	TECHNICAL SPECIFICATION Nº: I-ET-3000.00-1500-800-PEK-019								
	CLIENT: PETROBRAS	SHEET: 1 of 11							
	JOB: Subsea Processing and Boosting Systems								
	AREA: Subsea Electrical Power System								
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AS INFORMAÇÕES DESTE DOCUMENTO SÃO PROPRIEDADE DA PETROBRAS, SENDO PROIBIDA A UTILIZAÇÃO FORA DA SUA FINALIDADE.									
FORMULÁRIO PERTENCENTE A PETROBRAS N-0381 REV. L.									

**TECHNICAL SPECIFICATION**

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REV. 0

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TÍTULO:

SUBSEA MOTOR-PUMP TRANSDUCER SYSTEM

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1 INTRODUCTION

This document presents the requirements to be met for the supply of the instrumentation that monitors the motor-pump assembly of Subsea Processing & Boosting Systems (SP&BS).

2 REFERENCE DOCUMENTS

2.1 PETROBRAS Documents

Doc. Nr.	Title
[1] I-ET-3000.00-1500-823-PEK-001	Qualification of wet-mate electrical connectors and accessories
[2] ET 3000.00-1516-823-PEK-008	Testes de qualificação para TPT
[3] RM	Material Requisition(s) with technical aspects and scope specific to the project
[4] I-ET-3000.00-1500-700-PEK-001	Subsea High-Voltage Electrical Motor
[5] SP&BS Technical Specification NOTE 02	Subsea Processing & Boosting System
[6] SP&BS Control System Technical Specification	SP&BS Control System

NOTE 02: Technical Specification specific of the bidding process.

2.2 Industry Codes, Standards, Rules and Regulations


The references standards listed below shall be used. Other recognized standards may be used only with PETROBRAS approval before detailed design phase starts.

Doc. Nr. or Author	Title
[7] API 6A	Specification for Wellhead and Tree Equipment
[8] API 17D	Design and Operation of Subsea Production Systems — Subsea Wellhead and Tree Equipment
[9] API 17F	Standard for Subsea Production Control Systems
[10] API 17Q	Recommended Practice on Subsea Equipment Qualification
[11] API 670	Machinery Protection Systems

3 TERMS, DEFINITIONS, ACRONYMS AND ABBREVIATIONS

3.1 For the purposes of this TS, the following Terms and Definitions apply.

SUBSEA MOTOR-PUMP TRANSDUCER SYSTEM (SMPTS): A proximity probe, accelerometer, or sensor, an extension or accelerometer cable, electrical connections, and low voltage penetrators. The transducer system generates a signal that is proportional to the measured variable.

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Field Proven: A field proven SMPTS component is one that have been successfully qualified with temperature, pressure, voltage, and currents ratings equal or superior to SP&BS requirements stated in this technical specification document, successfully installed in water depth equal or greater than 1,500 meters and in operation without failures for at least 5 years.

Fully redundant: Requirements from functional safety guidelines that establish the need for redundancy with two fully separated parallel measuring channels, including two individual probes/sensors and two signals conditioning electronic module.

3.2 For the purposes of this TS, the following Acronyms and Abbreviations apply.

SP&BS: Subsea Processing and Boosting System

SMPTS: Subsea Motor-Pump Transducer System

SUPPLIER: Company directly awarded by PETROBRAS responsible for the complete scope of supply and related activities. SUPPLIER may award sub-suppliers to deliver part of the scope of work maintaining responsibility over sub-suppliers' scope.

TPT: Pressure and Temperature Transmitter.

4 SUBSEA MOTOR-PUMP TRANSDUCER SYSTEM

4.1 All components of the SMTPS shall comply with design and qualification requirements to be applied in the SP&BS, as per [3].

4.2 The requirements for the SMPTS for SP&BS project are measuring radial shaft vibration, casing vibration, shaft axial position, phase reference and barrier fluid pressure and temperature.

4.3 As a minimum, SUPPLIER monitoring solution shall include the following devices as part of the SMPTS:


4.3.1 4 (four) Radial Shaft Vibration Probes (two per bearing).

4.3.2 2 (two) Axial Position Probes.


4.3.3 1 (one) Phase Reference Transducer for each different shaft speed.

4.3.4 3 (three) Accelerometer sensors.


4.3.5 2 (two) Pressure and Temperature transmitters.

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- 4.4 The monitoring devices (sensors and probes) shall have electrical interfaces requirements in accordance with the standard presented in [9].
- 4.5 The design life for the SMPTS parts and devices shall comply with the same requirements presented for the motor, as per [4], and for the pump, as per [5], which are presented in [3].
- 4.6 All SMPTS components shall be designed to operate in the specified temperature class of the motor-pump set, according defined in [7].
- 4.6.1 In case of temperature class of the SMPTS elements does not achieve the temperature class of the motor-pump set, SUPPLIER may submit to PETROBRAS a claim to reduce the temperature class under the following conditions:
- 4.6.1.1 SUPPLIER shall propose a Thermal class that match the temperature ratings presented in the table 2 of the item 4.3.2 of [7].
- 4.6.1.2 SUPPLIER shall attach in the claim request a finite element thermal analysis showing the temperature in the proposed element installed in the equipment. The thermal analysis shall consider the pump in rated operational conditions and boosting the fluid settled-out minimum and maximum temperature, according to requirements presented in [3].
- 4.6.1.3 PETROBRAS will be responsible for analyses and approval of the required claim. PETROBRAS will not accept proposal with thermal class below the requirements presented in [9].
- 4.7 The housing of the monitoring devices (probes and sensors) shall be rated for working pressures specified in [3].
- 4.8 All SMPTS components shall be installed in a cavity flooded with barrier fluid. No component shall have contact with the process fluid.
- 4.9 All SMPTS components shall be designed and qualified in accordance with [7], [8] and [9].
- 4.9.1 The low voltage penetrator, if proposed, shall be designed, and qualified according to requirements presented in section 7 of this Technical Specification.
- 4.10 Proximity Probe Transducers shall be used to Radial Shaft Vibration, Axial Position, and Phase Reference monitoring. The accuracy of this probes shall be in accordance with [11].

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- 4.11 The four Radial Shaft Vibration Probes shall be installed to monitor the motion of the pump shaft. Each pair of Radial Shaft Vibration Probes shall be coplanar, 90° apart each other and perpendicular to the shaft axis.
- 4.12 The proximity probes and phase reference probe shall be no contacting type. No contacting monitoring probes including Radial Shaft Vibration Probes, Axial Position Probes and Phase Reference Transducers shall be designed and installed in accordance with [11]. Shaft surface preparation in the probe area shall be in accordance with [11]. During the detailed design phase, the motor-pump set drawing highlighting the position of the proximity probes and phase reference probe shall be submitted to PETROBRAS for analysis and approval.
- 4.13 The accelerometer sensors shall be installed in the motor-pump casing. The accelerometers shall preferably be positioned as close as possible to the bearings that are not being monitored by proximity probes. During the detailed design phase, the motor-pump set drawing highlighting the sensor positions shall be submitted to PETROBRAS for approval.
- 4.14 For probes and sensors base on mounting flange, the standard API 6BX - 1.13/16" - 10 kpsi shall be employed.
- 4.15 The pressure and temperature gauges shall be installed to monitoring the barrier fluid. The transmitter shall be fully redundant and the connection with the equipment shall have a flange API type (6BX - 1.13/16" - 10 kpsi). During the detailed design phase, the motor-pump set drawing highlighting the probes positions shall be submitted to PETROBRAS for approval.
- 4.16 Penetrators for pressure retaining equipment shall be designed to operate at the rated absolute pressure applied as per [3].
- 4.17 All parts of the monitoring devices, housing, cables, and penetrators shall be compatible with the fluids they are in contact.
- 4.18 The SMPTS shall be connected to the Subsea Control Module (SCM) of SP&BS Control System, which is specified in [6]. The communication and power supply of the SMPTS shall be fully compatible with the SCM, fault tolerant, according to definitions and requirements established in Annex E of the [9].

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5 PRESSURE SENSOR REQUIREMENTS


5.1 The barrier fluid pressure sensor shall have the following specifications:

- 5.1.1 Calibration range: 0 to SP&BS pressure, as per [3].
- 5.1.2 Maximum design pressure: 1,5 x SP&BS pressure and burst pressure: 2,0 x SP&BS pressure.
- 5.1.3 Calibrated temperature range: 0°C a + 100°C.
- 5.1.4 Operational temperature range: - 18°C a + 121°C, as per [7].
- 5.1.5 Stability: $\pm 0,1$ % FS / year.
- 5.1.6 Accuracy: $\pm 0,2$ % FS (“zero/span setting and temperature effects” – TOTAL ERROR BAND).
- 5.1.7 Repeatability: $\pm 0,06$ % FS.
- 5.1.8 Resolution: 0,03 % FS.
- 5.1.9 Protocol: SIIS Level 2 interface as described in [9].

6 TEMPERATURE SENSOR REQUIREMENTS

6.1 The barrier fluid temperature sensor shall have the following specifications:

- 6.1.1 Calibrated temperature range: 0°C a + 100°C.
- 6.1.2 Operational temperature range: - 18°C a + 121°C, as per [7].
- 6.1.3 Stability: 0,5 % FS / year.
- 6.1.4 Accuracy: ± 1 % FS (“zero/span setting” – TOTAL ERROR BAND).
- 6.1.5 Repeatability: $\pm 0,1$ % FS
- 6.1.6 Resolution: 0,03 % FS
- 6.1.7 Protocol: SIIS Level 2 interface as described in [9]


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7 PENETRATOR AND ELECTRICAL FEEDTHROUGH SYSTEM

- 7.1 This section covers penetrators and electrical feedthrough systems which establish barriers between internal barrier fluid cavity and the external environment, when applied for the electrical components of the monitoring system.
- 7.2 The design/conception of the interface between the electrical system and the penetrator housing in the motor or pump casing shall guarantee the sealing and prevent the leakage even in case of failure of the electrical components.
- 7.3 The penetrator and electrical feedthrough systems shall have metal sealing with the motor-pump casing interface.
- 7.4 The electrical penetrators shall have a proper designed interface to receive the cables which comes from the sensors/probes.
- 7.5 The cable connection at the rear of the connector assemblies shall provide a redundant sealing system with at least two mechanical barriers against water and barrier fluid ingress.
- 7.6 The electrical feedthrough systems shall be design according to requirements presented in [9].
- 7.7 Regarding the mechanical properties, the penetrator shall be designed and tested mechanically, according to requirements presented in [7], to be applied in a 5kpsi Subsea Pump System.

8 QUALIFICATION

- 8.1 All components of the SMPTS shall be submitted to qualification tests to certify that requirements of the project are fully met.
- 8.2 A qualification program shall be developed for each component of the SMPTS following the practice presented in [10].
- 8.2.1 The qualification program shall include all tests and procedures established in [9], except for tests 9.2.2 and 9.2.4.
- 8.2.2 The electrical feedthrough systems shall be qualified according to requirements presented in [9]:

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8.2.2.1 The penetrator also shall be categorized and qualified to standardized pressure classes, in accordance with [7]. The level of technical qualification shall be considered as PSL 3G and PR2.

8.2.2.2 The applicable temperature range shall be clearly specified and related to the pressure rating requirements. The temperature rating for the thermal tests shall met requirements presented in section 4.6 of this Technical Specification.

8.3 The TPT shall be qualified according to [2].

8.4 SUPPLIER shall submit the qualification test program to analysis and approval of PETROBRAS at least 90 days before the date of start activities.

8.5 PETROBRAS might, if wishes, witness the tests related to the qualification program.

8.6 Qualification test records and reports shall be submitted to PETROBRAS for analysis and approval.

8.7 The exemption from the SMPTS component qualification program can be granted by PETROBRAS, once they have already submitted to a qualification process according to the criteria presented in this document or if they meet the field proven criteria. To dispense the qualification, process SUPPLIER shall present the supporting documents to PETROBRAS analysis and approval.


9 FACTORY ACCEPTANCE TEST (FAT)

9.1 The components of the SMPTS shall be submitted to the Factory Acceptance Tests (FAT) to validate the functionality and integrity of the components before the delivery.

9.2 SUPPLIER shall submit the FAT program to analysis and approval of PETROBRAS at least 90 days before the date of start activities.

9.3 The FAT shall be conducted by the manufacturer and witnessed by a PETROBRAS representative.

9.4 The FAT program shall include all tests and procedures presented in section 9.3 of [9], with the exception of subsections 9.3.2.2, 9.3.3, 9.3.5, 9.3.6, 9.3.8 and 9.3.9 (the latter is applicable to the FAT / SIT of the control system as a whole, not to the FAT of SMPTS components).

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9.5 Regarding the section 9.3.4 (Functional and Continuity Tests) of the [9], the following additional tests shall be performed:

9.5.1 PROXIMITY PROBES, ACCELEROMETER and PHASE REFERENCE

9.5.1.1 Electrical functional tests performed within the full range of supply voltage.

9.5.1.2 Functional tests shall include communication with the same electronic module considered to subsea application.

9.5.1.3 SUPPLIER shall individually bench test each component according to requirements presented in [11] section 11.3.

9.5.1.4 Calibration shall be performed. Calibration procedures shall consider the whole operational range in speed/frequency of the motor-pump set. Calibration shall verify accuracy requirements which are presented in [11]. SUPPLIER shall submit the calibration procedures to analysis and approval of PETROBRAS.

9.5.2 Pressure and Temperature Transmitter (TPT):

9.5.2.1 Pressure calibration test shall be performed with 3 (three) different pressure levels at 60°C and 4°C or under conditions specified by the manufacturer and previously approved by PETROBRAS (“zero/span setting and temperature effects” – TOTAL ERROR BAND –maximum ± 0.2 % FS).


9.5.2.2 Temperature calibration test shall be performed with 3 (three) different temperature levels or under conditions specified by the manufacturer and previously approved by PETROBRAS (“zero/span setting and temperature effects” – TOTAL ERROR BAND –maximum ± 1 % FS).

9.5.2.3 Insulation resistance test between the sensor pins and the ground. The result of the test shall present values greater than 1 G Ω at 50 Vdc and the reading recorded 60 seconds after application of the test voltage.

9.5.2.4 Electrical functional tests performed within the full range of supply voltage.

9.5.2.5 Functional and operational test (including communication test with the same electronic module considered to subsea application).

9.5.3 Electrical penetrators:

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9.5.3.1 Electrical tests.

9.5.3.2 Insulation resistance test (IR > 10 GΩ @ 500 Vdc) and the reading recorded 60 seconds after application of the test voltage).

9.5.3.3 Continuity resistance test.

9.5.3.4 Contact resistance test.

9.5.3.5 Mechanical tests.

9.5.3.6 Visual inspection.

10 DOCUMENTS

10.1 10.1 Documents shall be produced according to the criteria presented by item 9.4 of the standard [9]. The following documents shall be delivered to PETROBRAS:

10.1.1 Qualification program.

10.1.2 Qualification tests reports.

10.1.3 FAT program.

10.1.4 FAT tests reports.

10.1.5 Datasheet with technical specifications of the SMPMS components.

10.1.6 All mechanical drawings.