resident and hydraulic connector receptacle glove (see item 7.2.12) in the ROV panel and establish hydraulic sealing

for each hydraulic termination lines.

7.2.10 UTA CONTRACTOR shall provide 2 (two) standard hydraulic connectors receptacles parking places, mounted on ROV panel compatible with the HFL JUMPER SET and with the “blind hot stab”.

7.2.11 UTA CONTRACTOR shall provide 2 (two) hydraulic connectors receptacles parking places with a closed tubing loop (HS channels A & B) to permit hydraulic flushing after offshore installation. Both shall be mounted on ROV panel compatible with the HFL JUMPER SET and with the “blind hot stab”.

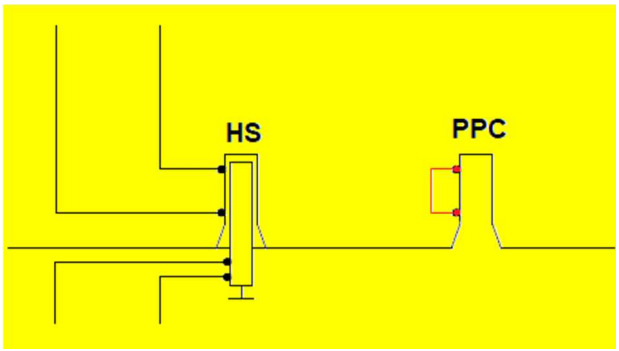

Figure 9 – Hydraulic connector parked place with closed tubing loop diagram example

Note: The hydraulic connectors receptacles parking places shall have different TAGS ID between items 7.2.7 and 7.2.8 to support ROV visual identification.

7.2.12 UTA CONTRACTOR shall provide 2 (two) hydraulic connector receptacle gloves as presented in Figure 8 with one hydraulic connectors type “blind hot stab” each, operable by a single ROV. UTA CONTRACTOR shall design and supply both tools to be delivered in the UTA structure to support at the underwater ROV operations.

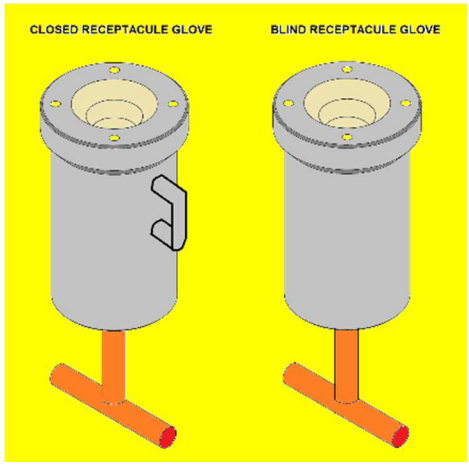

Figure 10 – Hydraulic connector receptacle gloves examples

7.2.13 All the hydraulic connectors (including parking places) shall be identified in the ROV panel by TAGs, for viewing by ROV. The identification shall adopt abbreviations that shall be defined by PETROBRAS during the detailing phase of the project.

7.2.14 UTA CONTRACTOR shall submit for PETROBRAS approval, the operational procedure for commissioning and decommissioning the UTA in the field.

7.3 Flying leads jumpers set

7.3.1 UTA CONTRACTOR's scope of supply for main flying lead JUMPERS SET: 2 (two) UTA EFLs and 2 (two) HFLs to complete the interconnection between UTA and SESDV, as shown in Figure 1.

7.3.2 UTA CONTRACTOR shall supply as a minimum of 1 (one) spare UTA EFL and 1 (one) spare HFL in dedicated transportation "IP-65" boxes.

7.3.3 All flying leads from the JUMPERS SET shall be at least 50 m long.

7.3.4 The physical routing of flying leads, in the arrangement of UTA and SESDV, according to Figure 1, shall be presented in the Technical Proposal.

7.3.5 All flying leads jumpers set shall be ROV operated subsea, including the operations of connection and disconnection terminations at UTA and FLDF.

7.3.6 All flying leads JUMPERS SET shall allow subsea installations and recovery operations using FLDF.

7.3.7 With respect to the EFLs JUMPERS SET:

7.3.7.1 The connectors of EFL terminations shall be 7 (seven) ways electrical model with all pins interconnected by electrical wiring (in twisted pair);

7.3.7.2 The connector of EFL termination that connects to the UTA shall have an electrical connector model with exposed pins (FEMALE CONNECTOR);

7.3.7.3 The connector of EFL termination that connects to the SESDV shall have an electrical connector model with non-exposed pins (MALE CONNECTOR).

7.3.7.4 UTA CONTRACTOR shall request to PETROBRAS, in the project detailing phase, the model of the electrical connector that shall be adopted at such termination of the EFL to SESDV (UTA and SESDV models).

7.3.8 With respect to the HFLs JUMPERS SET:

7.3.8.1 The 2 (two) HFLs of the JUMPERS ASSEMBLY shall be interchangeable and shall have identical hydraulic specifications;

7.3.8.2 For each HFL, both hydraulic connectors terminations shall be identical, shall be exchangeable and shall be of "dual hot stab" type, according to PETROBRAS standard;

7.3.8.3 Each HFL shall contain 2 (two) independent hydraulic lines;

7.3.8.4 The hydraulic control lines shall be thermoplastic hoses;

7.3.8.5 UTA CONTRACTOR shall submit to PETROBRAS approval the volumetric expansion values specified for the hydraulic hoses of the HFLs JUMPERS SET.

7.4 Flying leads deployment frame

7.4.1 FLDF consists of a structure to support the flying leads JUMPERS SET underwater handling by single ROV.

7.4.2 FLDF descent and ascent method (including structural and hydrodynamic aspects), as well as, the handling of flying leads during operations with FLDF, shall be submitted for approval by PETROBRAS at the project detailing phase.

7.4.3 At FLDF structure, shall be designed with appropriated locations for parking and ROV manipulation by the electrical and hydraulic connectors of both the ends of any flying lead jumpers set.

7.4.4 FLDF shall be able to simultaneously accommodate 2 (two) EFLs and 2 (two) HFLs of the JUMPERS SET, during the installation and underwater recovery of the flying leads.

7.4.5 FLDF shall admit its submarine operation (descent and ascent) in cases where they are accommodated simultaneously in its structure any combination of EFLs and HFLs.

7.4.6 The number of FLDFs that will make up the scope of supply will be defined in the RM to which this ET is attached (minimum supply of 1 unit).

7.4.7 FLDF shall contain resident hydraulic instrumentation that allows to safely depressurize the HFL lines, when recovered from the underwater environment.

7.4.8 During the FLDF design and geometry definition phase, considering the preliminary dimensions (length, width and height), UTA CONTRACTOR shall prepare and submit a Preliminary Installation Analysis to PETROBRAS. This analysis shall aim to verify the technical feasibility of installing the FLDF at all stages of the operation (overboarding, entering the water, descent, settlement and recovery). These hydrodynamic studies shall include calculations of the hydrodynamic coefficients, calculations of increased mass, coefficient of dynamic amplification and forces involved during installation.

7.4.9 FLDF shall be designed for safe installation and uninstallation for an operational window as follows:

7.4.9.1 Significant wave height Hs : 1.5m ≤ Hs ≤ 2.0m, with an interval of 0.1m;

7.4.9.2 Peak period Tp : 6.0s < Tp <12.0s, with an interval of 1.0s.

7.4.10 In the Preliminary Installation Analysis, UTA CONTRACTOR shall inform the feasibility or not of the operation for each sea state (Hs x Tp).

7.4.11 UTA CONTRACTOR shall adopt standard DNV-RP-H103 for analysis installation and uninstallation in the FLDF project.

7.4.12 FLDF sling design shall consider both transport handling, installation and uninstallation operations. The slings and all accessories (e.g., shackles, sling yokes etc) shall be part of the scope of supply of the FLDF.

7.4.13 The pick-up point on the FLDF shall be designed for only 1 (one) pad eye, meeting the condition of transport handling, installation and uninstallation.

7.4.14 FLDF design shall be compatible with the soil equation, which will be provided in the RM of which this ET is part.

7.4.15 During the project detailing phase, PETROBRAS will inform UTA CONTRACTOR of the installation vessel and the characteristics of the installation cable.

7.4.16 The structure and the lifting and installation eyes of the FLDF shall be designed even to withstand the suction loads during displacement (tool recovery) of the seabed.

7.4.17 The approval of the final geometry of the FLDF is subject to the approval of the Preliminary Installation Analysis by PETROBRAS. This analysis does not replace the FLDF "Installation Analysis" document, which shall be delivered by UTA CONTRACTOR in the final phase of the project.

8 INSTALLATION AND INTERVENTION REQUIREMENTS

8.1.1 The structure of the UTA shall contains and support flange terminations to mechanical connect to the umbilical line structures and shall have baskets in order to accommodate 2 (two) HFLs and 2 (two) EFLs, from the JUMPERS SET. The placement of baskets in the structure shall make it possible to:

8.1.1.1 The offshore installation of UTA, with the flying leads being simultaneously accommodated in the structure;

8.1.1.2 The handling by the ROV manipulator of the flying leads accommodated in UTA.

8.1.2 All subsea operations shall consider the use of a single ROV.

8.1.3 All ROV interfaces shall be in accordance with documentation specified in the respective RM to which this ET is attached.

8.1.4 All installation and recovery operations shall have their basic procedures submitted for PETROBRAS approval during the project detailing phase and provided as part of CONTROL SYSTEM.

9 SYSTEM AVAILABILITY

9.1.1 The availability of CONTROL SYSTEM shall be guaranteed by adequate MTTF values.

9.1.2 The MTTF of the entire CONTROL SYSTEM shall also be informed, calculated for the operating conditions indicated in this ET.

9.1.3 UTA CONTRACTOR shall clearly inform which methods are used to calculate availability, as well as, the assumptions adopted.

10 TECHNICAL DOCUMENTATION

10.1.1 The documentation shall be in accordance with the requirements from the RM of which it is attached ET.

10.1.2 UTA CONTRACTOR shall present in the project detailing phase, for approval by PETROBRAS, the operational procedures applicable with respect to the CONTROL SYSTEM.

10.1.3 UTA CONTRACTOR shall present in the project detailing phase, for approval by PETROBRAS, the procedure for assembling the ELECTRICAL SYSTEM at UTH.

10.1.4 UTA CONTRACTOR shall present in the project detailing phase, for approval by PETROBRAS, the procedure for assembling the HYDRAULIC SYSTEM at UTH.

10.1.5 UTA CONTRACTOR shall present, in the project detailing phase, for PETROBRAS approval, the procedure for the storage and preservation of the CONTROL SYSTEM.

10.1.6 The technical documentation shall include at least the following:

- Block diagram;
- Piping and Instrumentation Diagram (P&ID);
- General arrangement drawings of UTA with flying leads;
- General arrangement drawings of FLDF with flying leads;
- General arrangement with routing of hydraulic system including HFLs;
- General arrangement with routing of electrical system including EFLs;
- Electrical connectors drawings and datasheet;
- Hydraulic connectors drawings and datasheet;
- Factory Acceptance Test Procedure/Reports;
- Acceptance and Performance test (TAP) Procedure/Reports;
- Operational procedure for UTA and FLDF.

11 TESTS AND INSPECTIONS

11.1.1 Regarding the qualification tests:

11.1.1.1 All components of CONTROL SYSTEM shall be subjected to qualification tests in order to confirm that these components shall comply with the design requirements. Qualification tests shall be reported to PETROBRAS.

11.1.1.2 The compatibility of CONTROL SYSTEM components with hydraulic fluids shall be proved from a qualification plan to be executed after the execution of the supply contract. It will not be necessary to requalify with respect to hydraulic fluids, if the system components have already been qualified according to Standard ISO 13628-6 and if they fully meet the requirements of this ET. In this case, during the project detailing phase, UTA CONTRACTOR shall submit a report of the respective qualifications for approval by PETROBRAS.

11.1.2 With respect to FATs:

11.1.2.1 The list of FATs of CONTROL SYSTEM, in addition to the FAT procedures themselves, shall be submitted for approval by PETROBRAS during the project detailing phase.

11.1.2.2 For hoses and electrical cables, the FAT shall have at least:

- Continuity test;
- Helium or nitrogen leak test as specified by the manufacturer and previously approved;
- Visual and dimensional inspection test.

11.1.2.3 For electrical connectors, the FAT shall have at least:

- Electrical tests: insulation resistance test (> 1 GΩ at 500 VDC), continuity test and contact resistance test;
- Mechanical tests: hydrostatic test, visual and dimensional inspection.

11.1.3 The SIT shall be performed by UTA CONTRACTOR before the CLM, with at least 1 (one) UTA, 1 (one) JUMPERS SET and, if it is the scope of supply, 1 (one) FLDF.

11.1.4 UTA CONTRACTOR shall have all the manufacturing facilities for any repairs and alterations that are necessary to the electrical components in an emergency, including services in marine units.

11.1.5 UTA CONTRACTOR shall provide proof of supply of all items to be purchased from sub-suppliers, which are an integral part of ELECTRICAL SYSTEM, through a letter of purchase intention, supply request or other supporting document.

11.1.6 The tests program shall demonstrate that all components of CONTROL SYSTEM have been successfully installed and connected and that CONTROL SYSTEM is fully operational.

12 PACKAGING AND STORING

12.1.1 In this ET, the term “IP-65” is used as defined in Standard IEC 60529.

12.1.2 The packaging methods shall be designed in order to completely protect all the equipment and parts of CONTROL SYSTEM against possible damage during transport, loading and unloading.

12.1.3 UTA CONTRACTOR shall submit for approval of PETROBRAS, the procedures for handling the CONTROL SYSTEM equipment, depending on the means of transport specified.

12.1.4 ELECTRICAL SYSTEM shall be delivered to PETROBRAS disassembled from UTA, packed by UTA CONTRACTOR in a dedicated (separated from other project’s supplies) IP-65 box that protects it from the weather, suitable for sea shipment. The use of wooden boxes shall not be allowed.

12.1.5 The spare EFL/HFL jumpers set shall be delivered to PETROBRAS packed in boxes IP65 which are protect from weather, suitable for sea shipment. The use of wooden boxes shall not be allowed.

12.1.6 The UTA EFLs and HFLs jumpers set shall be delivered to PETROBRAS accommodated in existing basket in the UTA structure (UTA body), respecting the total quantity according to RM in which this ET is referenced.

12.1.7 The FLDF shall be delivered to PETROBRAS covered in canvas to protect against ultraviolet rays and other weather conditions.

12.1.8 The UTA structure shall be delivered to PETROBRAS covered in canvas to protect against ultraviolet rays, so that the CONTROL SYSTEM, components located in the UTA structure, shall be protected from the weather.

12.1.9 The description of the packaging of CONTROL SYSTEM components shall be included in the Technical Documentation and shall be submitted for approval by PETROBRAS during the project detailing phase.

13 CONDITIONING

13.1.1 UTA CONTRACTOR shall be responsible for the conditioning of CONTROL SYSTEM equipment from the beginning of manufacture until delivery to the PETROBRAS staff for which it is intended, including the period of transportation.

13.1.2 When required in RM, UTA CONTRACTOR shall submit for approval of PETROBRAS, the procedures for the implementation of the conditioning of CONTROL SYSTEM equipment, according even to the PETROBRAS standard N-858.

14 TRAINING

14.1.1 Training shall be provided to qualify personnel appointed by PETROBRAS to operate and maintain (install, dismantle, replace parts and make adjustments) each system component.

14.1.2 Training shall be performed at PETROBRAS facilities in Rio de Janeiro, Brazil (on-shore). Training courses shall be given for two classes of 6 students (total of 12 students). The two classes shall be scheduled at least 1 month apart, to accommodate for PETROBRAS offshore labor regime. Training course shall be sized for 3 days as a minimum. Lessons shall be taught in Portuguese.

14.1.3 The training program shall cover basic system operation and maintenance aspects. A detailed training program shall be submitted for PETROBRAS approval.

14.1.4 The training program shall cover, at least, the following items:

- Complete description of equipment and system;
- Technical and operational characteristics;
- Operating principles;
- Operational cautions and warnings;
- Operational procedures and routines;
- Preventive maintenance routines;
- ROV operations (subsea equipment retrieval and installation);
- Storage and conservation of equipment.

15 AFTERMARKET SUPPORT SERVICES

15.1.1 UTA CONTRACTOR shall commit to deploy in Brazil infrastructure and support for maintenance and aftermarket services, which shall be part of the Technical Proposal.

15.1.2 The effective implantation of this aftermarket infrastructure and support shall occur until the delivery date of the equipment of the scope of supply to PETROBRAS and shall be a condition for the CLM by PETROBRAS.

16 SCOPES OF SUPPLY

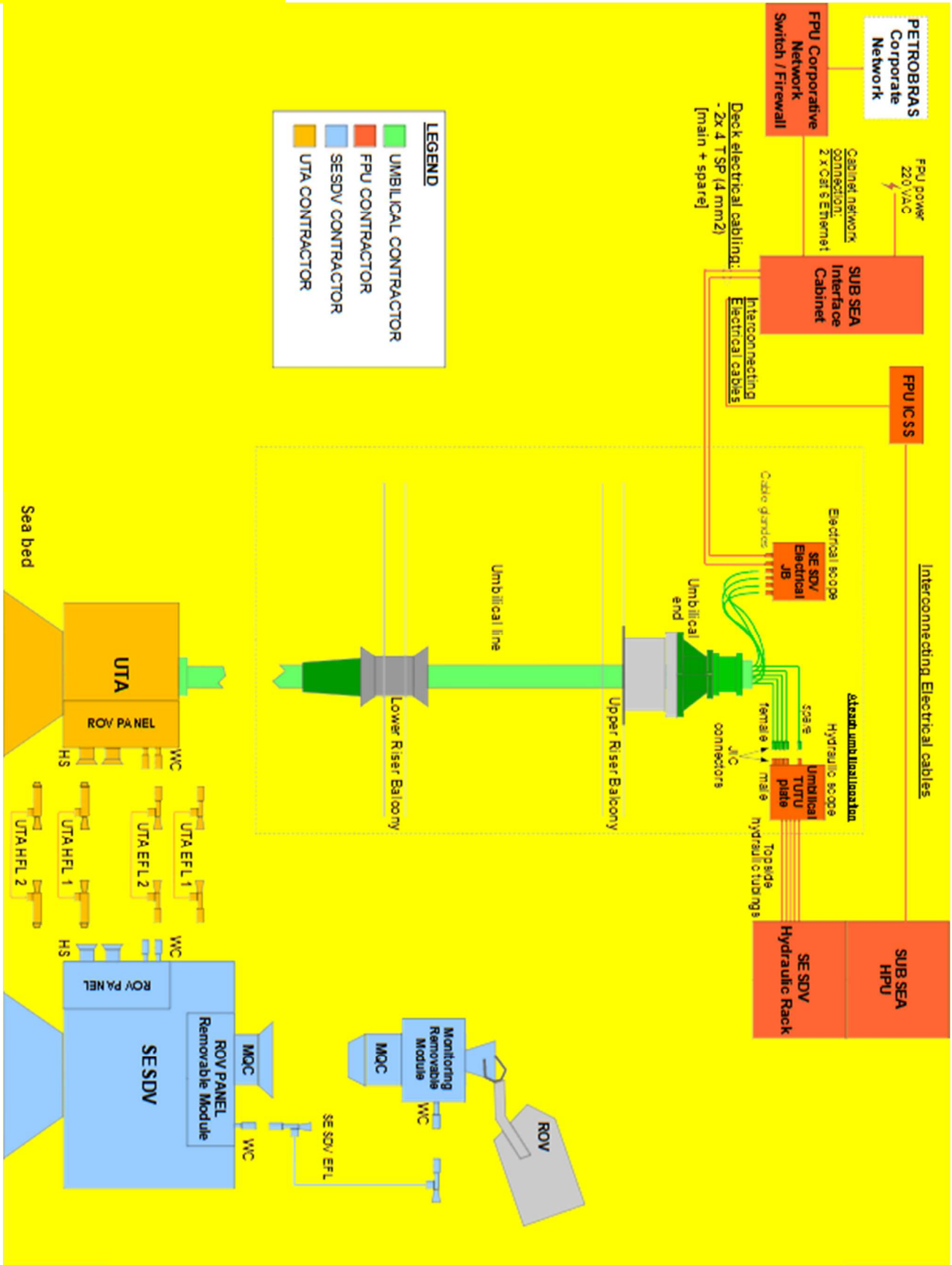

Figure 11 – Diagram of SESDV system main components standard scope of supplies

ANNEX A: TELECOM REQUIREMENTS

A.1 Main requirements

A.1.1 If requested in project RM, the UTA can be used as a big subsea pass-through box for the umbilical lines for the optical telecom functionality. The UTA shall be designed as an in-line equipment. See Figure 12.

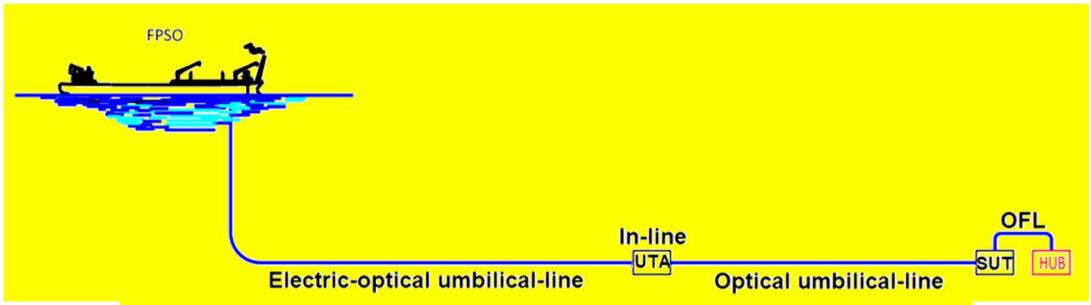

Figure 12 — Schematic of subsea layout with UTA from ANNEX A case.

A.1.2 An optical basic schematic arrangement for UTA from ANNEX A case is shown in the Figure 13. UTA CONTRACTOR however may suggest a different internal arrangement and submit to PETROBRAS for approval.

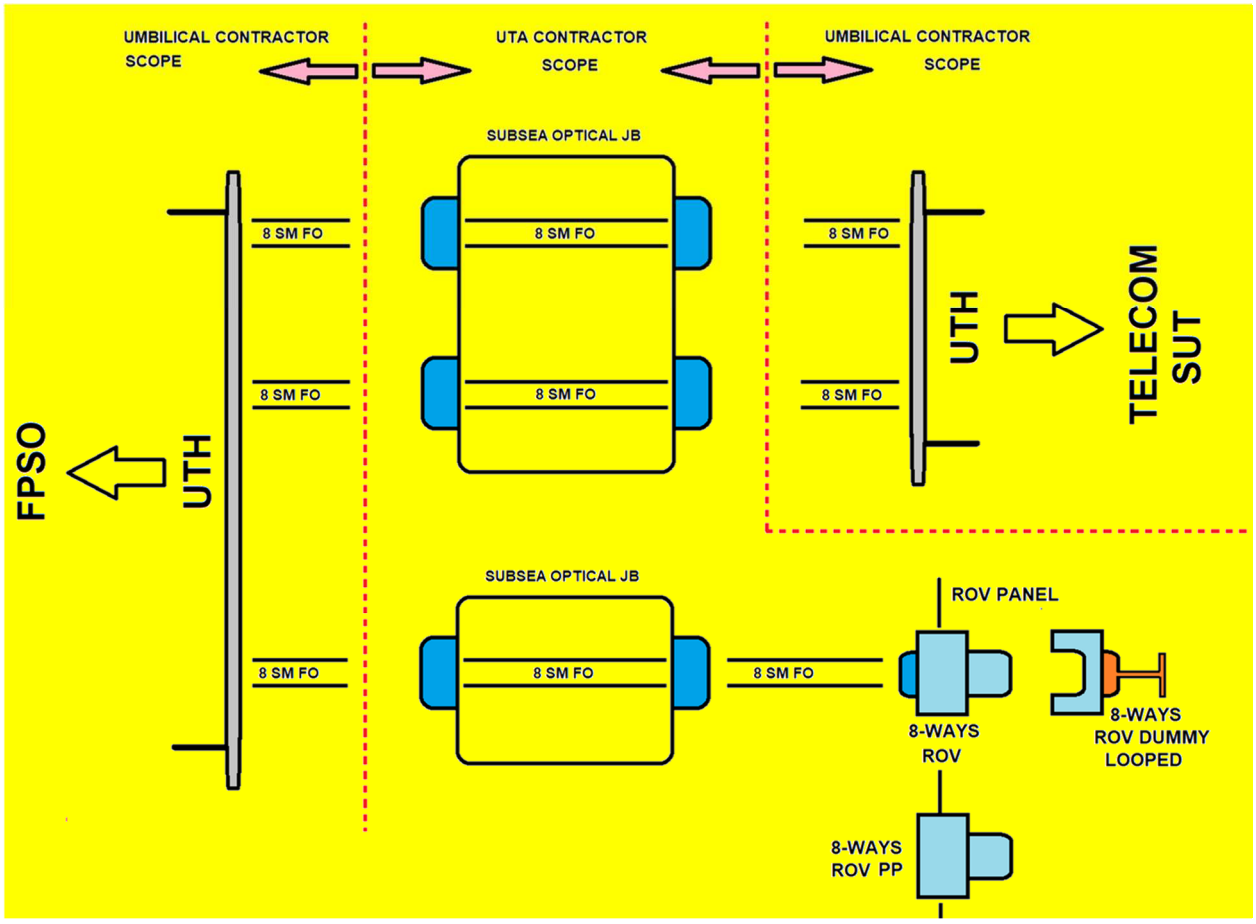

Figure 13 — Optical basic schematic arrangement for UTA from ANNEX A case.

A.2 Optical wet mate connector and optical flying lead

A.2.1 The optical wet mate connectors' model shall be chosen during the construction phase in formal consultation with PETROBRAS.

A.2.2 The optical wet mate optical connector model shall conform to the following requirements:

- be 8 (eight) or more-ways optical fiber cores, with fibers end face Angled Physical Contact (APC);
- be ROV-operated;
- be suitable for operation in the foreseen environment, with a maximum operating depth of at least 3,000-meters (three-thousand meters);
- be able to withstand at least 100 mates/demates cycles;
- have a design life of at least 25 years;
- be qualified according to API 17F (shall present evidences);
- have a track record of at least 30 units installed worldwide and operating continually without failure for a period of 02 years.

A.2.3 The optical wet mate optical bulkhead connectors' pigtails shall be designed/supplied with same specification of the fibers from umbilical cables.

A.2.4 The mechanical/optical interface mounting assembly (e.g. subsea junction box) between the wet mate bulkhead connectors' pigtails and the umbilical lines' pigtails inside UTA shall be qualified according to API 17F.

A.2.5 For all SUTs, all the optical wet mate bulkhead connectors shall be supplied with dummy connectors to protect the connectors' integrity during operations offshore.

A.2.6 Some of the dummy connectors shall be designed to have some closed looped pins to check the fibers integrity during and after installation. UTA CONTRACTOR shall select the dummy connectors during the construction phase in formal consultation with PETROBRAS.

A.2.7 UTA CONTRACTOR shall supply parking places for all optical wet mate bulkhead connectors. Parking places shall be designed in UTA's structure.

A.2.8 UTA CONTRACTOR shall provide 1 (one) test connectors kit for optical wet mate connectors for supporting UTA OPTICAL SYSTEM mounting/testing. All UTA OPTICAL SYSTEM (including test connectors) shall be supplied in dedicated transportation "IP-65" boxes.

A.2.9 UTA CONTRACTOR shall supply OFL to connect with single ROV operations.

A.2.10 The OFL shall be designed with PBOF hoses of 50-meters length and both ends mounted with optical wet mate connectors compatible with wet mate bulkhead connectors from UTA.

A.2.11 The OFL shall be designed/supplied with same specification of the fibers from umbilical cables. UTA CONTRACTOR shall supply as a minimum of 1 (one) OFL in a dedicated transportation "IP-65" box.

A.2.12 UTA CONTRACTOR shall supply the FLDF (from section 7.4) with parking places for both optical wet mate connectors from the OFL.

A.3 TELECOM optical cable requirements

A.3.1 The Telecommunication Optical Cable from umbilical line shall comply with the following requirements:

A.3.1.1 Have 24 (twenty-four) or more single mode optical fiber cores;

A.3.1.2 Be suitable for operation in the foreseen environment, with a maximum operating depth of at least 3,000-meters (three-thousand meters);

A.3.1.3 Have a design life of at least 25 years;

A.3.1.4 Operate with sea water temperature from -10º up to +50º C.

A.3.1.5 Withstand with air temperature from -10º up to +50º C.

A.3.1.6 Storage temperature from -15º up to +50º C.

A.3.1.7 Certification and qualification by UJ CONSORTIUM.

A.3.1.8 Supplier shall inform all optical and mechanical characteristics of the provided cable.

A.3.1.9 Cable shall be qualified to ensure fiber protection against water depth pressure, longitudinal water ingression in case of rupture, chemical aggression, and hydrogen darkening during lifetime.

A.3.1.10 Considering a period of 14 days after rupture, the longitudinal water ingression shall respect the maximum allowed ingression of 1km.

A.3.1.11 Cable structure shall ensure that there will be no performance degradation on fiber during deployment, burial, and recovery, considering industry best practices.

A.3.1.12 Cable structure shall ensure that there will be no additional attenuation on fibers during lifetime due to hydrogen molecules ingression due to metallic structure corrosion.

A.3.1.13 The acceptable cable to be used is Single Armoured Cable.

A.3.1.14 Fiber optic coating shall:

A.3.1.14.1 Inhibit armature corrosion.

A.3.1.14.2 Resist to marine life and rodents.

A.3.1.14.3 Be flexible enough to allow the cable to follow seabed detours.

A.3.1.14.4 Not be toxic or flammable.

A.3.1.14.5 Have properties that ensure handling, settling and recovery during launching and maintenance operations.

A.3.1.14.6 Not damage the environment.

A.3.1.15 Cable application shall comply ITU-G.978 – Characteristics of optical fiber submarine cables.

A.3.1.16 PETROBRAS shall approve the cable application.

A.3.1.17 Cables in discordance with ITU shall be evaluated and authorized by PETROBRAS if it is necessary due to environmental variables to be mapped during the protect stage.

A.3.2 Cable marks and identification:

A.3.2.1 Cable shall be identified and marked in accordance with recommendation 16, emission 1 from ICPC;

A.3.2.2 The physical structure, colors and fonts from labels and markings shall be proposed by supplier and approved by PETROBRAS;

A.3.2.3 IDs shall be visible considering a 0,5m distance;

A.3.2.4 Cable shall have an alphanumeric ID printed on cable. This code shall be enough to identify number and type of fibers and other cable specification;

A.3.2.5 ID shall be repeated every 5 meters;

A.3.2.6 IDs and markings shall remain intact during loading, unloading, deployment, recovery, and repair;

A.3.2.7 A numeric length scale shall be printed on cover;

A.3.2.8 Cable shall present distance markings on every one kilometer;

A.3.2.9 Cables shall have labels that define the marking of all junctions;

A.3.2.10 Beside junctions, every cable transition shall be marked and identified.

A.4 Optical fiber requirements

A.4.1 The following requirements shall be applied to the optical fibers of the umbilical, subsea optical cable, SUT, flying leads and optical connectors.

A.4.2 The optical fibers shall be according to ITU-T G series recommendations and the technical characteristics of G.652D recommendation.

A.4.3 On the 1550nm window, the optical fiber shall have the following characteristics:

A.4.3.1 Attenuation shorter than or equal to 0.18 dB/km;

A.4.3.2 Dispersion shorter than or equal to 18.00 ps/nm.km;

A.4.3.3 Dispersion Slope shorter than or equal to 0.088 ps/nm².km;

A.4.3.4 PMD shorter than or equal to 0.20 ps/√km.

A.4.4 The optical fibers shall not present any variation of attenuation greater than 0.01 dB/km throughout its length.

A.4.5 The cladding diameter shall be 125 μm with a maximum tolerance of ± 2 μm.

A.4.6 The cladding circularity error shall be shorter than 1%.

A.4.7 Once covered by the primary coating, the optical fiber when submitted to a curvature radius equal to or greater than 37.5mm, shall not present a variation of attenuation for wavelengths between 1300 and 1625nm, in accordance with ITU-T G-652.

A.4.8 Optical fibers when submitted to 30 nm curvature radius by 100 turns, the increase of attenuation for the wavelengths between 1300 and 1625nm shall be smaller than 0.1 dB, in accordance with ITU-T G.652 recommendation.

A.4.9 The optical fiber that will compound the optical fiber cable shall endure a minimum stretching tension of 0.69 Gpa (~7000 Kgf/cm2) without affect its physical and optical characteristics.

A.4.10 UTA CONTRACTOR and UMBILICAL CONTRATOR shall inform the following characteristics of the optical fibers used to manufacture the optical fiber cable:

A.4.10.1 Refractive index profile;

A.4.10.2 Maximum attenuation coefficient at the 1310nm transmission window;

A.4.10.3 Minimum attenuation coefficient at the 1310nm transmission window;

A.4.10.4 Maximum attenuation coefficient at the 1550nm transmission window;

A.4.10.5 Minimum attenuation coefficient at the 1550nm transmission window;

A.4.10.6 Maximum chromatic dispersion (ps/nm.Km) at the 1300nm transmission window;

A.4.10.7 Maximum chromatic dispersion (ps/nm.Km) at the 1550nm transmission window;

A.4.10.8 Cut-off wavelength;

A.4.10.9 Detailing of Hydrogen impermeabilization;

A.4.10.10 Modal field diameter;

A.4.10.11 Core / cladding concentricity error;

A.4.10.12 Core non circularity;

A.4.10.13 PMD - Polarization Mode Dispersion.

A.4.11 For acceptance, the optical fibers shall be followed by the characterization reports issued by the manufacturers.

A.5 Optical tests

A.5.1 All subsea optical devices (i.e. umbilical lines, UTA, wet mate connectors, OFLs), shall be tested at the factory, on the installation vessel prior to launch and post launching at the commissioning stage.

A.5.2 The tests shall be performed according to Table 1:

TESTS	FACTORY	VESSEL	COMMISSIONING
Total optical attenuation	x	x	
Optical attenuation - OTDR	x	x	x
Chromatic Dispersion	x		
PMD	x		

Table 1 – List of tests

A.5.3 UMBILICAL CONTRACTOR shall perform optical attenuation tests from the DIO (Internal Optical Distributor) installed at the telecommunications room connected to the submarine optical telecom HUB after installing the umbilical line including fusions at the riser balcony and subsea connection in the optical telecom HUB.

A.5.4 UTA CONTRACTOR and UMBILICAL CONTRACTOR shall use appropriate instruments and with valid calibration certificates, in order to perform these factory and offshore tests.

A.5.5 It shall be UTA CONTRACTOR and UMBILICAL CONTRACTOR's responsibility to supply all the accessory materials necessary for the perfect execution of all tests factory and offshore.

A.6 Optical tests technical description

A.6.1 Total optical attenuation

A.6.2 This test shall be performed using a power meter and light source in order to measure the total attenuation / insertion loss of the DUT (Device Under Test)

A.6.3 The tests shall be carried out on the 1550nm optical window in both directions (A-B and B-A).

A.6.4 The results shall preferably be presented according to Table 2:

Coil ID/ Loop:	Date:	Technical resp.:
Equipment:	S/N:	
Equipment:	S/N:	
Wave length (λ):	Fiber length:	

Fibers		A-B			B-A			Mean [dB]	Att. Coef. [dB/km]
A	B	P_A[dBm]	P_B[dBm]	Att[dB]	P_B[dBm]	P_A[dBm]	Att[dB]		

Table 2 – Suggested format for presenting results of total optical attenuation

A.6.5 In addition to the results table, all measurement traces with identification of the respective events shall be presented.

A.6.6 Optical attenuation – OTDR

A.6.7 The optical attenuation tests shall be performed with OTDR (Optical Time Domain Reflectometer) in both directions, whenever possible to be performed.

A.6.8 For the commissioning tests, CONTRACTOR shall consider that the corresponding optical system is a repeated type and then in the fibers tested there shall be presence of wavelengths in the C band.

A.6.9 In order to perform measurements on the commissioned system, CONTRACTOR shall evaluate the need for the application of optical filters or C-OTDR type instruments (Coherent Optical Time Domain Reflectometer).

A.6.10 In addition to the events throughout the DUT, the OTDR tests shall evaluate the ORL (Optical Return Loss) per event.

A.6.11 The results shall preferably be presented according to Table 3:

Coil ID/ Loop:	Date:	Technical resp.:
Equipment:	S/N:	
Equipment:	S/N:	
Wave length (λ):		

Fibers		Distributed loss [dBm/km] (A-B)	Distributed loss [dBm/km] (B-A)	Mean [dB/km]	Lenght [km]	Mean loss [dB]
A	B					

Table 3 – Suggested format for presenting optical attenuation results - OTDR.

A.6.12 **Chromatic Dispersion**

A.6.13 Chromatic dispersion tests shall be performed at wavelengths 1310nm, 1550nm and 1625nm.

A.6.14 The measurement technique to be applied in these tests shall be decided by the CONTRACTOR.

A.6.15 The results shall preferably be presented according to Table 4:

Coil ID/ Loop: Date: Technical resp.:
Equipment: S/N:
Equipment: S/N:

Fibers		Lambda Zero[nm]	Dispersion [ps/(nm.km)]			Total disp. @1550nm [ps/nm]	Inclination [ps/(nm².km)]		Sellmeier Coeficients		
A	B		1310nm	1550nm	1625nm		Lambda Zero	1550nm	A	B	C

Table 4 – Suggested format for presenting the results of the chromatic dispersion.

A.6.16 **Dispersion by Polarization Mode**

A.6.17 The measurement technique to be applied in these tests shall be decided by CONTRACTOR.

A.6.18 Measurements shall be performed at intervals greater than 60 minutes.

A.6.19 The results shall preferably be presented according to Table 5:

Coil ID/ Loop: Date: Technical resp.:
Equipment: S/N:
Equipment: S/N:
Fiber length:

Fibers		M 1	M 2	M 3	M 4	M 5	M 6	M 7	M 8	M 9	PMD Delay [ps]	PMD Coef. [ps/√km]
A	B											

Table 5 – Suggested format for presenting PMD results.

A.6.20 **Acceptance criteria**

A.6.21 The acceptance criteria shall be as described at Table 6:

TESTS	FACTORY (UTA CONTRACTOR scope)	VESSEL / COMMISSIONING (UMBILICAL CONTRACTOR scope)
Total optical attenuation	Attenuation per kilometer less than or equal to 0.20dB/km @1550nm.	Attenuation per kilometer less than or equal to 0.20 dB/km @1550 nm ±10%
Optical attenuation - OTDR	○ Attenuation per kilometer less than or equal to 0.20dB/km @1550 nm; ○ Optical splices with OIL less than 0.2dB; ○ Connections to wetmate connectors with OIL and ORL better or equal to that specified in the element datasheet.	○ Attenuation per kilometer less than or equal to 0.20dB/km @1550nm. ○ Optical splices with insertion loss <0.2dB. ○ Connections to wet mate connectors with OIL and ORL better or equal to that specified in the element datasheet.
Chromatic Dispersion	DC < 18 ps/nm^2*km	N/A
PMD	PMD < 0,2 ps/km^{0,5}	N/A

Table 6 – Tests acceptance criteria.