PETROBRAS	**TECHNICAL SPECIFICATION**	**Nº** I-ET-3010.1M-1200-850-P4X-001	
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DP&T-SRGE	**TITLE:** **SPECIAL MONITORING SYSTEMS**		NP-1
			ESUP

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SUMMARY

1 INTRODUCTION

1.1 Object

1.1.1 This document establishes the main technical requirements that shall be considered in the Special Monitoring Systems.

1.1.2 These requirements are general information related to all systems or refer to subjects that are not defined in other documents and some are remarks that shall be considered at Detailed Design Phase.

1.2 Definitions

1.2.1 Refer to I-ET-3010.00-1200-940-P4X-002 – GENERAL TECHNICAL TERMS.

1.3 Abbreviations

The following abbreviations are used in this document:

- A&C Automation & Control
- AEPR Automation & Electrical Panels Room
- ALARM Alarm Management System
- AMS Asset Management System
- CCR Central Control Room
- CLOTS Control Loops Optimization Tuning System
- CSS Control and Safety System
- EHM Electrohydraulic Multiplex Control System
- ESD Emergency Shutdown
- EWS Engineering Workstation
- FGS Fire and Gas System
- HMI Human Machine Interface
- HPU Hydraulic Power Unit
- HSTS Hull Structural Tanks Level, Interface, Pressure And Temperature Monitoring Systems
- LAN Local Area Network
- MCS Subsea Master Control System
- OPC Open Platform Communications
- OWS Operation Workstation
- PCS Process Control System
- PDG Permanent Downhole Gauge
- PLC Programmable Logic Controller
- PSD Process Shutdown
- SAS Subsea Acquisition System
- SCM Subsea Control Module
- SCSSV Surface Controlled Subsurface Safety Valve
- SESDV Subsea Shutdown Valve
- SOS Supervision and Operation System
- SPCS Subsea Production Control System

- TPT-AR Temperature and Pressure Transmitter - High Resolution
- UPS Uninterruptible Power Supply
- WAG Water Alternating Gas Injection Manifold
- WCR Well Control Rack
- WCT Wet Christmas Tree

2 REFERENCE DOCUMENTS, CODES AND STANDARDS

2.1 External References

2.1.1 International Codes, Recommended Practices and Standards

ASTM - AMERICAN SOCIETY FOR TESTING AND MATERIALS

ASTM	G21	STANDARD PRACTICE FOR DETERMINING RESISTANCE OF SYNTHETIC POLYMERIC MATERIALS TO FUNGI

IEC - INTERNATIONAL ELECTROTECHNICAL COMMISSION

IEC	60068	ENVIRONMENTAL TESTING. GENERAL AND GUINDANCE
IEC	60079	EXPLOSIVE ATMOSPHERES - ALL PARTS
IEC	60092-504	ELECTRICAL INSTALLATIONS IN SHIPS - PART 504: AUTOMATION, CONTROL AND INSTRUMENTATION
IEC	60529	DEGREES OF PROTECTION PROVIDED BY ENCLOSURES (IP CODE)
IEC	60533	ELECTRICAL AND ELECTRONIC INSTALLATIONS IN SHIPS - ELECTROMAGNETIC COMPATIBILITY
IEC	60945	MARITIME NAVIGATION AND RADIO COMMUNICATION EQUIPMENT AND SYSTEMS – GENERAL REQUIREMENTS – METHODS OF TESTING AND REQUIRED TEST RESULTS
IEC	61000	ELECTROMAGNETIC COMPATIBILITY (EMC) SERIES - ALL PARTS
IEC	61086	COATINGS FOR LOADED PRINTED WIRE BOARDS (CONFORMAL COATINGS)
IEC	61131	PROGRAMMABLE CONTROLLERS - ALL PARTS

EEMUA - ENGINEERING EQUIPMENT & MATERIALS USERS' ASSOCIATION

EEMUA	PUB N° 191	ALARM SYSTEMS - A GUIDE TO DESIGN, MANAGEMENT AND PROCUREMENT

IEEE – INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS

IEEE	802.1Q	LOCAL AND METROPOLITAN AREA NETWORKS—MEDIA ACCESS CONTROL (MAC) BRIDGES AND VIRTUAL BRIDGE LOCAL AREA NETWORKS

ISA – INTERNATIONAL SOCIETY OF AUTOMATION

ISA	5.1- 2009	INSTRUMENTATION SYMBOLS AND IDENTIFICATION
ISA	18.2	MANAGEMENT OF ALARM SYSTEMS FOR THE PROCESS INDUSTRIES

2.1.2 Brazilian Codes and Standards

INMETRO – INSTITUTO NACIONAL DE METROLOGIA, NORMALIZAÇÃO E QUALIDADE INDUSTRIAL

PORTARIA Nº 179 (18/MAIO/2010)	REGULAMENTO DE AVALIAÇÃO DA CONFORMIDADE PARA EQUIPAMENTOS ELÉTRICOS PARA ATMOSFERAS EXPLOSIVAS, NAS CONDIÇÕES DE GASES E VAPORES INFLAMÁVEIS E POEIRAS COMBUSTÍVEIS.
PORTARIA 89 (23/FEVEREIRO/2012)	ALTERAÇÃO DA PORTARIA INMETRO Nº 179, DE 18/MAIO/2010.

2.1.3 All MTE – Ministério do Trabalho regulations (NRs) shall be followed.

2.2 Internal Documents

2.2.1 Project Specification

I-DE-3010.1M-1200-942-P4X-002	GENERAL ARRANGEMENT
I-DE-3010.1M-1200-944-P4X-001	PIPING AND INSTRUMENT DIAGRAM - GENERAL NOTES
I-DE-3010.1M-5520-800-P4X-002	AUTOMATION AND CONTROL ARCHITECTURE
I-DE-3010.1M-1428-942-P4X-001	M-17 – AUTOMATION AND ELECTRICAL – EQUIPMENT LAYOUT PLAN
I-ET-3010.00-1200-800-P4X-002	AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGED UNITS
I-ET-3010.1M-1200-800-P4X-005	FIELD INSTRUMENTATION
I-ET-3010.1M-1210-888-P4X-001	PRODUCTION WELL CONTROL RACK
I-DE-3010.1M-1210-888-P4X-001	PRODUCTION WELL CONTROL RACK - LAYOUT
I-DE-3010.1M-1210-888-P4X-002	PRODUCTION WELL CONTROL RACK - FUNCTIONAL DIAGRAM
I-DE-3010.1M-1210-888-P4X-005	SESDVs CONTROL RACK - LAYOUT
I-DE-3010.1M-1210-888-P4X-006	SESDVs CONTROL RACK - FUNCTIONAL DIAGRAM
I-ET-3010.00-5520-861-P4X-001	CONTROL AND SAFETY SYSTEM – CSS
I-ET-3010.00-1200-859-P4X-001	AUTOMATION REQUIREMENTS FOR CORROSION MONITORING SYSTEM
I-ET-3010.00-5520-861-P4X-002	SUPERVISION AND OPERATION SYSTEM - SOS
I-ET-3010.00-5520-888-P4X-001	AUTOMATION PANELS
I-ET-3010.00-5140-700-P4X-002	SPECIFICATION FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS

I-ET-3010.00-5140-700-P4X-003	ELECTRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE UNITS
I-MD-3010.1M-5520-800-P4X-001	AUTOMATION AND CONTROL SYSTEM FUNCTIONS - TOPSIDES
I-MD-3010.1M-5520-800-P4X-002	AUTOMATION AND CONTROL SYSTEM FUNCTIONS - HULL
I-ET-3010.00-1200-800-P4X-013	GENERAL CRITERIA FOR INSTRUMENTATION PROJECTS
I-ET-3010.00-1210-390-P4X-001	HYDRAULIC POWER UNIT (HPU) FOR SUBSEA SYSTEM
I-RL-3010.1M-1200-940-P4X-004	PROCESS SIMULATION REPORT
I-ET-3010.00-5529-812-PAZ-001_F	ANNULUS PRESSURE MONITORING AND RELIEF SYSTEM.
I-ET-3010.1M-1231-321-P4X-001	MAIN GAS MOTOCOMPRESSOR
I-ET-3010.1M-1231-321-P4X-002	EXPORTATION GAS MOTOCOMPRESSOR
I-ET-3010.1M-1252-321-P4X-001	INJECTION GAS MOTOCOMPRESSOR
I-ET-3010.1M-1254-321-P4X-001	CO2 TURBOCOMPRESSOR
I-ET-3010.00-1200-850-P4X-002	ASSET MANAGEMENT SYSTEM (AMS)
I-ET-3010.1M-1351-800-P4X-001	HULL STRUCTURAL TANKS LEVEL, INTERFACE, PRESSURE AND TEMPERATURE MONITORING SYSTEMS

3 TECHNICAL REQUIREMENTS

3.1 Control Loops Optimization and Tuning System (CLOTS)

3.1.1 It shall be part of the supply the installation and customization to the application of 3 (three) PETROBRAS software packages, named BR-TUNNING, BR-PERFEX and BR-OPTIMUS the first for control loops tuning and the second for variability optimization.

3.1.2 These software packages shall be provided by PETROBRAS, being part of the present scope all services related to their configuration, installation and interconnection to CSS/SOS.

3.1.2.1 Through this system it shall be possible to access and optimize all control loops implemented by the CSS including those from package type P0. Control loops from package P1, P2, P2C, P2S and P2SC shall not be implemented at CLOTS. The number of control loops to be considered for this system, as well as for package critical loops shall be defined during the execution of the Detailed Design Phase.

3.2 Alarm Management System (ALARM)

3.2.1 The ALARM shall be implemented in order to get a robust, stable and effective system considering the following objectives:

- Protect plant uptime and safety, reducing losses caused by ineffective alarming;
- Increase operator effectiveness by reducing the number of alarms that requires operator intervention;
- Reduce time and effort to develop, deploy and maintain an alarm system;
- Integrate abnormal situation management intelligence to prevent, detect and mitigate plant incidents.

3.2.1.1 The implementation shall include the system installation in Automation Maintenance Workstation (PN-5500005A/B) and the customization to the application of a PETROBRAS software package, named BR-ALARMExpert, to be provided by PETROBRAS.

3.2.1.2 They shall be resident in an Automation Maintenance Workstation (PN-5500005A/B), integrated to the CSS Architecture, for acquisition of active alarms.

3.2.1.3 The ALARM shall achieve the following minimum goals:

- Average of 30 (thirty) alarms/hour/operator under normal operation condition;
- Maximum of 100 (one hundred) alarms during 10 minutes under abnormal condition;
- Alarm rate greater than 30 (thirty) alarms/hour during, at maximum, 5% of the day.

3.2.1.4 The design of ALARM shall take into account the practices stated in the:

- EEMUA - PUBLICATION 191 - ALARM SYSTEMS - A GUIDE TO DESIGN, MANAGEMENT AND PROCUREMENT;
- ISA-18.2 - MANAGEMENT OF ALARM SYSTEMS FOR THE PROCESS INDUSTRIES;
- Brazilian codes, when applicable.

3.2.2 Supply of System Software/Application Programs and respective Licenses

3.2.2.1 The software BR-ALARMExpert and its license shall be provided by PETROBRAS.

3.3 Subsea Acquisition System (SAS)

3.3.1 The SAS shall be responsible for monitoring pressure and temperature sensors (PDG and TPT-AR) of each direct control (HD) satellite well.

3.3.2 These panels shall house the 19” racks SAS equipment for all PDGs and TPT-ARs of, at least, 2 (two) satellite production wells, and shall be identified as Subsea Signal Acquisition System Rack (PN-5524001A/B).

3.3.3 SAS shall have at least the following features:

- Visualize functions as: selected sensor, unit selection, date and time, sensor voltage, sensor drained current, etc;
- Communication interface: EIA-485 with MODBUS-RTU communication protocol for PDG digital signal and for TPT – AR signal;
- SAS programming: insertion of date and time, sensor types, sensor factors, acquisition of stored process data at memory, etc;
- Internal memory for storage process data. Storage interval defined by user.

3.3.4 Two modular panels to be installed at air conditioning environment, at AEPR, shall be supplied. The panel shall comply with I-ET-3010.00-5520-888-P4X-001 – AUTOMATION PANEL and shall support the installation of the SAS and CI-ELECTRICAL equipment.

NOTE: SAS modular panels shall have also free space for future installation of equipment for 2 (two) CI-ELECTRICAL systems. See item 3.4 for further details.

3.3.5 Subsea Signal Acquisition System Rack PN-5524001A/B shall be provided with terminal strips enough to interconnect the pairs of wires from sensors. All wires shall be fully identified. The dimensions of the panels and the quantity of SAS equipment, as well as interconnection requirements, shall be confirmed at Detailed Design Phase.

3.3.6 In order to enable the SAS equipment installation, cables shall be provided to connect PDG and TPT-AR signals from umbilical junction boxes of the direct control satellite production wells to PN-5524001A/B.

3.3.7 TPT and PT signals from Direct Control WCTs shall be wired from umbilical junction box to the CSS. 6 (six) Analog Inputs shall be considered wired to CSS – PCS. These signals can be 4-20 mA or MODBUS RTU.

3.3.8 The SAS modules shall communicate with MCS panels via two redundant switches installed in PN-5524001A/B. These switches shall have at least 32 ports.

3.3.9 This panel shall be powered by as according to I-ET-3010.00-5140-700-P4X-003 – ELECTRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE UNITS. The different power supplies inside the panel shall be converted and distributed, including where necessary AC/DC stabilized power supply unit for the cabinet internal distribution of 24 Vdc.

3.3.10 For further details see ET-3000.00-1516-823-PEK-006 - DETALHES DE PROJETO DA UEP SINAIS DE MONITORAÇÃO DA ANM (TPT, PT E PDG).

3.4 Intelligent Completion (CI-Electrical)

3.4.1 An Intelligent Completion (CI) is a well completion equipped with downhole sensors and remotely operated flow control valves. There are two main designs possible regarding remote control called CI-ELECTRICAL.

3.4.2 The CI-ELECTRICAL is a P2C Package type and will have 5 (five) associated panels (PN-1210011A/B/C/D/E), to be furnished by PETROBRAS. All panels shall be installed in AEPR (Module 17). The signals from these packages shall be integrated with the CSS and with MCSs through the Ethernet Switch.

3.4.3 The valves shall be operated manually by HMIs installed at CI-ELECTRICAL panels (or CI-ELECTRICAL equipment) or remotely by SOS HMIs in the CCR. The pressure and temperature sensor signals as well as valve position shall be sent to PI (Plant Information) and a reference time source shall be read from SOS.

3.4.4 CI-ELECTRICAL panels shall have the following main characteristics:

- Ethernet Communication via OPC-UA protocol;
- Bottom cable access and frontal access;
- Be fed according to I-ET-3010.00-5140-700-P4X-003 – ELECTRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE UNITS.

3.4.5 This panel shall be powered as according to I-ET-3010.00-5140-700-P4X-003 – ELECTRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE UNITS. The different power supplies inside the panel shall be converted and distributed, including where necessary AC/DC stabilized power supply unit for the cabinet internal distribution of 24 Vdc.

3.5 Subsea Production Control System (SPCS)

3.5.1 Proper integration shall be carried out regarding the interfaces between SPCS with A&C System.

3.5.2 The SPCS shall be designed to provide the operation, control and monitoring of the following types of subsea equipment:

- Satellite Production Wells (SPW), each with a Wet Christmas Tree (WCT)

fitted for Direct Hydraulic Control System (WCT-HD);

- Satellite Production Wells (SPW), each with a Wet Christmas Tree (WCT) fitted for Electrohydraulic Multiplex Control System (WCT-MUX);
- Subsea Water Alternating Gas Injection Manifolds (WAG) fitted EHM System;
- Subsea Production Manifold (SPM) with Electrohydraulic Multiplex Control System (EHM);
- Gas pipeline SESDV (Subsea Emergency Shutdown Valve) actuated by Direct Hydraulic Control System.
- All screens of subsea system shall be accessible from SOS.
- Intelligent Completion (CI-ELECTRICAL).

3.5.3 1 (one) Hydraulic Power Unit (UH-1210001) for water-based control fluid shall be provided with a local control panel (PN-UH-1210001) to supply both the WCT-MUX and the WCT-HD. PN-UH-1210001 (hardwired signals) shall be interconnected with CSS. This HPU shall be able to be supervised by SOS HMIs through digital network communication (Gigabit Ethernet).

3.5.4 This HPU shall comply with I-ET-3010.00-1210-390-P4X-001 – HYDRAULIC POWER UNIT (HPU) FOR SUBSEA SYSTEM

3.5.5 EHM System general information:

3.5.5.1 A type of control system for subsea equipment that uses common electrical and hydraulic supplies in a single umbilical, from topside to one or more “subsea control modules” or “control pods” to actuate the subsea equipment hydraulic valves and monitor its subsea sensors. Those “control pods” shall be hereafter referred as SCM. To accomplish this, each SCM shall have its own internal electronics and directional (solenoid) control valves.

3.5.5.2 The EHM System requires topside equipment referred thereafter as “Control Cabinets” (or MCS) to provide power for the SCMs and communication between those and the SOS HMIs and CSS. The MCSs (PN-1210001-007A/B) shall be supplied as a pair of racks fitted with a PLC or industrial grade computer servers and special power supplies and modems. The electric communication signal shall be superimposed in the same pair of wires that power the SCMs (so called power line carrier subsystem). Optical communication channels shall be used as well. Each Control Cabinet rack thus provides power and communication for one or more SCM, so two such Cabinets shall provide redundant power and communications for one or more SCM networks. The two matched Control Cabinet racks shall be referred as “Channel A or 1” and “Channel B or 2”.

3.5.5.3 The MCSs shall be connected with the FPSO PCS and PSD systems, respectively to the Package Unit LAN communications network (CSS) via SAS Panel Ethernet Switch, and hardwired (PSD) interfaces (more on both later). Although the primary (main) means of operator’s interface with the EHM System shall be through the SOS HMIs, typically, a given number of Control Cabinet pairs shall be also connected to a dedicated Operator Workstation provided by PETROBRAS, in order to allow the operation of the subsea

equipment fitted with EHM System, independent of the SOS HMIs when necessary. This dedicated OWS shall also allow the operation of intelligent completion systems that shall be fitted to some production wells. A Control Cabinet pair shall also have a dedicated Engineering Workstation (EWS) for internal configuration and display of “housekeeping” parameters not related to the control application.

3.5.5.4 A typical subsea Wet Christmas Tree with EHM System (referred thereafter as WCT-MUX) shall have its own SCM fitted to the WCT itself. If this WCT-MUX is installed in a Satellite Well, it shall be connected directly to the FPSO through a “multiplex-type” control umbilical. Otherwise, if this WCT-MUX is connected to a subsea manifold, the WCT-MUX SCM shall typically share (use) the same electric and hydraulic network of the manifold SCMs through the manifold “multiplex-type” control umbilical connected to the FPSO. Each subsea manifold (either for production, water & gas injection) shall usually have an EHM System fitted, typically with one or more SCM installed in the manifold itself for its own control and monitoring functions.

3.5.5.5 Control Cabinet room(s) layout shall also be designed to allow changing the interconnections between each umbilical electrical and optical cables and all EHM and CI-ELECTRICAL Control Cabinets and the SAS Panel, according to different well completion and WCT types to be operated during the Contract lifetime.

3.5.5.6 To provide interconnection between signals from wellheads to MCS Panels and CI-ELECTRICAL panels, rearrangement panels shall be supplied. These panels (PN-1210016A/D) are called “Topsides Electrical Assignment Panel (TEAP)”.

3.5.5.7 Each MCS control cabinet shall have bottom cable access and frontal access.

3.5.5.8 All electrical and optical cables shall be routed from each umbilical hang off interface junction boxes to the room(s) where the EHM Control Cabinets, CI-ELECTRICAL Control Cabinets and the SAS Panel will be located.

3.5.5.9 It shall be provided two electrical junction boxes next to each umbilical top connector. One shall be used for the EHM and CI-ELECTRICAL and the other for the WCT-HD instrumentation. Both junction boxes shall be certified according to hazardous area classification. JBs and local panels located in Topsides non hazardous open areas shall be certified to operate in Zone 2, Group IIA, T3 hazardous areas.

3.5.5.10 The subsea umbilical’s electrical pig-tails are typically 800mm long. The junction box shall be removable to make room during the pull-in/pull-out procedures.

3.5.5.11 It shall be used cables between each junction box and the respective EHM Control Cabinets, CI-ELECTRICAL Control Cabinet and the SAS Panel according to I-ET-3010.1M-1200-800-P4X-005 – FIELD INSTRUMENTATION and I-ET-3010.00-1200-800-P4X-013 – GENERAL CRITERIA FOR

INSTRUMENTATION AND CONTROL DESIGN. Cables for EHM and CI-ELECTRICAL shall be composed of individually shielded and twisted pairs of 6.0mm2 conductor cross section. Junction boxes shall have individual ground terminals.

3.5.5.12 It shall be provided an optical junction box for two optical cables next to each umbilical top connector. The optical junction box shall be certified according to hazardous area classification.

3.5.5.13 PETROBRAS will provide the length of each optical cable pig-tail during the detail design phase. The optical junction box shall be removable to make room during the pull-in/pull-out procedures.

NOTE 1: The SPCS shall be designed to interface with 3 (three) basic types of Control Cabinet pairs for the subsea EHM System standardized. The differences between them shall be the quantity and types of subsea equipment that shall be controlled, or more precisely, the total number of SCMs that can share one or more networks per Cabinet pair, being:

- Control Cabinets TYPE 1 for up to 5 (five) satellite WCT-MUX connected directly to the FPSO = total of 5 (five) SCMs;
- Control Cabinets TYPE 2 for 2 (two) pair of WCT-MUXs in piggyback configuration + 1 satellite WCT-MUX connected directly to the FPSO (each set) = total of 5 (five) SCMs;

NOTE 2: The MCS Control Cabinets shall be provided by PETROBRAS.

NOTE 3: The SPCS shall be designed to allow the interface of Control Cabinets from 3 (three) different Suppliers, in any combination according with number and TYPES of Control Cabinets specified in the item 3.5.10.

NOTE 4: The SPCS shall be designed to allow the installation of the Control Cabinets during the construction phase and integration of FPSO or during offshore operation of the UNIT. AEPR (module 17) layout (ex.: access for installation of MCSs and CI-ELECTRICAL inside module) and SPCS communications network connections and electrical power supply shall be designed to permit this installation during offshore operation. The cable way design and routing inside M-17 Module for cables from Riser Balcony to MCS and CI-ELECTRICAL Panels shall foresee the possibility of interconnection of any cable to any MCS and CI-ELECTRICAL during production unit lifetime through TEAP panel (PN-1210016A/D).

NOTE 5: The wells with Intelligent Completion (IC) shall have IC equipment including the PDG and other downhole instrumentation monitored and operated from the EHM System dedicated Operation Workstations (see item 3.5.5.3).

NOTE 6: The umbilicals, beyond shall be used for hydraulic functions for the subsea valves, shall also be used for chemical injections, electrical power supply for electronics devices, signal data acquisition from Wet Christmas Tree (WCT).

3.5.6 The following types of equipment listed below, from the seabed to the Unit,

comprise the EHM System part of the SPCS:

- Wet Christmas Tree with EHM System (WCT-MUX) for WAG injection, PWAG and production wells;
- Umbilicals for EHM System;
- Control Cabinets TYPE 1 for EHM System;
- Control Cabinets TYPE 2 for EHM System;
- Operation Workstation for EHM System;
- Hydraulic Power Unit (UH-1210001).

3.5.7 The following types of equipment listed below, from the seabed to the Unit, comprise the Direct Hydraulic Control System part of the SPCS:

- Wet Christmas Tree with Direct Hydraulic Control System (hereafter referred as WCT-HD);
- Umbilicals for Direct Hydraulic Control System;
- Signal Acquisition System (SAS) for DHWCT;
- Well Control Racks (WCR) for WCT-HD and SESDV;
- Hydraulic Power Unit (UH-1210001).

3.5.8 1 (one) Hydraulic Power Unit (see I-ET-3010.00-1210-390-P4X-001 – HYDRAULIC POWER UNIT (HPU) FOR SUBSEA SYSTEM) for water-based control fluid shall be provided to supply both the EHM System and the Direct Hydraulic Control System;

3.5.9 The default quantities of the above equipment that the SPCS shall be dimensioned as:

- Up to 7 (seven) Satellite Production Wells, each with EHM System (WCT-MUX). Up to 2 (two) of these Satellite Production Wells can have Direct Hydraulic Control System (WCT-HD).
- Up to 4 (four) pairs of WAG injection wells, each well in each pair with EHM System (WCT-MUX), being one umbilical for both WCT-MUX in the pair;
- Up to 4 (four) satellite production and WAG injection wells, each with EHM System (WCT-MUX).

NOTE 1: Maximum of four 4 (four) SESDV valves for Direct Hydraulic Control from the FPSO. The exact quantity shall be confirmed during the Detailed Design Phase.

3.5.10 The SPCS shall be designed to provide monitoring and operation of the EHM System part of the SPCS from the FPSO's SOS HMIs in the CCR through a total of 7 (seven) pairs of Control Cabinets, total 14 (fourteen) individual Control Cabinet racks.

3.5.11 Each Control Cabinet rack shall be based on 19" type standard. Front and rear accesses shall be provided;

3.5.12 All Control Cabinets (PN-1210001 ~ 007 A/B) shall be located at AEPR, with air conditioning ambiance. The maximum room temperature shall be less than 35ºC;

3.5.13 Each pair of control cabinet shall be fed according to I-ET-3010.00-5140-700-P4X-003 – ELECTRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE UNITS. The different power supplies inside the panel shall be converted and distributed, including where necessary AC/DC stabilized power supply unit for the cabinet internal distribution of 24 Vdc.

3.5.14 Communication network between each Control Cabinet with the FPSO CSS system shall be through Gigabit Ethernet. The communication protocol shall be OPC;

3.5.15 Each Control Cabinet rack shall have available 32 (thirty two) digital inputs (0 - 24 Vdc) for interface with PSD, such as ESDs levels. The exact functions and Cause & Effect Diagram shall be agreed together with PETROBRAS during the Detailed Design Phase. For interface between MCS and CSS see item 3.5.36.

3.5.16 4 (four) dedicated Operating Workstations for the EHM System part of the SPCS (PN-1210010A/B/C/D) shall be installed at CCR. Specifications of the cables and connectors between the Control Cabinets and the MCS shall be provided by PETROBRAS during the Detail Design Phase.

3.5.17 The SPCS shall be designed to provide monitoring and operation of the Direct Hydraulic Control System part of the SPCS from the FPSO's SOS HMIs in the CCR through the WCRs.

3.5.18 PSD shall be in charge of generating commands to the Production Well Control Rack Direct Hydraulic (PN-1210008) in order to permit that all X-mas trees valves and VHIF-I valves are operated and monitored from CSS HMIs.

3.5.19 The WCT-HD shall be direct hydraulically controlled from Production Well Control Rack (PN-1210008) installed on the FPSO. The gas pipeline emergency valve (SESDV) shall be direct hydraulically controlled from SESDV Control Rack (PN-1210009). These racks shall be electrically interconnected to a CSS Remote I/O Panel, located near the racks. The hydraulic fluid shall be provided by the common Hydraulic Power Unit for Subsea System (UH-1210001).

3.5.20 Opening/closing logic sequences for the WCRs valves shall be carried out by PSD. The same occurs for the gas pipeline SESDV.

NOTE: The production choke valves shall be in the topside of platform and shall be operated by CSS.

3.5.21 It shall be provided the integration between all topside equipment of the SPCS and the Unit, which comprises assembly, hook-up, cabling, tubing, junction boxes, etc. required to interface each well control umbilical with the Control Cabinet racks, HPU, Subsea SESDV control panel, and the Unit's systems (SOS, CSS and others).

3.5.22 All interfaces shall be submitted to PETROBRAS for approval, as well as the commissioning procedure. The subsea cause and effect chart also shall be submitted for PETROBRAS approval.

3.5.23 The PDG and TPT-AR installed at the satellite production wells shall be connected to the SAS. It shall be possible to monitor and supervise the satellite production and water injection wells variables from SOS HMIs.

3.5.24 The SPCS shall be operated from Subsea Operation Workstations (OWS), PN-1210010 A/B/C/D, and SOS HMIs, using dedicated screens and pop-up menus. As a preliminary requirement, the following screens shall be implemented as an intuitive way of navigating through the system in a logical manner as the main building blocks are connected:

- WCT-MUX, according to its function (Production Satellite well, production/WAG Satellite well, WAG satellite wells in piggyback).
- WCT-HD
- HPU monitoring.
- Configuration of a Production Satellite Well to WAG-Injection Well;]

3.5.25 Each OWS be powered as according to I-ET-3010.00-5140-700-P4X-003 – ELECTRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE UNITS.

3.5.26 PETROBRAS shall provide the subsea P&ID for configuration of the HMI screens. The screens of SOS HMIs shall be configured with the same features as the Subsea Operation Workstation.

3.5.27 The following minimum information shall be available on screens, from the subsea system WCT-MUX and WCT-HD (where applicable):

- Valve (including downhole valve) open/close;
- Pressures from WCT instruments;
- Temperatures from WCT instruments;
- Downhole pressures;
- Downhole temperatures;
- Intelligent Completion status;
- Corrosion monitor signal from gas pipeline.

3.5.28 The following minimum information shall be available on screens, from the subsea system manifolds:

- Valve open/close;
- Pig detection;
- Pressures from manifold instruments;
- Temperatures from manifold instruments;
- Injection flow rates from manifold instruments (water and gas);
- Corrosion monitoring from manifold or pipeline instruments.
- Choke actuation and position feedback.

3.5.29 Each type of subsea equipment shall be represented by intuitive building blocks to represent the field layout.

3.5.30 The HPU UH-1210001 shall be monitored from the SOS HMIs using dedicated screens and pop-up menus. The reservoirs levels, the pressure at the HPU UH-

1210001 outlet headers, the pumps status (on/off) and the pressure of main header (hydraulic pumps outlet), shall be displayed locally and at the SOS HMIs.

3.5.31 The SESDVS Control Rack PN-1210009 panel shall be operated from the SOS HMIs using dedicated screens and pop-up menus.

3.5.32 The CCR shall monitor if the umbilical lines are pressurized. Pressure switches or pressure transmitters shall be fitted upstream of each umbilical hydraulic line topside interface.

3.5.33 It shall be possible for the operator to configure a time delay for the closing and for the opening of each WCT valve. This shall be easily accomplished by simple pop-up menus on the CCR screen at password protected supervisor level. Default values for time delays shall be informed by PETROBRAS.

3.5.34 It shall be possible to reconfigure the normal closing sequence of all WCT valves. This shall be easily accomplished by calling special CCR screens under password protected supervisor level. Default sequences shall be informed by PETROBRAS.

3.5.35 All SPCS hydraulic lines from the HPU to the respective umbilical hang offs prepared for multiplex umbilical shall be delivered flushed to ISO 4406 class 17/15/12 cleanliness with fluid.

3.5.36 Interfaces between MCS and CSS

3.5.36.1 There shall be 1 (one) MCS panel pairs interconnected with each satellite production well. Each panel shall have available 45 (forty five) digital output signals (9 per well) for interface with CSS-PSD and CSS-FGS, such as ESD-1/2/3/4.

3.5.36.2 There shall be 1 (two) MCS panel pairs interconnected with each pair of WAG wells in piggyback configuration. Each panel shall have available 72 (seventy two) digital output signals (18 per pair of wells in piggyback) for interface with CSS-PSD and CSS-FGS, such as ESD-1/2/3/4.

3.5.36.3 There shall be 1 (one) MCS panel pair interconnected with each satellite production/WAG well. Each panel shall have available 36 (thirty six) digital output signals (9 per well) for interface with CSS-PSD and CSS-FGS, such as ESD-1/2/3/4.

3.5.36.4 A total of 256 (two hundred and fifty six) digital output signals uses hardwired interface between MCS and CSS-PSD/FGS. For further details, see tables 1, 2 and 3 on Annex.

3.5.37 Portable Umbilical Pressurization System (PUPS)

3.5.37.1 PUPS is a topside portable device to safely pressurize each control line of an umbilical during installation, from any LP or HP pressure supply from the

HPU. Each PUPS shall allow for quick air removal and safe pressurization/depressurization of up to twelve (12) umbilical tubings or thermoplastic hoses from one or two topside umbilical termination unit connection lines.

NOTE 1: PUPS shall be used for CONTROL line pressurization only, with water-based control fluids MacDermid HW443, MacDermid HW525P or Castrol Transaqua DW to be maintained to ISO 4406 Class 17/15/12 cleanliness.

3.5.37.2 Each PUPS shall be composed of two identical hydraulic headers, each one with a common pressure inlet port, a pressure regulator, manometer, 6 (six) function branch outlet ports and one drain port to drain/bleed any of the 6 outlets. Each drain and outlet port, as well as each manometer shall have their own isolating valve. All components shall be stainless steel type with at least ½" O.D. suitable for the above said control fluid and fluid cleanliness. The drain/bleed ports shall be used also to take fluid sampling when necessary.

3.5.37.3 The PUPS shall be able to pressurize each umbilical line with a regulated pressure between 1,000 psi and 3,000 psi, from any supply between 4,000 and 10,000 psi. However, all PUPS hydraulic components shall be rated to 10,000 psi operation. Each of the 12 (twelve) pressurization outlets shall be terminated with a quick connector adapter to allow the fitting of a ½" or $^{3}/_{8}$" male JIC 37° termination prior the pressurization. Each PUPS shall be provided with sets of at least 13x 3/8" and 5x ½" male JIC 37° fittings. It shall be considered to provide each PUPS with its own storage box for those fittings when not in use. Two such PUPS shall be supplied.

3.6 Plant Operation Mode Changing

3.6.1 The gas compression and processing plant shall be capable to operate in 04 (four) operation modes, according to specific process conditions. These operation modes are described in document I-RL-3010.1M-1200-940-P4X-004 - PROCESS SIMULATION REPORT.

3.6.2 In case of operation mode changing, the compressor control system of each train shall be capable of setting automatically proper the compressor control parameters to the new operation mode. This functionality shall be designed taking into account the communication network among the Master Controllers (Compressor Capacity Control) in order to avoid compressor recycle, to reduce plant pressure floating and to avoid unnecessary gas flaring, when a plant upset or downstream process unit shutdown occurs.

3.6.3 As described in compressor technical specifications (I-ET-3010.1M-1231-321-P4X-001 - MAIN GAS MOTOCOMPRESSOR, I-ET-3010.1M-1231-321-P4X-002 - EXPORTATION GAS MOTOCOMPRESSOR, I-ET-3010.1M-1252-321-P4X-001 - INJECTION GAS MOTOCOMPRESSOR and I-ET-3010.1M-1254-321-P4X-001 - CO2 TURBOCOMPRESSOR), compressors PACKAGER will provide an additional system based in a computer system Compressor Capacity Control System Workstation (PN-5500010A/D) connected directly to

anti-surge, capacity and load sharing controllers with dedicated serial RS485 for each train.

3.7 Asset Management System (AMS)

3.7.1 For Requirements regarding AMS, refer to I-ET-3010.00-1200-850-P4X-002 – ASSET MANAGEMENT SYSTEM (AMS).

3.8 Hull Structural Tanks Level, Interface, Pressure And Temperature Monitoring Systems (HSTS)

3.8.1 For Requirements regarding HSTS, refer to I-ET-3010.1M-1351-800-P4X-001 – HULL STRUCTURAL TANKS LEVEL, INTERFACE, PRESSURE AND TEMPERATURE MONITORING SYSTEMS.

3.9 Riser Annulus Condition Surveillance System (RACS)

3.9.1 See I-ET-3010.00-5529-812-PAZ-001_F – ANNULUS PRESSURE MONITORING AND RELIEF SYSTEM.

3.10 Riser Annulus Pressure Monitoring System

3.10.1 See I-ET-3010.00-5529-812-PAZ-001_F – ANNULUS PRESSURE MONITORING AND RELIEF SYSTEM.

4 ANNEX

Table 1 – I/O Interface Signals – Satellite Production Wells or Satellite Production/WAG well (type 1 cabinets)

Signal	Action	I/O Type	PN-121000XA/B
ESD-4	Closure of SCSSV	DO	1
ESD-3	Close Wing and Master WCT valves	DO	1
ESD-2	Closure of riser surface ESDVs (CSS) Closure of COV and PCOV (MCS)	DO	1
ESD-1	Individual Actuation for each well	DO	5
Total of I/Os per MCS			8

Table 2 – I/O Interface Signals – Pair of WAG Wells in piggyback (type 2 cabinets)

Signal	Action	I/O Type	PN-121000XA/B
ESD-4	Closure of SCSSVs	DO	1
ESD-3	Close Wing and Master WCT valves	DO	1
ESD-2	Closure of riser surface ESDVs (CSS) Closure of COV and PCOV (MCS)	DO	1
ESD-1	Individual Actuation for each well	DO	5
Total of I/Os per MCS			8