PETROBRAS	**TECHNICAL SPECIFICATION**	**Nº** I-ET-3000.00-1510-854-PEK-001	
	CLIENT PETROBRAS		**SHEET** 1 of 29
	JOB		
	AREA –		
SUB	**TITLE** **MONITORING SYSTEM FOR SUBSEA EMERGENCY SHUT-DOWN VALVE (SESDV)**		***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
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THIS FORM IS PART OF PETROBRAS N-0381 REV. L

TABLE OF CONTENTS

1 INTRODUCTION

This document presents the technical specifications and functional characteristics of the Subsea Emergency Shut-down Valve (SESDV) Monitoring System responsible for the import/export system of the submarine arrangement in the Development of PETROBRAS Production Field.

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*;

EC – Electrical connector

EFL – Electrical Flying Lead;

EJ – Electrical jumper

ET –Technical Specification;

FAT – Factory Acceptance Test;

FPU – Float Production Unit;

HC – Hydraulic connector;

HS – *Hot Stab*;

ICSS - Integrated Control and Safety System

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;

PBOF – Pressure Balanced Oil Filled;

PVT – Performance Verification Test;

PT – Pressure Transducer;

ROV –Remotely Operated Vehicle;

RM – Material Requisition;

RMS – Root Mean Square;

RTU – Remote Terminal Unit;

SESDV – Subsea Emergency Shut-down Valve;

UEH – Electro-Hydraulic Umbilical;

UEP – Stationary Production Unit;

UTA – Umbilical Termination Assembly;

SIT – Site Integration Test;

WC – *Wet mate Connector;*

ZT – Position transducer.

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 - (**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-3000.00-1510-800-PEK-002 UMBILICAL TERMINATION ASSEMBLY (UTA) CONTROL SYSTEM – FOR SUBMARINE EXPORT SYSTEMS;

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

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

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

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

4 DEFINITIONS

SESDV CONTRACTOR	The company contracted by PETROBRAS to design, construct, supply and install the SESDV and its accessories.
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.
SUPPLIER	Company hired by SESDV CONTRACTOR, to supply components from SESDV MONITORING 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 SESDV 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.
Hydraulic Coupler	Hydraulic coupling element, used in pairs, to establish continuity of an individual hydraulic line. Confront this definition with “Hydraulic Multi-connector”.
Hydraulic Multi-connector	Subsea connector operable by ROV used in pairs, formed by a set of hydraulic couplers arranged on a plate, to establish continuity of a row set hydraulic lines in parallel. Confront this definition with “Hydraulic Coupler”.
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 monitoring 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 SESDV.

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 SESDV CONTRACTOR shall consider SUPPLIERs with experience in subsea monitoring systems.

6 GENERAL TECHNICAL REQUIREMENTS

6.1 System overview

6.1.1 The MONITORING 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 MONITORING SYSTEM design life: 30 years.

6.1.2 SESDV CONTRACTOR shall previously identify, in the phase of submission of the TECHNICAL PROPOSAL, all subsea equipment that needs maintenance during the lifetime of the SESDV MONITORING 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 SESDV CONTRACTOR shall design and build the SESDV structure according to [15].

6.1.4 SESDV shall include in the ROV panels a subsea QR Code as described in [15].

6.1.5 All components from MONITORING SYSTEM (except MONITORING REMOVABLE MODULE, that shall have its own cathodic protection) shall be protected by the cathodic protection from SESDV [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 MONITORING SYSTEM shall be protected against crevice corrosion.

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

6.1.8 SESDV CONTRACTOR shall present a reliability study based on standard MIL-STD-217F for the MONITORING 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 MONITORING SYSTEM shall ensure that its components are prepared to resist efforts during subsea offshore installations and recovery of SESDV structure or MONITORING REMOVABLE MODULE (section 7.2).

6.1.11 MONITORING SYSTEM project, including the SESDV 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).

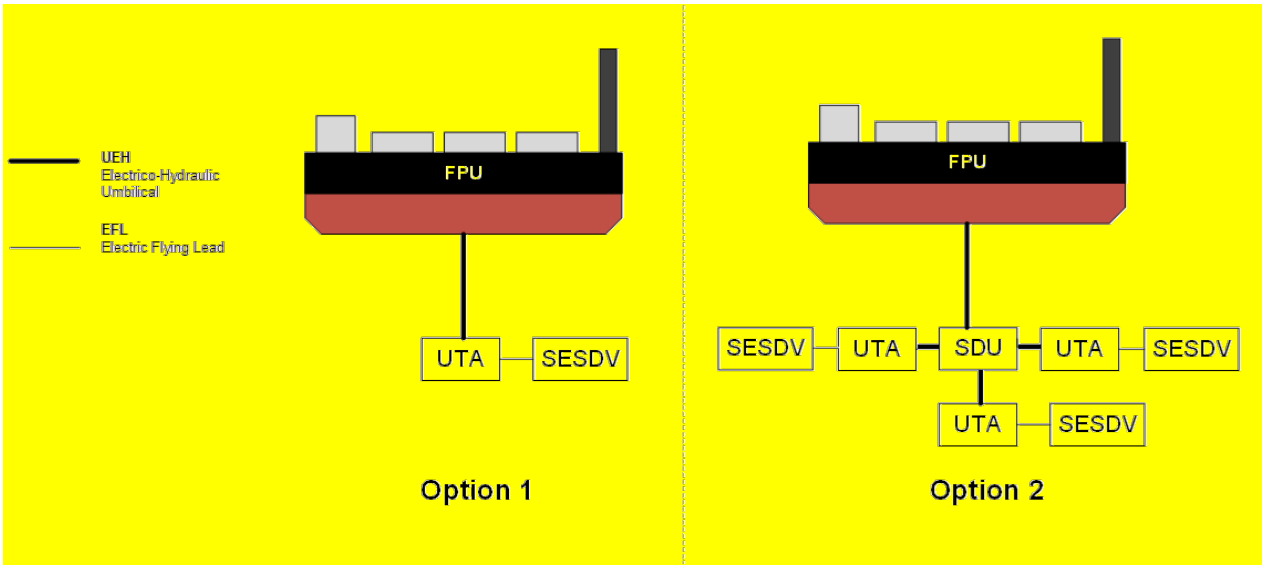

Figure 1 – General schematic of the subsea layout with SESDV Monitoring System (two options)

6.1.13 The SESDV MONITORING SYSTEM shall contain sensors (main and redundant) in order to monitor:

- Valve position indication (ZT) of the SESDV shutter;
- Pressure (PT) from hydraulic actuation system control line of SESDV system.

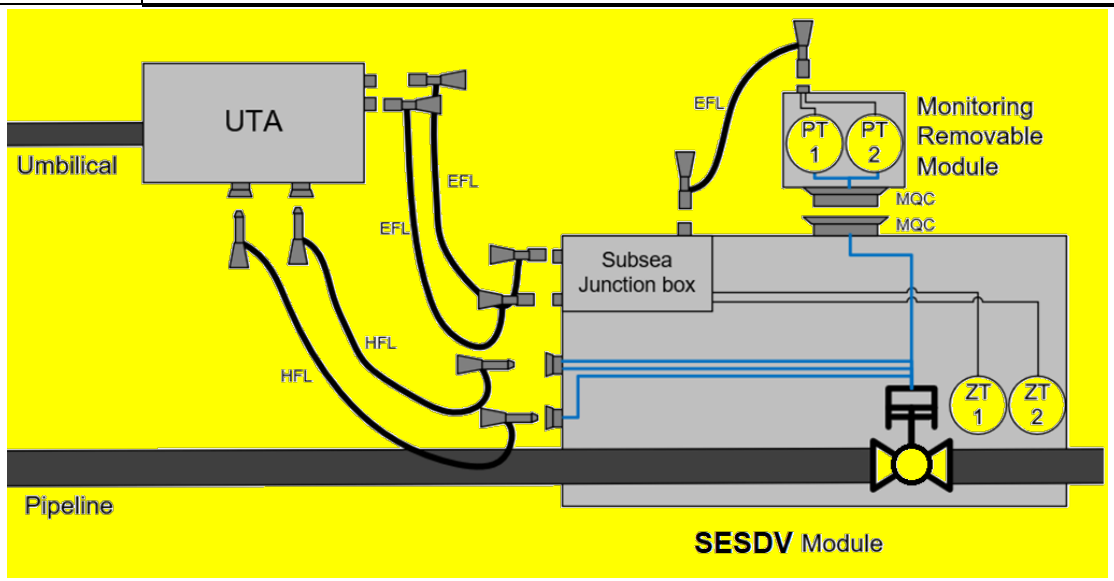

Figure 2 – SESDV MONITORING SYSTEM subsea general schematic

6.1.14 The electrical conductors used for sensors' power supply and data communication shall be terminated in subsea wet mate electrical bulkhead connectors at a ROV panel residing in the structure of the SESDV.

6.1.15 The subsea electrical connections, between SESDV ROV panel and UTA, shall be designed using an EFL (Electrical Flying Lead) type jumper.

6.1.16 From FPU Topside, the electrical cables from the UEH shall be connected to a RTU from FPU ICSS, for the power supply and data acquisition of the SESDV MONITORING SYSTEM signals.

6.1.17 SESDV MONITORING SYSTEM comprises the scope of supply for each subsea SESDV detailed in the RM to which this technical specification is attached.

6.1.18 SESDV MONITORING SYSTEM shall be provided in accordance with this technical specification, including all documentation listed as a reference (Chapter 3).

6.1.19 Any discrepancy or alternative solution, presented by the SUPPLIER, (in relation to the one originally specified by PETROBRAS) shall be explicitly indicated in its Technical Proposal in its own item entitled "Deviations" or "Alternatives to Specifications". PETROBRAS may accept or reject the proposed deviations.

6.1.20 If there is a conflict of specifications in this documentation and in its references, the most demanding specification shall prevail, unless otherwise expressly directed by PETROBRAS.

6.1.21 In the subsea layout, the maximum distance between the UTA and the SESDV shall be 30 m and the minimum length for the EFL & HFL shall be 50 m.

6.1.22 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.

6.1.23 For electrical analysis, the maximum length of the UEH shall be 10 km using TSP conductors with 2.5mm^2 cross section.

6.2 Electrical components requirements

6.2.1 In the import/export system subsea layout, one SESDV shall receive electrical conductors, coming from the FPU, through a general arrangement using UEH and UTA, as shown in Figure 2. The SESDV composes the gas or oil import/export system of the FPU of oil & gas production system.

6.2.2 The requirements from Section 6.2 (and its sub-items) shall be applicable to all electrical components from MONITORING SYSTEM.

6.2.3 The following requirements are valid for all electrical components of the MONITORING SYSTEM:

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

6.2.3.2 Rated current: 10A RMS AC.

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

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

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

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

6.2.8 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.

6.2.9 Bend stiffeners shall be provided at the interface between the PBOF hoses and the wet mate connectors or 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.

6.2.10 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 SESDV MONITORING SYSTEM.

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

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

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

6.2.11.3 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;

6.2.11.4 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;

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

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

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

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

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

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

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

6.2.15 All the electrical jumpers terminated to interface PT and ZT sensors shall be designed with a flange “double-barrier” electrical penetrator solution qualified for SESDV subsea application scenario.

6.2.16 All types of subsea electrical connectors/penetrators of the SESDV MONITORING 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 SESDV MONITORING 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 have electrical wires 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 SESDV CONTRACTOR shall use EFLs with electrical connectors from the same SUPPLIER model, except in cases indicated at project’s RM. During SESDV detailing design phase, SESDV CONTRACTOR shall make a formal consultation to PETROBRAS for the definition of ROV CONNECTOR UTA 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 MONITORING SYSTEM.

6.3.2 The terms "hydraulic couplers" and "hydraulic multi-connectors" are defined in this ET at Section 4.

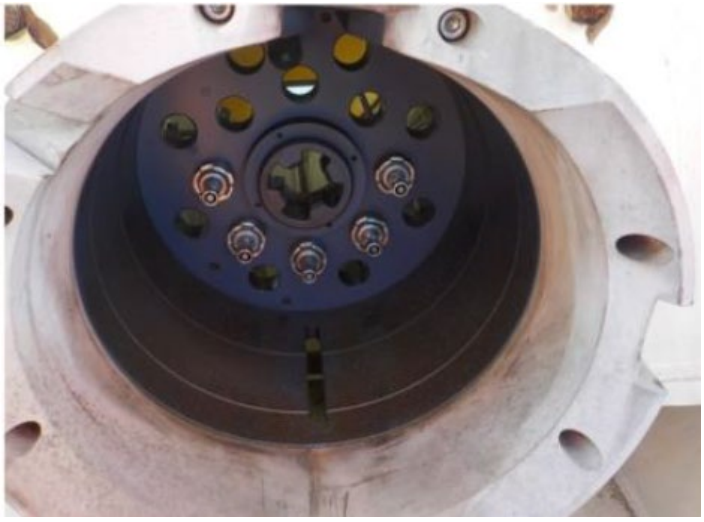

Figure 3 – Hydraulic multi-connector example (MQC example)

6.3.3 Working pressure of the hydraulic components of the monitoring system: 5.000 psi.

6.3.4 Internal diameter of the hydraulic lines of the MONITORING SYSTEM: 1/2".

6.3.5 The hydraulic components of the monitoring system shall comply with the cleaning class standard SAE AS4059: 6B to 6F classes.

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

6.3.7 After placement of the AFM, SESDV CONTRACTOR shall provide the compatibility analyses showing that hydraulic control fluid adopted in the project is compatible with all materials used in the MONITORING SYSTEM that will be in contact with such control fluid.

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

6.3.9 For the delivery of the equipment to PETROBRAS, all hydraulic circuits of the MONITORING SYSTEM and SESDV control system shall be filled with the control fluid with corrosion protection in the vapor phase, standardized by the COMPANY.

6.3.10 SESDV 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.

6.3.11 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.

6.3.12 The hydraulic couplers (couplings) shall have metal to metal primary seal type and resilient secondary seal. The part of the connector that contains the seals shall be

located on the equipment that is easiest to install and recover to the surface.

6.3.13 The hydraulic couplers shall allow at least ten (10) connecting subsea complete cycles and disconnection, without the need to replace the seals. SUPPLIER shall inform in the details of the project before the placement of AFM by PETROBRAS the maximum number of connection and disconnection cycles after which the seals shall be replaced.

6.3.14 The hydraulic couplers shall be connected and disconnected normally (without damage or degradation), even when subjected to maximum operating pressure.

6.3.15 Each hydraulic couplers connection pair shall have a check valve to minimize the ingress of seawater during connection and disconnection operations. The maximum ingress of seawater during a connection shall not exceed 5 ml.

6.3.16 The check valve of the hydraulic coupler shall be suitable for operating at water depth of the MONITORING SYSTEM and shall not open unduly in case the external pressure to the coupler is equal to or lower than the operating water depth.

6.3.17 There shall not have any fluid leakage when the connection and the disconnection of the couplers hydraulic even at maximum pressure test.

6.3.18 All types of hydraulic couplers and hydraulic multi-connectors of the monitoring system equipment shall be subjected to PVT type tests after placing the SUPPLIER AFM, including cycling connection and disconnection in a hyperbaric chamber according to procedures approved by PETROBRAS. The samples used in these tests shall be chosen randomly from those manufactured for the MONITORING SYSTEM and cannot be reused as part of the MONITORING SYSTEM equipment after the tests.

6.3.18.1 As an alternative to meet the requirement of previous item, SUPPLIER shall be allowed to present to PETROBRAS approval, in the project detailing phase, the qualification history of the couplers from a previous supply, in PETROBRAS projects. The history shall comprise couplers with successful performance in the field, as well as understand the fulfillment of the same or more demanding requirements in relation to this ET. Copper alloys such as "Hiduron 130" and "Nibron" are historically incompatible with hydraulic fluid MacDermid HW443, so these materials are not allowed the use of such materials in hydraulic couplers for Monitoring System at the regions of the couplers in which there is contact with hydraulic control fluid.

6.3.19 The hydraulic multi-connectors of the MONITORING SYSTEM shall have a locking mechanism with rotational type for ROV actuation. The design of the hydraulic multi-connector shall be such that, in the event of receiving over torque, the locking mechanism shall have a failure mode that allows the unlocking of the hydraulic multi-connector.

6.3.20 HYDRAULIC SYSTEM block valves shall be subjected to PVT type tests by the SUPPLIER after placing the AFM, including connection and disconnection cycling 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 MONITORING SYSTEM and shall not be reused as part of the MONITORING SYSTEM equipment after the tests.

6.3.21 HYDRAULIC SYSTEM block valves shall have a rotating type mechanism for mechanical actuation ROV interface.

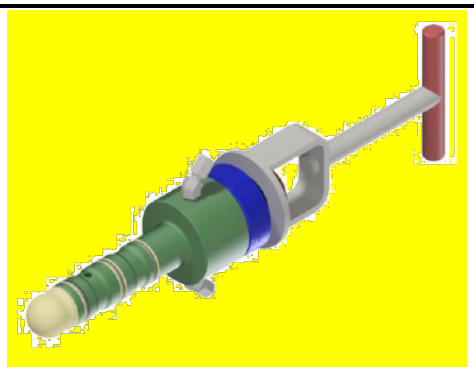

Figure 4 – Hot-stab (PETROBRAS standard)

6.3.22 The hydraulic supply for the SESDV actuation shall be of "dual hot stab" type, according to PETROBRAS standard. All hydraulic actuation lines shall have a corresponding block valve that shall be a rotating type mechanism for mechanical actuation ROV interface at SESDV ROV panel.

6.3.23 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 MONITORING SYSTEM COMPONENTS

7.1 System overview

7.1.1 For each SESDV, discriminated in the scope of supply, shall be included in 1 (one) SESDV MONITORING SYSTEM, comprising: monitoring module (section 7.2), subsea instrumentation (section 7.3), electrical distribution (section 7.4), hydraulic system (section 7.5) and EFL jumper (section 7.6). The general scheme of the MONITORING SYSTEM is shown in Figure 5.

7.1.2 The ELECTRICAL SYSTEM is characterized by components that perform SUBMARINE INSTRUMENTATION and ELECTRICAL DISTRIBUTION, as detailed in Sections 7.3 and 7.4.

7.1.3 All accessories and spare components of the MONITORING SYSTEM shall be supplied in appropriate packaging for storage, according to the requirements of Section 12.

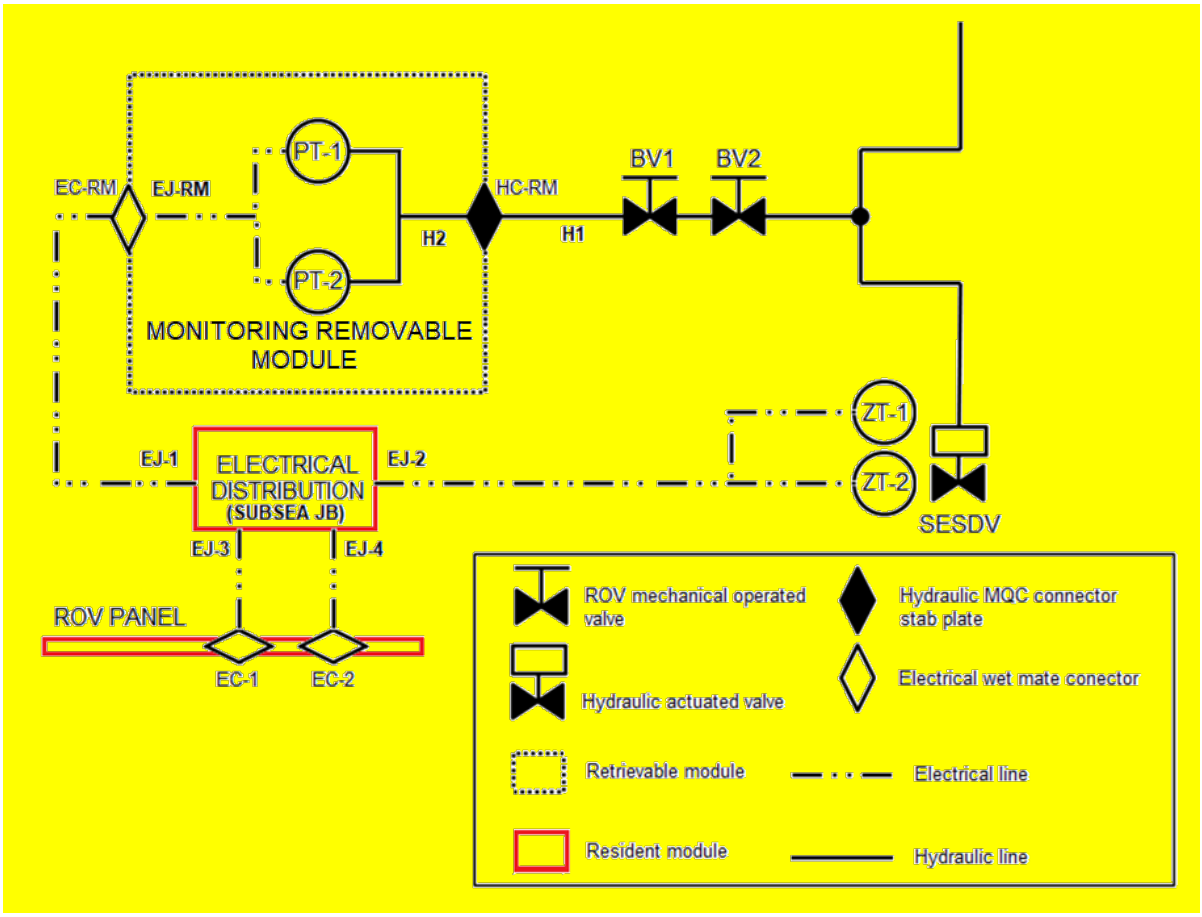

Figure 5 – SESDV MONITORING SYSTEM general schematic

7.2 Monitoring removable module

7.2.1 The SESDV MONITORING SYSTEM shall have in its composition 1 (one) MONITORING REMOVABLE MODULE.

7.2.2 The MONITORING REMOVABLE MODULE structure houses the PT instrumentation and part of the HYDRAULIC SYSTEM, according to the diagram in Figure 5.

7.2.3 The hydraulic interconnection and mechanical support of the MONITORING REMOVABLE MODULE shall be completely carried out through a hydraulic multi-connector of the HYDRAULIC SYSTEM.

7.2.4 The MONITORING REMOVABLE MODULE shall be capable of being installed and recovered in the subsea environment independently of the SESDV structure, through single ROV operation, without the need of auxiliary lifting cables.

7.2.5 The SESDV structure shall be capable of being installed and recovered from the subsea environment with the MONITORING REMOVABLE MODULE interconnected.

7.2.6 MONITORING REMOVABLE MODULE (including MONITORING REMOVABLE MODULE CABLING) shall be supplied in dedicated transportation “IP-65” box for the offshore installation.

7.2.7 SESDV CONTRACTOR shall provide 1 (one) electrical test connectors kit for ROV wet mate connectors for supporting MONITORING REMOVABLE MODULE mounting, testing, installation etc.

7.2.8 SESDV CONTRACTOR shall provide 1 (one) hydraulic kit for MQC connectors for supporting MONITORING REMOVABLE MODULE mounting, flushing, testing, installation etc.

7.2.9 SESDV CONTRACTOR shall supply as a minimum amount of 1 (one) spare MONITORING REMOVABLE MODULE in dedicated transportation “IP-65” boxes.

7.3 Submarine Instrumentation

7.3.1 The electrical system shall have in its composition the submarine instrumentation comprising of:

- 2 (two) PT sensors (main and redundant), resident inside the MONITORING REMOVABLE MODULE (ROV retrievable module), with the function of monitor the pressure of the actuation hydraulic line of the SESDV;
- 2 (two) ZT sensors (main and redundant), resident inside the SESDV actuation structure, with the function of monitor the position indication of the SESDV shutter.

7.3.2 The PT and ZT sensors shall have its entire electrical interface established by 2 (two) wires, which simultaneously perform the electrical supply and the analog communication (passive 4-20mA sensor). Analog communication and power supply shall be in accordance with Appendix D of API 17F (2014).

7.3.3 The canister, in which the sensors and electronic devices will be installed, shall be filled with an inert gas with a pressure of at least 1 atm, which is intended to protect against damage caused by condensation of water vapor inside the compartment.

7.3.4 SESDV CONTRACTOR shall include in the subsea junction boxes a screw for fixing earthing cable strap connecting it to the SESDV structure.

7.3.5 SESDV CONTRACTOR shall include in the PT sensors a screw for fixing earthing cable strap connecting it to the MONITORING MODULE structure.

7.3.6 SESDV CONTRACTOR shall include in the ZT sensors a screw for fixing earthing cable strap connecting it to the SESDV structure.

7.3.7 Features of PT sensors:

7.3.7.1 Calibration range: 0 to 7500 psi;

7.3.7.2 Maximum allowable pressure: 10k psi;

7.3.7.3 Break pressure: 15k psi;

7.3.7.4 Stability: ± 0.1 % FS/year;

7.3.7.5 Accuracy: ± 0.2 % FS (“zero / span setting and temperature effects” - TOTAL ERROR BAND);

7.3.7.6 Repeatability: ± 0.06% FS;

7.3.7.7 Resolution: 0.03 % FS;

7.3.7.8 Power supply: 12 to 36 VDC;

7.3.7.9 Output signal: 4 to 20 mA.

7.3.8 Features of ZT sensors:

7.3.8.1 Fully opened position: 4 mA;

7.3.8.2 Fully closed position: 20 mA;

7.3.8.3 Accuracy: ± 0.6% FS (“zero / span setting and temperature effects” - TOTAL ERROR BAND);

7.3.8.4 Power supply: 12 to 36 VDC;

7.3.8.5 Output signal: 4 to 20 mA.

7.4 Electrical distribution

7.4.1 The ELECTRICAL SYSTEM has in its composition the ELECTRICAL DISTRIBUTION:

7.4.1.1 MONITORING REMOVABLE MODULE CABLING: which shall be characterized by the MONITORING REMOVABLE MODULE internal electrical cabling to be interfaced with the SESDV MAIN CABLING by subsea electrical jumper (SESDV EFL).

7.4.1.2 SESDV MAIN CABLING: which shall be characterized by subsea electrical jumpers all arranged inside SESDV structure and centralized by a resident subsea junction box solution.

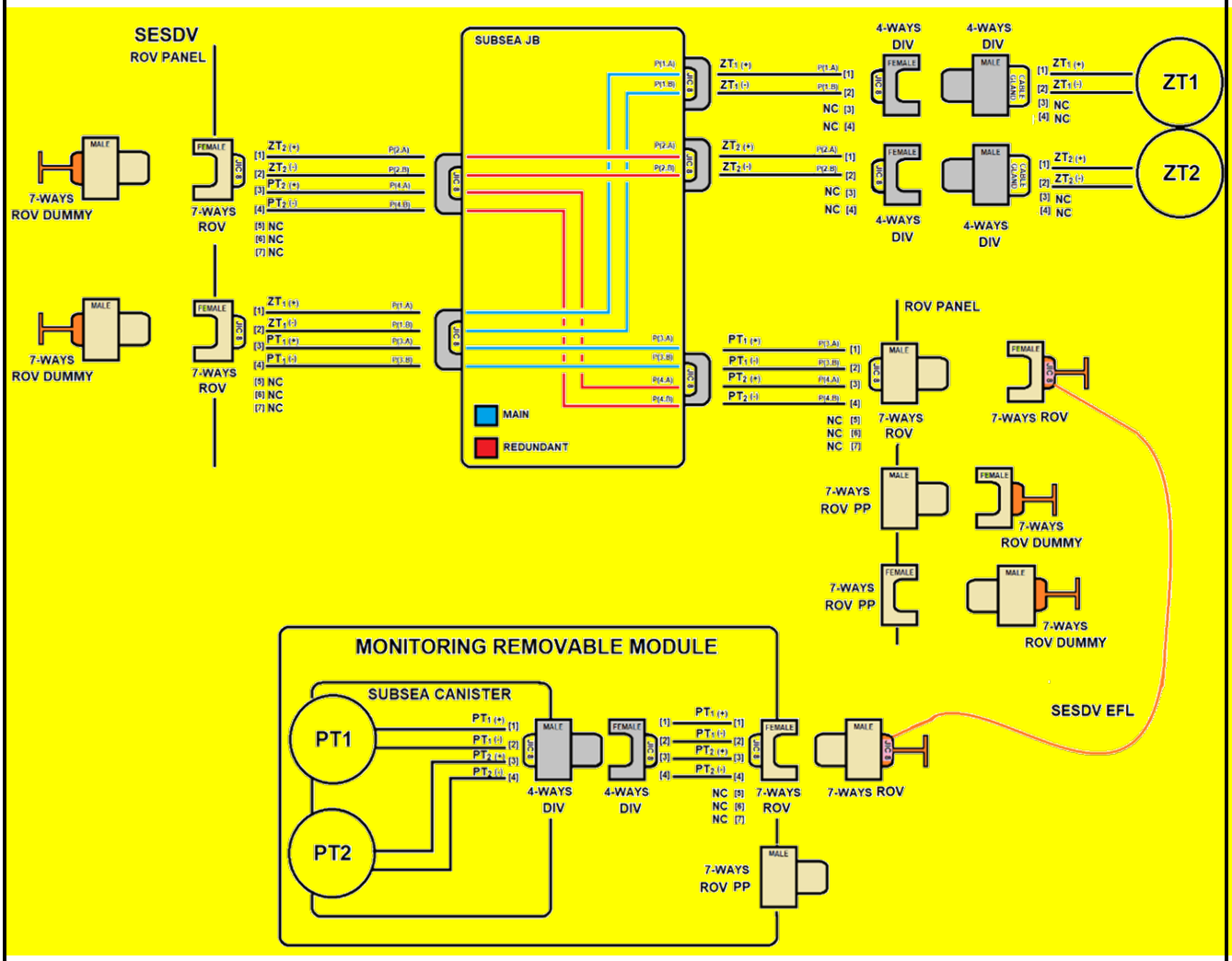

Figure 6 – ELECTRICAL SYSTEM wiring diagram from SESDV MONITORING SYSTEM

7.4.2 ELECTRICAL SYSTEM wiring diagram with the ELECTRICAL DISTRIBUTION is presented in Figure 6. All ELECTRICAL SYSTEM (except parking places) shall be supplied in dedicated transportation "IP-65" boxes for the offshore installation.

7.4.3 The ROV wet mate connectors (to interface with UTA) at SESDV ROV panel shall be mounted according to the following pinout wiring arrangement:

- EC-1 (main): pins #1 / #2 (ZT-1 signals) and pins #3 / #4 (PT-1 signals);

- EC-2 (redundant): pins #1 / #2 (ZT-2 signals) and pins #3 / #4 (PT-2 signals).

7.4.4 SESDV CONTRACTOR shall design/supply 1 (one) resident subsea junction box to configure all the electrical conductors.

7.4.5 SESDV CONTRACTOR shall provide 2 (two) protective ROV dummy connectors (x2 MALE – SESDV MODEL), operated by ROV to protect wet mate bulkhead connectors for underwater UTA installation operation.

7.4.6 SESDV CONTRACTOR shall provide 2 (two) protective ROV dummy connectors (x1 MALE & x1 FEMALE – SESDV MODEL), operated by ROV to protect wet mate bulkhead connectors for MONITORING REMOVABLE MODULE underwater maintenance.

7.4.7 SESDV CONTRACTOR shall provide 4 (four) connectors parking places (x3 FEMALE – SESDV MODEL and x1 MALE– SESDV MODEL), mounted on ROV panel compatible with the EFL JUMPER SET terminations.

7.4.8 All the electrical bulkhead connectors and parking places shall be identified by TAGs in the ROV panels for viewing by ROV. The identification shall adopt abbreviations that will be defined by PETROBRAS during the details of the project.

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

7.4.10 SESDV CONTRACTOR shall request to PETROBRAS, in the project's detailing phase, the models of UTA 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 7.

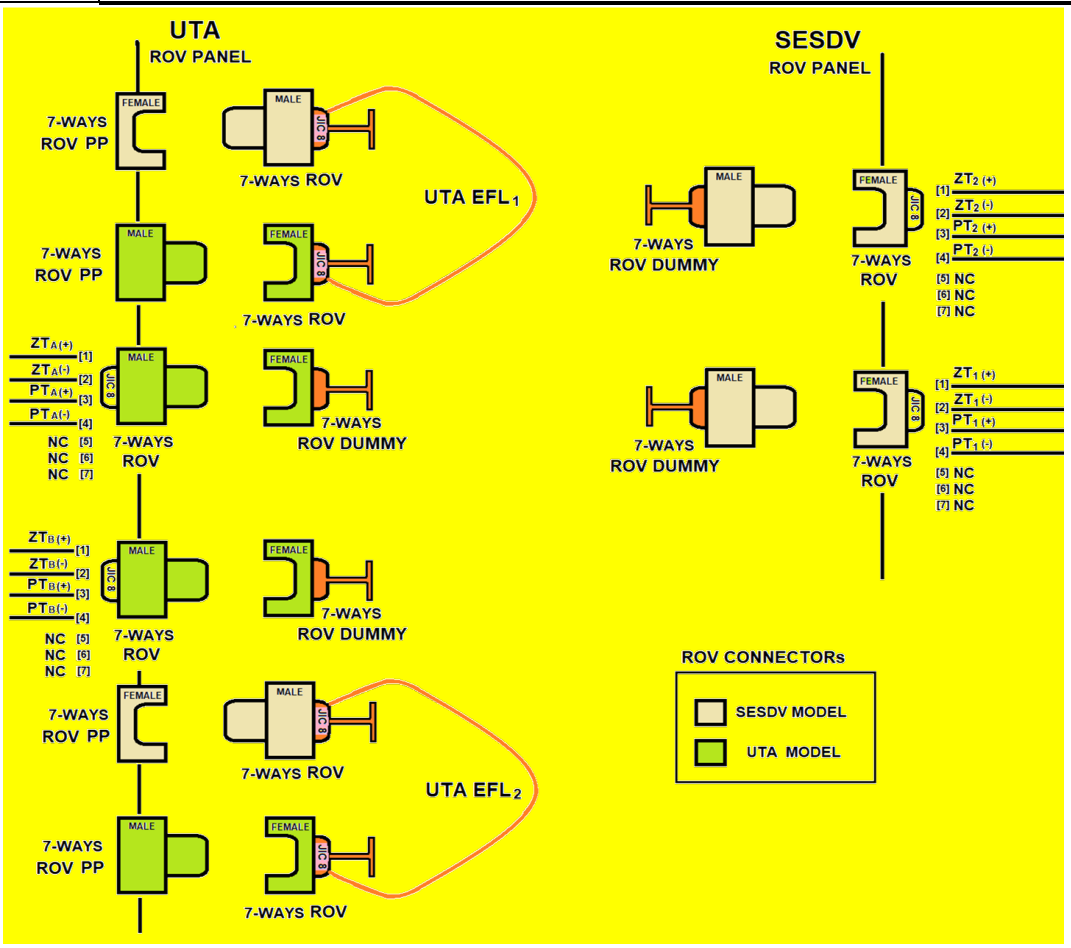

Figure 7 – SESDV & UTA ELECTRICAL SYSTEM interface schematic drawing

7.4.11 The installation of the interface for the electrical bulkhead wet mate connectors, in ROV panels, shall be in accordance with the dimensions shown in Figure 8.

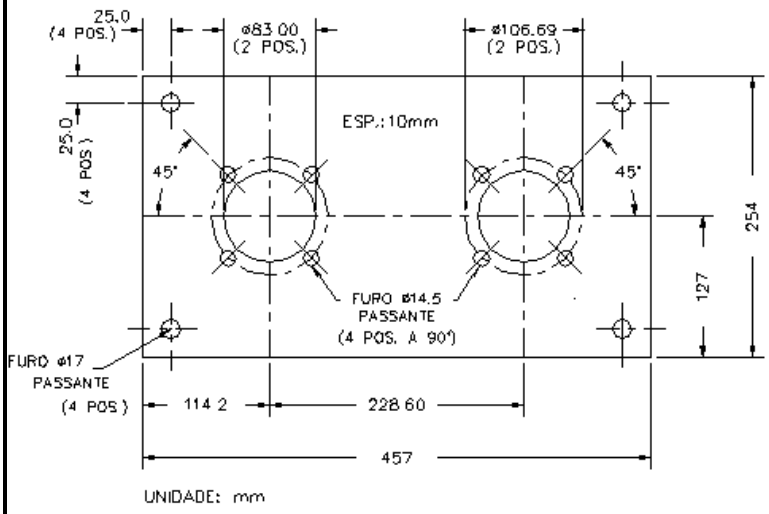

Figure 8 – Standardization of electrical connector housing for ROV panel

7.4.12 SESDV CONTRACTOR shall submit for approval by PETROBRAS, after placing the AFM, the operational procedures for commissioning and decommissioning the MONITORING SYSTEM in the field.

7.5 Hydraulic system

7.5.1 MONITORING SYSTEM shall have in its composition the HYDRAULIC SYSTEM, composed of 1 (one) hydraulic line with branches H1 and H2 as defined:

7.5.1.1 The H1 branch shall be resident in the SESDV structure and interconnects to the SESDV's hydraulic actuation line.

7.5.1.2 The H2 branch shall be resident in the MONITORING MODULE and is terminated at the pressure tap of the PTs canister of the SUBMARINE INSTRUMENTATION.

7.5.2 Regarding the hydraulic piping of the H1 branch:

7.5.2.1 The first end of the H1 branch is connected to the SESDV's hydraulic actuation line;

7.5.2.2 The second end of the H1 branch is terminated in a hydraulic multi-connector residing in the SESDV structure and interfaces with the MONITORING REMOVABLE MODULE;

7.5.2.3 The H1 branch shall contain 2 (two) blocking valves with individual mechanical actuation by ROV, called BV1 and BV2, according to the scheme of Figure 5. The individual mechanical actuation interfaces shall be located on the ROV panel of the SESDV structure.

7.5.3 Regarding the hydraulic piping of the H2 branch:

7.5.3.1 The first end of the H2 branch shall be terminated in a hydraulic multi-connector residing in the MONITORING MODULE and interfaces with the H1 branch residing in the SESDV structure;

7.5.3.2 The second end of the H2 branch shall be terminated at the PT pressure port of the subsea instrumentation.

7.5.4 HYDRAULIC SYSTEM shall have 1 (one) hydraulic multi-connector mounted on the SESDV structure, for termination of the H1 branch of the HYDRAULIC SYSTEM. Such hydraulic multi-connector shall be compatible for connection to the MONITORING REMOVABLE MODULE hydraulic multi-connector.

7.5.5 HYDRAULIC SYSTEM shall have 1 (one) hydraulic multi-connector mounted on the MONITORING REMOVABLE MODULE, for terminating the H2 branch of the HYDRAULIC SYSTEM and for supporting and mechanically locking the MONITORING REMOVABLE MODULE, when connected to the SESDV structure.

7.5.6 HYDRAULIC SYSTEM shall have 1 (one) hydraulic multi-connector “parking place” mounted on the SESDV structure. Such multi-connector shall be compatible for connection to the MONITORING REMOVABLE MODULE hydraulic multi-connector.

7.5.7 HYDRAULIC SYSTEM shall have 1 (one) hydraulic multi-connector of the type "long-term protective cover", operable by ROV. The hydraulic termination, residing in this protection multi-connector, shall be individual for the hydraulic line and establish tightness when in contact with the hydraulic coupler belonging to the hydraulic multi-connector residing in the SESDV structure. Such protection multi-connector shall be compatible with all hydraulic multi-connectors resident in the SESDV structure.

7.5.8 The hydraulic multi-connectors shall be identified by TAGs at the SESDV structure, for viewing by ROV. The identification shall adopt abbreviations that will be defined by PETROBRAS during the details of the project.

7.5.9 The hydraulic multi-connectors of the hydraulic system shall be model with a minimum of thirteen (13) and a maximum of fourteen (14) hydraulic couplers.

7.5.10 SESDV CONTRACTOR shall present, for PETROBRAS approval, the operational procedure for commissioning and decommissioning the MONITORING SYSTEM in the field.

7.6 Flying-leads jumpers set

7.6.1 It shall comprise the SESDV CONTRACTOR main scope of supply of MONITORING SYSTEM, 1 (one) SESDV EFL for the electrical interconnection between MONITORING REMOVABLE MODULE and SESDV ROV panel, as presented in Figure 6.

7.6.2 SESDV EFL shall be at least 10 meters long.

7.6.3 The physical routing of SESDV EFL, in SESDV structure, shall be presented in the Technical Proposal.

7.6.4 EFL shall be operable in subsea environment by single ROV, including the operations of connecting and disconnecting its ends from SESDV.

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

7.6.6 The connector of SESDV EFL termination that connects to the SESDV ROV PANEL shall have an electrical connector model with exposed pins (FEMALE MODEL).

7.6.7 The connector of SESDV EFL termination that connects to the MONITORING REMOVABLE MODULE shall have an electrical connector model with non-exposed pins (MALE MODEL).

7.6.8 SESDV 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 SESDV EFL.

7.6.9 SESDV CONTRACTOR shall supply as a minimum amount of spare electrical items: 1 (one) spare UTA EFL and 1 (one) spare SESDV EFL in dedicated transportation “IP-65” boxes. The spare UTA EFL shall be 50 meters long.

7.6.10 SESDV CONTRACTOR shall supply as a minimum amount of 1 (one) spare HFL in dedicated transportation “IP-65” boxes. The spare HFL shall be 50 meters long.

7.6.11 . With respect to the spare HFL requirements:

7.6.11.1 Both hydraulic connectors terminations shall be identical, shall be exchangeable and shall be of "dual hot stab" type, according to PETROBRAS standard;

7.6.11.2 The spare HFL shall contain 2 (two) independent hydraulic lines;

7.6.11.3 The hydraulic control lines shall be ½” thermoplastic hoses.

7.6.12 .SESDV CONTRACTOR shall submit to PETROBRAS approval the volumetric expansion values specified for the hydraulic hoses of the spare HFL.

8 INSTALLATION AND INTERVENTION REQUIREMENTS

8.1.1 The structure of the SESDV shall have basket in order to accommodate 1 (one) SESDV EFL. The placement of basket in the structure shall make it possible to:

8.1.1.1 The offshore installation of SESDV, with the EFL being simultaneously accommodated at the basket;

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

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 MONITORING SYSTEM.

9 SYSTEM AVAIBILITY

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

9.1.2 The MTTF of the entire MONITORING SYSTEM shall also be informed, calculated for the operating conditions indicated in this ET. SESDV 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 SESDV CONTRACTOR shall present in the project detailing phase, for approval by PETROBRAS, the operational procedures applicable with respect to the MONITORING SYSTEM.

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

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

10.1.5 CONTRACTOR shall present, in the project detailing phase, for PETROBRAS approval, the procedure for the storage and preservation of the MONITORING 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 SESDV with flying leads and MONITORING REMOVABLE MODULE;
- General arrangement with routing of hydraulic system including MONITORING REMOVABLE MODULE;
- General arrangement with routing of electrical system including MONITORING REMOVABLE MODULE;
- Sensors drawings, electrical analysis according to item 6.1.11, calibration certificates and datasheets;
- Electrical connectors drawings and datasheets;
- Hydraulic connectors drawings and datasheets;
- Factory Acceptance Test Procedure/Reports;
- Acceptance and Performance test (TAP) Procedure/Reports;
- Operational procedure for MONITORING REMOVABLE MODULE;
- ROV operational procedures.

11 TESTS AND INSPECTIONS

11.1.1 Regarding the qualification tests:

11.1.1.1 All components of MONITORING 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 MONITORING 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, 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 MONITORING SYSTEM, in addition to the FAT procedures themselves, shall be submitted for approval by PETROBRAS during the project detailing phase.

11.1.3 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.

11.1.4 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.

11.1.5 MONITORING SYSTEM components shall be submitted to hyperbaric chamber tests including EFL, MONITORING MODULE and SUBSEA INSTRUMENTATION.

11.1.6 The SIT shall be performed by CONTRACTOR before the CLM, with MONITORING SYSTEM integrated at SESDV structure.

11.1.7 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.

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

11.1.9 The tests program shall demonstrate that all components of MONITORING SYSTEM have been successfully installed and connected and that MONITORING 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 MONITORING SYSTEM against possible damage during transport, loading and unloading.

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

12.1.4 ELECTRICAL SYSTEM shall be delivered to PETROBRAS disassembled from SESDV structure, packed by SESDV 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 MONITORING REMOVABLE MODULE with accessories 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 spare HFL jumper 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.

12.1.7 The spare EFL 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.

12.1.8 The SESDV EFL jumper shall be delivered to PETROBRAS accommodated in existing basket in the SESDV structure (UTA body), respecting the total quantity according to RM in which this ET is referenced.

12.1.9 The SESDV with MONITORING SYSTEM shall be delivered to PETROBRAS covered in canvas in order to protect against ultraviolet rays, so that the components of MONITORING SYSTEM, resident in SESDV structure, shall be protected from the weather.

12.1.10 The description of the packaging of MONITORING 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 SESDV CONTRACTOR shall be responsible for the conditioning of MONITORING 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, SESDV CONTRACTOR shall submit for approval of PETROBRAS, the procedures for the implementation of the conditioning of MONITORING 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 SESDV 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

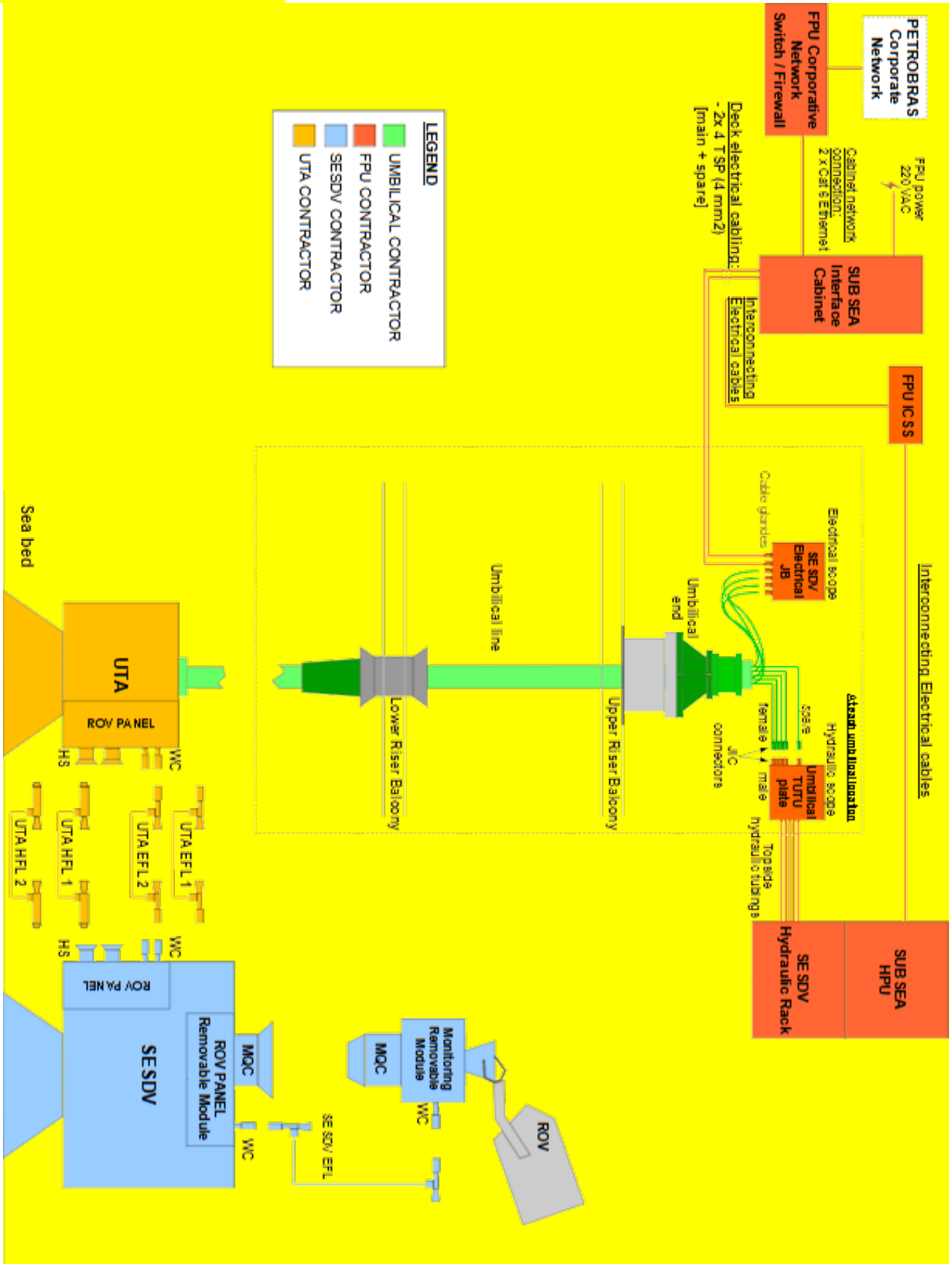

Figure 9 – Diagram of SESDV system main components standard scope of supplies