INDEX OF REVISION

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0	ORIGINAL
A	REVISED WHERE INDICATED
B	REVISED WHERE INDICATED, INCLUDING CONSISTENCY ANALYSIS

	REV. 0	REV. A	REV. B	REV. C	REV. D	REV. E
DATE	JAN/12/24	JUN/11/24	JUL/16/24			
EXECUTION	CTTD	CTTD	CTTD			
CHECK	U44D	U44D	U44D			
APPROVAL	U361	U361	U361			

SUMMARY

1 INTRODUCTION

1.1 Objective

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

1.1.2 These requirements can be:

I. general information related to all systems.

II. requirements of subjects that are not defined in other documents.

III. remarks that shall be followed during Detail Engineering Design Phase.

1.2 Definitions

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

1.3 Abbreviations, acronyms, and initialisms

TERM	DEFINITION
AC/DC	Alternating Current / Direct Current
A&C	Automation & Control
AEPR	Automation & Electrical Panels Room
AF	Asset Framework
ALARM	Alarm Management System
AMS	Asset Management System
BCSS	Bomba Centrífuga Submersa Submarina (Portuguese definition for ESP)
BSDL	Boca de Sino Diverless
CCR	Central Control Room
CCR	Central Control Room
CCR-EA	Central Control Room - Equipment Ambiance
CCR-OA	Central Control Room - Operation Ambiance
CGS	Compressor Governor System
CS	Classification Society
CSS	Control and Safety System
DC	Direct Current
DHSV	DownHole Safety Valve (synonym of SCSSV)
DHSV-E	DownHole Safety Valve – Electrical
DIO	Distribuidor Interno Óptico (Optical Internal Distributor)
DMZ	Demilitarized Zone (TI RELATED)
DOU	Diário Oficial da União (Official Gazette of the Federal Government)
EHMUXSCS	Electrohydraulic Multiplex Subsea Control System
EMS	ESP Management System
ESD	Emergency Shutdown
ESP	Electrical Submersible Pumps (English definition for BCSS)
EWS	Engineering Workstation
FAT	Factory Acceptance Test
FGS	Fire and Gas System

TERM	DEFINITION
FPSO	Floating, Production, Storage and Offloading
FPU	Floating Production Unit
HCS	Hull Control System
HD	*Hidráulico Direto* (Direct Control of a WCT)
HFGS	Hull Fire and Gas System
HMI	Human-Machine Interface
HPU	Hydraulic Power Unit
HSD	Hull Shutdown System
HSHMS	Hull Structure Health Monitoring System
HSTS	Hull Structural Tanks Level, Interface, Pressure and Temperature Monitoring Systems
IACS	International Association of Classification Societies
I/O	Input / Output
IP	Ingress Protection Ratings
JB	Junction Box
JIC	Joint Industry Council
LAN	Local Area Network
LV	Low Voltage
MCS	Master Control Station (Subsea)
MMS	Machine Monitoring System
mmWC	Millimeters of Water Column
MPA	Módulo de Procedimentos Automatizados (Automatized Procedures Module)
MSG	Manifold Submarino de Gás (Subsea Gas Manifold)
MSIA	Manifold Submarino de Injeção de Água (Water Injection Subsea Manifold)
MSP	Manifold Submarino de Produção (Subsea Production Manifold)
OD	Outer Diameter
OPC	Open Platform Communications
OPC-UA	OPC Unified Architecture
OWS	Operation Workstation
PCHE	Printed Circuit Heat Exchanger
PCS	Process Control System
PDG	Permanent Downhole Gauge
PE	Protective Earth (Conductor in a cable)
P&ID	Piping and Instrument Diagram
PI	Plant Information®
PLC	Programmable Logic Controller
PRM	Permanent Reservoir Monitoring
PSD	Process Shutdown
PT	XTree Pressure Transducer
P-XO	Pig Crossover Valve
RTDS	Real Time Data Server
RTU	Remote Terminal Unit
SAS	Subsea Acquisition System
SAT	Site Acceptance Test
SBMS	Sistema de Bombeamento Multifásico Submarino (Submarine Multiphase Pumping System)
SCADA	Supervisory Control and Data Acquisition
SCHI/C	Individual Shield and colective Shield
SCM	Subsea Control Module

TERM	DEFINITION
SCSSV	Surface Controlled Subsurface Safety Valve (synonym of DHSV)
SESDV	Subsea Emergency Shutdown Valve
SIT	Site Integration Test
SOS	Supervision and Operation System
SPCS	Subsea Production Control System
SPU	Stationary Production Unit (FPSO)
SPW	Satellite Production Wells
SWIM	Subsea Water Injection Manifold
SWIW	Satellite Water Injection Wells
TBD	To Be Defined (During Detail Enginnering Design Phase)
TCP	Transmission Control Protocol
TEOAP	Topsides Electrical-Optical Assignment Panel
TPT	XTree Pressure and Temperature Transducer
TPT-P	TPT-Pressure
TPT-T	TPT-Temperature
TUTU	Topsides Umbilical Terminal Unit
TWAP	Topsides Well Assignment Panel
UEH	Umbilical Eletro-Hidráulico (Electro-Hydraulic umbilical)
UI	Unified Interpretation—A resolution issued by IACS
UPS	Uninterruptible Power Supply
UR	Unified Requirement—A resolution issued by IACS
UV	Ultraviolet
VHIF	Válvula Hidráulica para Isolação da Formação (Hydraulic Valve for Isolation Formation)
VSD	Variable Speed Drive
WAG	Water Alternating Gas Injection Manifold
WCR	Well Control Rack
WCT	Wet Christmas Tree
WCT-HD	Wet Christmas Tree - Direct Hydraulic Control
WCT-MUX	Wet Christmas Tree - Multiplexed
XO	Crossover Valve
Xtree	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 – ALL PARTS
IEC	60079	EXPLOSIVE ATMOSPHERE – 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 (EMC)
IEC	60945	MARITIME NAVIGATION AND RADIOCOMMUNICATION 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) – ALL PARTS
IEC	60228	CONDUCTORS OF INSULATED CABLES
IEC	62381	AUTOMATION SYSTEMS IN THE PROCESS INDUSTRY-FACTORY ACCEPTANCE TEST (FAT), SITE ACCEPTANCE TEST (SAT) AND SITE INTEGRATION TEST (SIT)

IEEE – INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS		
IEEE	802.1Q	LOCAL AND METROPOLITAN AREA NETWORKS - BRIDGES AND BRIDGED NETWORKS

ISA – INTERNATIONAL SOCIETY OF AUTOMATION		
ISA	5.1	INSTRUMENTATION SYMBOLS AND IDENTIFICATION

2.1.2 Brazilian Codes and Standards

INMETRO – INSTITUTO NACIONAL DE METROLOGIA, QUALIDADE E TECNOLOGIA	
PORTARIA Nº 115 (21/MARÇO/2022)	REQUISITOS DE AVALIAÇÃO DA CONFORMIDADE PARA EQUIPAMENTOS ELÉTRICOS PARA ATMOSFERAS EXPLOSIVAS - CONSOLIDADO

2.1.2.1 All Regulatory Standards (Normas Regulamentadoras–NRs) in force, published in the Diário Oficial da União (DOU), shall be followed.

2.1.3 Classification Society

2.1.3.1 The detailed design shall be submitted to Classification Society for approval.

2.1.3.2 The Unified Requirements (URs) and Unified Interpretations (UIs) of IACS, applicable and in force in the detailing design, shall be observed and their requirements implemented.

2.1.3.3 The design and installation shall be updated following requirements, comments of Classification Society as well as URs and UIs mentioned in item 2.1.3.2. Internal references

2.1.4 Internal Reference documents are important not only for package-related requirements, but also for requirements that dictate how interfaces with other systems shall be executed.

2.1.5 Project Documents

Table 2.1-I – Reference Project Documents (Hull structural tanks P&IDs are not listed)

DOCUMENT NUMBER	TITLE
CORPORATIVE DIRECTIVES	
DR-ENGP-M-I-1.3	SAFETY ENGINEERING GUIDELINE
DOCUMENTS 3000.00	
I-ET-3000.00-1510-854-PEK-002	MONITORING SYSTEM FOR SUBSEA EMERGENCY SHUT-DOWN VALVE (SESDV) – FPU SCOPE
I-ET-3000.00-1516-823-PEK-006	SPU PROJECT DETAILS WET MONITORING SIGNALS (TPT, PT and PDG)
I-ET-3000.00-5139-800-PEK-005	HYDRAULIC POWER UNIT FOR SUBSEA EQUIPMENT WITH MULTIPLEXED ELECTROHYDRAULIC AND DIRECT HYDRAULIC CONTROL SYSTEM
DOCUMENTS 3010.00	
I-DE-3010.00-1210-888-P4X-001	PRODUCTION WELL CONTROL RACK - LAYOUT
I-DE-3010.00-1210-888-P4X-002	PRODUCTION WELL CONTROL RACK - FUNCTIONAL DIAGRAM
I-DE-3010.00-1210-888-P4X-005	SESDVs CONTROL RACK - LAYOUT
I-DE-3010.00-1210-888-P4X-006	SESDVs CONTROL RACK - FUNCTIONAL DIAGRAM
I-ET-3000.00-1519-29B-PZ9-012	TOPSIDE ARRANGEMENT AND INTERFACES WITH SUBSEA UMBILICAL SYSTEMS
I-ET-3010.00-1200-321-P4X-001	TECHNICAL SPECIFICATION FOR CENTRIFUGAL COMPRESSOR DRIVEN BY ELECTRIC MOTOR

DOCUMENT NUMBER	TITLE
I-ET-3010.00-1200-800-P4X-002	AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGE UNITS
I-ET-3010.00-1200-800-P4X-013	GENERAL CRITERIA FOR INSTRUMENTATION PROJECTS
I-ET-3010.00-1200-800-P4X-015	REQUIREMENTS FOR TUBING AND FITTING (ALIGNED TO IOGP-JIP33 S-716)
I-ET-3010.00-1200-850-P4X-002	ASSET MANAGEMENT SYSTEM (AMS)
I-ET-3010.00-1200-859-P4X-001	AUTOMATION REQUIREMENTS FOR CORROSION MONITORING SYSTEM (CMS)
I-ET-3010.00-1200-940-P4X-002	GENERAL TECHNICAL TERMS
I-ET-3010.00-1210-888-P4X-001	PRODUCTION WELL CONTROL RACK
I-ET-3010.00-1210-888-P4X-003	SESDVS CONTROL RACK
I-ET-3010.00-1351-140-P4X-002	DIGITAL TWIN FOR HULL STRUCTURAL INTEGRITY MANAGEMENT
I-ET-3010.00-5140-700-P4X-002	SPECIFICATION FOR ELECTRICAL MATERIAL FOR OFFSHORE UNITS
I-ET-3010.00-5140-700-P4X-003	ELECTRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE UNITS
I-ET-3010.00-5520-861-P4X-001	CONTROL AND SAFETY SYSTEM - CSS
I-ET-3010.00-5520-861-P4X-002	SUPERVISION AND OPERATION SYSTEM - SOS
I-ET-3010.00-5520-861-P4X-003	VIRTUALIZATION OF AUTOMATION SYSTEM COMPUTERS
I-ET-3010.00-5520-888-P4X-001	AUTOMATION PANELS
I-ET-3010.00-5529-812-PAZ-001	ANNULUS PRESSURE MONITORING AND RELIEF SYSTEM
DOCUMENTS 3010.2Q	
I-DE-3010.2Q-1200-942-P4X-002	GENERAL ARRANGEMENT
I-DE-3010.2Q-1200-944-P4X-001	GENERAL NOTES
I-DE-3010.2Q-1428-942-P4X-001	M-17 - AUTOMATION AND ELECTRICAL - EQUIPMENT LAYOUT PLAN
I-DE-3010.2Q-5520-800-P4X-002	AUTOMATION AND CONTROL ARCHITECTURE
I-DE-3010.2Q-5520-800-P4X-004	NETWORK INTERCONNECTION DIAGRAM
I-ET-3010.2Q-1200-800-P4X-001	INSTRUMENTATION ADDITIONAL TECHNICAL REQUIREMENTS
I-ET-3010.2Q-1200-800-P4X-004	MULTIPHASE FLOW METERING SYSTEM (MFMS)
I-ET-3010.2Q-1200-800-P4X-005	FIELD INSTRUMENTATION
I-ET-3010.2Q-1200-800-P4X-014	AUTOMATION INTERFACE OF PACKAGED UNITS
I-ET-3010.2Q-1351-800-P4X-001	HULL STRUCTURAL TANKS LEVEL, INTERFACE, PRESSURE AND TEMPERATURE MONITORING SYSTEMS
I-MD-3010.2Q-5520-800-P4X-001	AUTOMATION AND CONTROL SYSTEM FUNCTIONS
I-MD-3010.2Q-5520-850-PEK-001	DESCRIPTIVE MEMORANDUM - SUBSEA MONITORING SYSTEM FOR FPSO REVIT MLS-MLL
I-RL-3010.2Q-1200-940-P4X-004	PROCESS SIMULATION REPORT
OTHERS	
I-ET-3500.00-1500-800-PEK-005	SUBSEA PRODUCTION CONTROL SYSTEM FOR FPSO
I-MD-3500.00-1500-610-PEK-002	SUBSEA MULTIPHASE BOOSTING SYSTEM DESCRIPTION AND INTERFACES WITH TOPSIDE FACILITIES

3 SYSTEMS RELATED TO SUPERVISORY AND AUTOMATION SYSTEMS

3.1 Optimization Software

3.1.1 A number of 7 (seven) BUYER owned software packages shall be installed and customized. These software packages are dedicated to control loops optimization, advanced control, monitoring and optimization, as well as alarm management.

3.1.2 The applications are:

I. BR-TUNING and PGA MALHAS for control loops tunning.

II. BR-OPTIMUS and MPA for advanced control and optimization:

III. Among other modules, MPA will consist of the Water Injection Advanced Control System, the Production Well Assisted Start-up System, the Band and Stabilization Control System and Advanced Control for Compression Systems.

IV. BR-AlarmExpert for Alarm Management.

V. WELLBOT for autonomous operation of wells with flow instability.

VI. PCHE Monitoring System for performance evaluation of the Printed Circuit Heat Exchangers.

3.1.3 These software packages shall be provided by BUYER, being part of the present scope, all services related to their configuration, installation and interconnection to CSS/SOS. For CSS and SOS descriptions refer to, respectively, I-ET-3010.00-5520-861-P4X-001 - CONTROL AND SAFETY SYSTEM - CSS and I-ET-3010.00-5520-861-P4X-002 - SUPERVISION AND OPERATION SYSTEM - SOS

3.1.4 The applications PGA MALHAS and BR-ALARMEXPERT shall be installed in a virtual machine in Telecom's "Automation DMZ Cluster" in the DMZ.

3.1.5 The other remaining 5 (five) applications shall be installed in a virtual image server called "BR OPTIMIZATION SERVER". This virtual image shall run at PN-5523009 – TOPSIDES SOS PROCESS CLUSTER, and shall have the following characteristics:

I. Microsoft Windows® Operating system (at its last stable version) or its equivalent at purchase time.

II. Microsoft® Office software or its equivalent at purchase time.

III. Other specific communication driver(s) necessary to integrate with the SOS shall be submitted for BUYER approval.

IV. This virtual image shall be accessible from all Topsides SOS HMIs (PN-5523002A/E) and Hull SOS HMI (PN-5523502A/E) thin clients.

3.2 Architecture Doors Connection to CSS/SOS

3.2.1 Some doors have associated limit switches or magnetic door holders in order to perform logics in certain conditions. There are two categories of doors that have associated instrumentation. They are:

3.2.1.1 Doors containing magnetic hold back device with liberation at Central Control Room:

3.2.1.1.1 Below is a list of locations of these doors:

I. Stairways.

II. Cabins.

III. Mess room.

IV. Dry storage rooms.

3.2.1.1.2 These doors have a magnetic hold back device, which is released by either by operator screen commands in SOS (one command per deck), fire alarm, or by a local latching pushbutton (one per door).

3.2.1.1.3 Door Normal Condition: Magnetic hold back device remains energized, so that, if the door is manually fully opened, it is kept locked open. This is meant to ease access of people or cleaning carts to certain areas.

3.2.1.1.4 Door Alarm condition: Magnetic hold back device is de-energized, so that the door is released to automatically close using a spring. This is meant to prevent smoke from entering these areas.

3.2.1.1.5 A typical schematic of the magnetic door holder is presented in figure below:

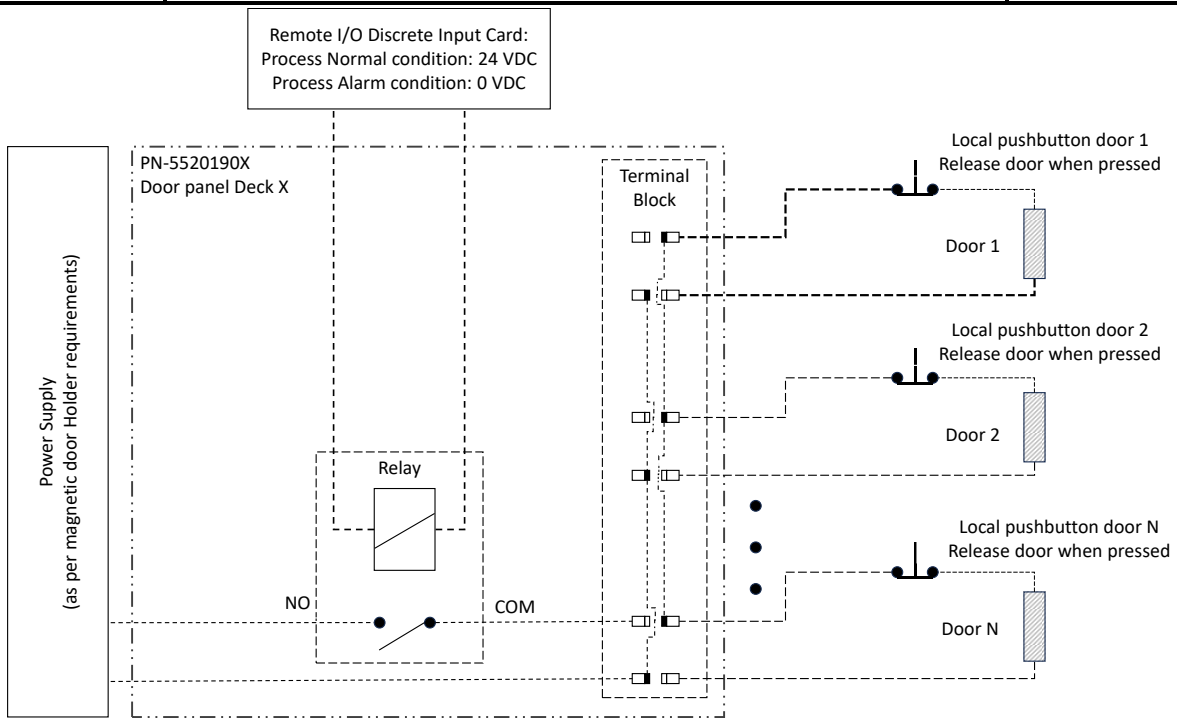

Figure 3.2-I - Typical schematic for doors containing magnetic hold back device with CCR release

3.2.1.2 Doors with associated open door limit switch and alarm:

3.2.1.2.1 Below is a list of types/locations of these doors:

I. Corridors,

II. Emergency rooms (which are class 1 rooms as per DR-ENGP-M-I-1.3 – SAFETY ENGINEERING GUIDELINE),

III. Watertight doors,

IV. Weathertight doors (SELLER shall check with classification society if weathertight doors should receive open door alarm during Detail Engineering Design Phase),

V. Rooms containing water mist system,

VI. Gas tight doors.

3.2.1.2.2 These doors have an associated limit switch in order to indicate and alarm in CCR that they are open. Also, these signals may take part in other logics of the FPSO. For example, water mist fire fighting system only works if the doors are properly closed. Therefore, the door limit switches take part in the water mist discharge.

3.2.1.2.3 A typical schematic for the door open alarm is presented below:

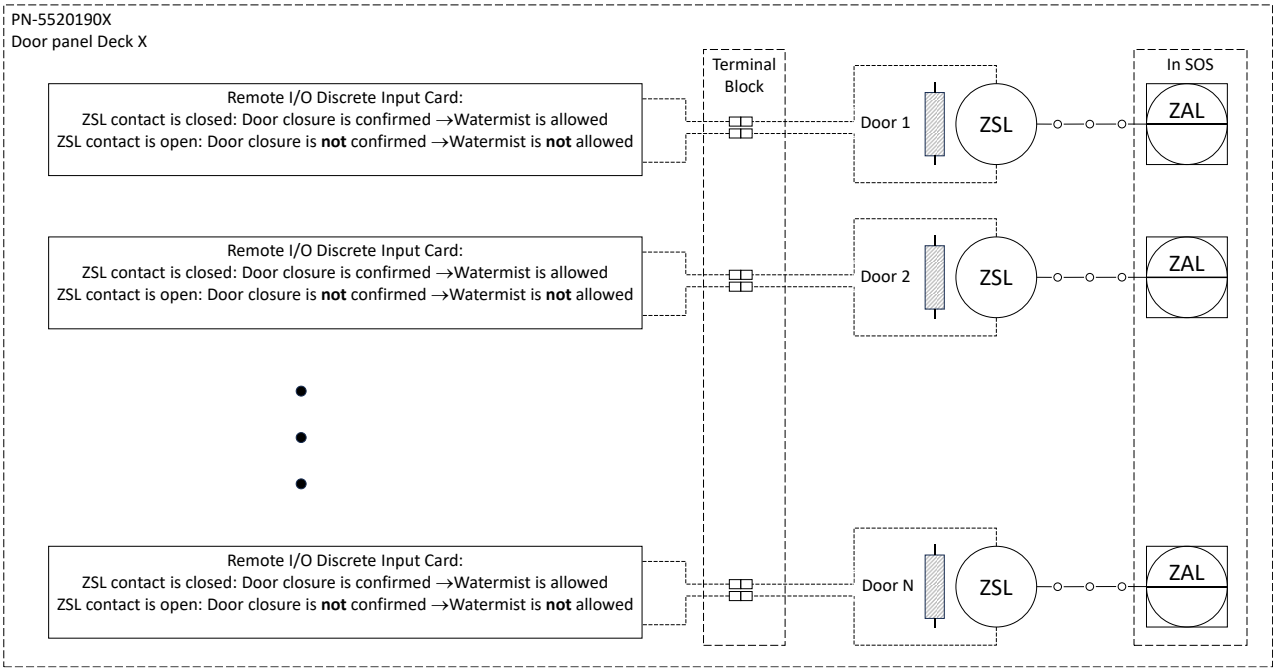

Figure 3.2-II - Typical schematic for doors with associated open door limit switch and alarm. Full logics shall be developed during Detail Engineering Design Phase.

3.2.2 In order to quantify the number of doors pertaining to each category, SELLER shall consult Architecture discipline's doors arrangement documents (both from Hull and Topsides) and manually count the doors based on the description of item 3.16.1, based on each environment of the doors (for example, stairway doors), and based on the tables showing the door types (gastight for example).

3.2.3 SELLER shall supply, interconnect, and test one frontal-access-only "door panel" per ambient that has applicable doors (for example, one door panel for Deck C, one door panel for the first elevation of M-17, and so on). Each of these panels shall contain the terminal blocks and relays applicable to that ambient and elevation. This panel shall be as small as possible (a size of a large junction box is desired as maximum size). These panels shall be included in equipment list of Detail Engineering Design Phase.

3.2.4 SELLER shall also supply, interconnect and test manual retentive pushbuttons to be installed near every door with magnetic door holder.

3.2.5 I/O points of doors will not be included in Automation basic design documentation and database. However, all door limit switches and magnetic hold back devices shall be connected to CSS/SOS. Any associated logic shall be configured in CSS/SOS. Alarms, and SOS status shall be represented in SOS screens. Commands to door release shall be given from SOS screens. Any associated cables, cable trays, junction boxes, I/O cards and other interconnection means needed for these signals shall be supplied by SELLER.

3.2.6 Logics and scope shall be verified/validated with architecture discipline, safety discipline and classification society during Detail Engineering Design Phase.

3.3 Plant Information® (PI)

3.3.1 The operational data of the Unit (FPSO) shall be sent to BUYER corporate Network through Plant Information® software (PI), from OSIsoft (AVEVA).

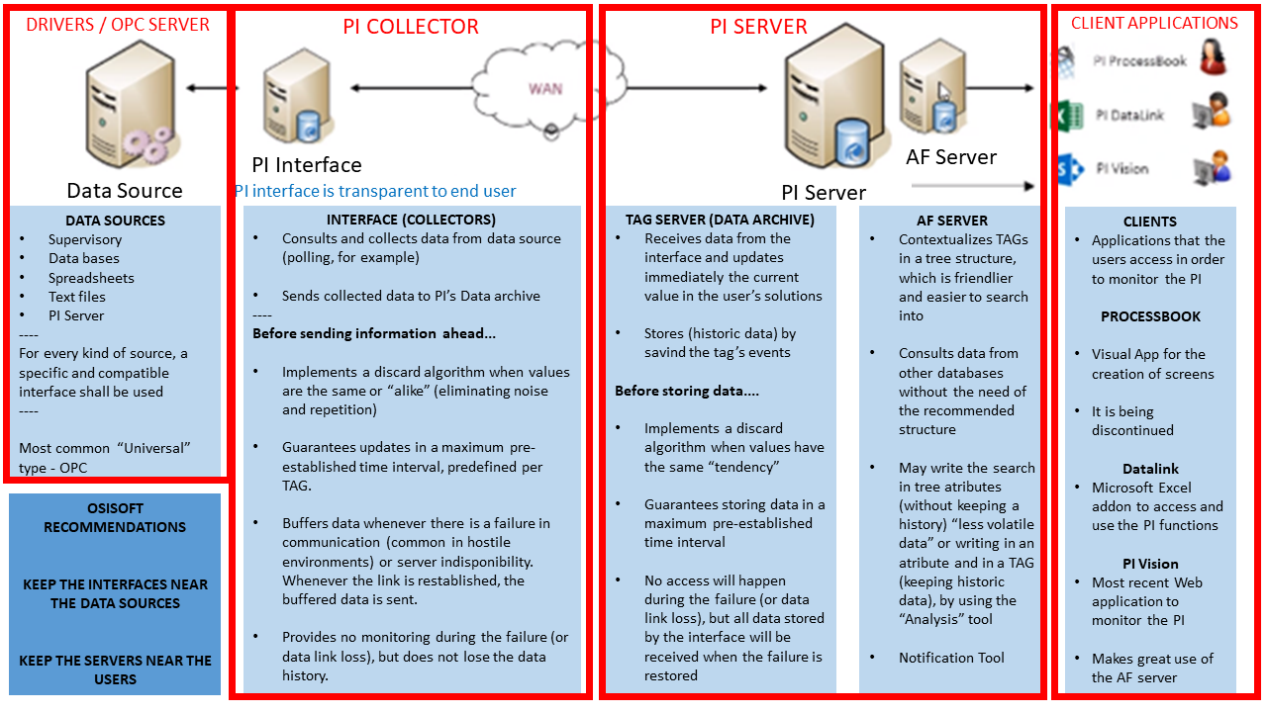

Figure 3.3-I – PI Main modules (in blue/black) and the generic name this document will use to refer to them (in red, in the top of the image)

3.3.2 PI is a modular software, as shown in Figure 3.3-I. Among the several modules required for it to work, there are:

3.3.2.1 OPC drivers / OPC servers

I. These components are installed in the Data Sources (i.e., supervisory systems servers) with data that is meant to be sent to onshore applications.

II. They make system data available for the PI Collectors.

3.3.2.2 PI Collectors

3.3.2.2.1 PI Collectors is a generic name for PI Interfaces, PI Adaptors and PI Connectors

3.3.2.2.2 PI Collectors are responsible for:

I. Grabbing data from OPC drivers / OPC servers through polling techniques.

II. Transforming data from OPC into PI proprietary protocol.

III. Sending data to PI Servers.

3.3.2.2.3 There are several types of PI Collectors. The type of PI collectors to be used may depend on the data source system manufacturer.

3.3.2.3 PI Server

3.3.2.3.1 The PI database itself (subdivided into Data archive and AF server).

3.3.2.3.2 The PI server is under BUYER Scope.

3.3.2.3.3 SELLER is responsible for the configuration of TAGs in the PI SERVER

3.3.2.4 Client application

3.3.2.4.1 The applications that consume data from the PI server

3.3.2.4.2 Client applications are under BUYER Scope

3.3.3 In order to configure PI to send data from the Automation network to onshore applications, the following architecture shall be followed:

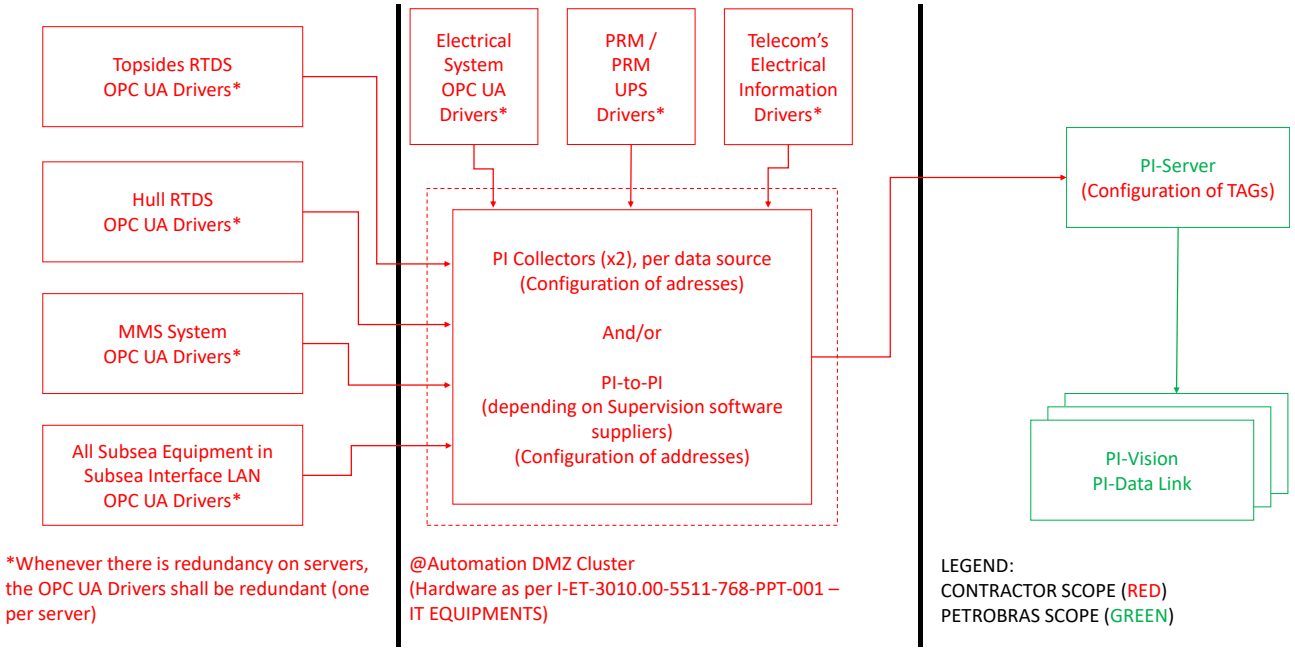

Figure 3.3-II – PI architecture

3.3.4 Regarding Licenses:

3.3.4.1 As seen in Figure 3.3-II, at least the following PI licenses are required (quantities of licenses shall be confirmed by SELLER in liaison with OSIsoft (AVEVA) and during Detail Engineering Design Phase):

I. Redundant OPC Driver licenses (Quantity and type to be confirmed Detail Engineering Design Phase). Whenever the data source servers are redundant, then the OPC drivers shall be redundant, i.e., one per server.

II. Redundant Licenses of PI Collector (PI Interfaces) for OPC-UA.

III. Licenses of PI – to – PI (may be necessary, depending on Supervision software suppliers).

3.3.4.2 All PI drivers, interfaces and servers shall be properly licensed.

3.3.4.3 Licenses shall be acquired by SELLER under BUYER's name, so that maintenance for the licenses may be done by BUYER during operation phase. SELLER shall liaise with OSIsoft (AVEVA) and BUYER in order to verify the possibility of updating the OSIsoft (AVEVA) <-> BUYER contract with the new licenses (PI-to-PI licenses and PI Collector licenses).

3.3.4.4 Software PI licenses shall be acquired in the most recent version available by OSIsoft (AVEVA) during commissioning phase.

3.3.4.5 All OPC drivers shall also be properly licensed.

3.3.5 Regarding OPC Drivers:

3.3.5.1 Standardized drivers shall be supplied and properly licensed to make data from the following systems available via OPC:

I. Hull Real Time Data Servers virtual images (HCS, HSD, HFGS, Hull Packages).

II. Topsides Real Time Data Servers virtual images (PCS, PSD, FGS, Topsides Packages).

III. TOPSIDE ELECTRICAL SYSTEM AUTOMATION DMZ SERVERS. This machine sends data from the Electrical System to PI and is installed inside PN-5140002 - Topside Electrical System Automation Panel.

IV. SPCS equipment.

V. MMS servers.

VI. PRM / PRM UPS data server.

3.3.5.2 The chosen standardized driver shall be chosen in liaison with OSIsoft (AVEVA) and with each of these system suppliers, in order to ensure compatibility.

3.3.6 Additional information and services:

3.3.6.1 Telecom panel’s voltage, current and power shall be available at PI system for onshore monitoring. In order to do so, redundant Modbus PI Collectors shall be provided at Automation DMZ server in order to reroute the information from telecom Panels to PI server. If necessary, Modbus drivers for publishing Telecom’s electrical panels voltage, current and power shall also be provided.

3.3.6.2 Other OPC Drivers and PI Collectors may be required, according to project needs. In case they exist, these additional OPC Drivers and PI Collectors are also SELLER’s scope of supply. Supplying all licenses, installation of the software, configuration and testing of all PI related machines and OPC Drivers shall be performed by SELLER. The configuration of OPC drivers and PI Collectors shall be performed by SELLER. This includes, for example, the configuration of addresses in PI Collectors in order to point them to the onshore PI Server.

3.3.6.3 The configuration of the TAGs in the PI Server shall be performed by SELLER. This will be accomplished by delivering a spreadsheet with PI TAGs information. SELLER shall ask BUYER for the spreadsheet template during PI configuration.

3.3.6.4 See also document I-DE-3010.2Q-5520-800-P4X-004 – NETWORK INTERCONNECTION DIAGRAM, for the representation of OPC drivers for PI and PI Collectors.

3.4 Asset Management System (AMS)

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

4 SYSTEMS RELATED TO TURBOMACHINERY

4.1 Compressor Governor System (CGS)

4.1.1 Compressor Governor System (CGS) for each service consists of the following: Capacity, Load Sharing and Anti-Surge Controls as well as a specific HMI.

4.1.2 As described in I-ET-3010.00-1200-321-P4X-001 - TECHNICAL SPECIFICATION FOR CENTRIFUGAL COMPRESSOR DRIVEN BY ELECTRIC MOTOR, compressors PACKAGER will provide additional workstations (PN-5500010A/B - Compressor Governor System Workstations) connected directly to anti-surge, capacity and load sharing controllers. These Workstations shall be suitable for mounting in a 19” rack and shall also be accessed onshore via jump host in DMZ.

5 SYSTEMS RELATED TO HULL

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

5.1.1 For Requirements regarding HSTS, refer to I-ET-3010.2Q-1351-800-P4X-001 – HULL STRUCTURAL TANKS LEVEL, INTERFACE, PRESSURE AND TEMPERATURE MONITORING SYSTEMS.

5.2 Hull Structure Health Monitoring System (HSHMS)

5.2.1 HULL STRUCTURE HEALTH MONITORING SYSTEM (HSHMS) is referred to as “Tension Monitoring system” in Telecom documentation. See I-ET-3010.00-1351-140-P4X-002 - DIGITAL TWIN FOR HULL STRUCTURAL INTEGRITY MANAGEMENT.

5.2.2 Details of Hull structure monitoring system and its correct interconnections shall be included both in Telecom scope of supply (and Telecom documents) and in Automation scope of supply (Automation documents).

5.2.3 HSHMS shall be placed logically in the DMZ, which allows it to consume data from Metocean Systems, and Navigation systems directly through DMZ switches (Telecom scope).

5.2.4 Loadmaster system is installed in PN-1358503 - STABILITY AND LOAD CALCULATION WORKSTATION. Therefore, in order to make Loadmaster system logically accessible to HSHMS, the following connections have been foreseen:

5.2.4.1 PN-1358503 - STABILITY AND LOAD CALCULATION WORKSTATION shall be acquired with an additional network card. SELLER shall liaise with Hull Structural Tanks Level, Interface, Pressure System (HSTS System) SUPPLIER in order to allow this additional network connection in PN-1358503 workstation.

5.2.4.2 PN-1358503 - STABILITY AND LOAD CALCULATION WORKSTATION shall also be connected to Package Unit LAN, so that its data reaches the firewall. Physical connections shall be provided and installed in order to do so.

5.2.4.3 Firewall rules shall be configured in FW-5517501/502 – CORPORATE FIREWALL (TELECOM) in order to allow data to flow from / to PN-1358503 - STABILITY AND LOAD CALCULATION WORKSTATION and from / to PN-1358510 HULL STRUCTURE HEALTH MONITORING SYSTEM PANEL.

6 SYSTEMS RELATED TO SUBSEA

6.1 Riser Balcony

6.1.1 Riser Annulus Pressure Monitoring System

6.1.1.1 See I-ET-3010.00-5529-812-PAZ-001 – ANNULUS PRESSURE MONITORING AND RELIEF SYSTEM. The type of Riser Annulus Pressure Monitoring System to be implemented is **Local Continuous Vented Type**.

6.1.1.2 Since the exact position of connection point is not possible to be determined prior to riser lift, the installations for the riser annulus vent shall be made up to vicinity slot hang-off. Once the riser lifting operation has been concluded, the remaining tubing installation shall be concluded. The supplier shall provide means for supporting tubing that is able to be fixed if it does not disturb or can be damaged by riser lifting operation or a non fixed one, so it can be removed and put back after riser is positioned.

6.1.2 Topsides Umbilical Terminal Unit (TUTU)

6.1.2.1 Several P&IDs of system 1210 show a Topsides Umbilical Terminal Unit (TUTU). The TUTU is basically a metal plate to interconnect umbilicals fluid lines, hoses or tubing, to Topsides through bulkhead connections. A TUTU plate is located next to each umbilical slot hang off position.

6.1.2.2 The TUTU provides interconnection of for services such as hydraulic commands, hydraulic power supply and chemical injection.

6.1.2.3 The TUTUs have not been represented in equipment list because they do not have a TAG associated in basic design. Regardless of this fact, TUTU supply, installation and interconnection are under SELLER scopes of supply and work.

6.1.2.4 TUTU shall be positioned in order to not block or interfere with pull-in/pull-out operations. Where this cannot be fully guaranteed, they shall be made removable.

6.1.2.5 Cancelled.

6.1.2.6 For requirements concerning TUTU design see I-ET-3000.00-1519-29B-PZ9-012 - TOPSIDE ARRANGEMENT AND INTERFACES WITH SUBSEA UMBILICAL SYSTEMS.

6.1.2.7 SELLER shall present design of each TUTU type for BUYER analysis.

6.2 Subsea Production Control System (SPCS)

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

I. Satellite Production Wells (SPW), each with a Wet Christmas Tree (WCT) fitted for Direct Hydraulic Control System (WCT-HD).

II. Satellite Water Injection Wells (SWIW), each with a Wet Christmas Tree (WCT) fitted for Direct Hydraulic Control System (WCT-HD).

III. Subsea Production Manifold (MSP) equipped with an Electrohydraulic Multiplex Subsea Control System (EHMUXSCS).

IV. Subsea Water Injection Manifold (MSIA) equipped with an Electrohydraulic Multiplex Subsea Control System (EHMUXSCS).

V. Chemical Injection Block Valves.

VI. Export Gas Manifold.

VII. Satellite Production Wells (SPW) with Submerged Subsea Centrifugal Pump─BCSS─(see item 6.7 below).

VIII. Subsea Production Manifold (MSP) with Subsea Multiphase Pump System─SBMS─(see item 6.7 below).

6.2.2 The SPCS shall be designed to allow the installation of the Control Cabinets during the construction phase and integration of FPSO and also during offshore operation of the Unit (FPSO). The AEPR (M-17) layout (ex.: access for installation of MCSs and DHSV-E inside module), SPCS communications network connections and electrical power supply shall be designed to permit this installation during offshore operation.

6.2.3 It shall be provided one (1) Hydraulic Power Unit (UH-1210001 - HYDRAULIC POWER UNIT FOR SUBSEA SYSTEMS) with a local control panel (PN-UH-1210001 - HYDRAULIC POWER UNIT FOR SUBSEA SYSTEMS CONTROL PANEL), to provide hydraulic supply, water-based control fluid, for Manifolds, WCT-HD for satellite production wells, WCT-HDs of satellite water injection wells, Gas Export Manifold and SESDV. The PN-UH-1210001 - HYDRAULIC POWER UNIT FOR SUBSEA SYSTEMS CONTROL PANEL hardwired signals shall be interconnected with CSS. This HPU shall be able to be supervised by SOS HMIs through digital network communication (Gigabit Ethernet).

6.2.3.1 This HPU shall comply with I-ET-3000.00-5139-800-PEK-005 - HYDRAULIC POWER UNIT FOR SUBSEA EQUIPMENT WITH MULTIPLEXED ELECTROHYDRAULIC AND DIRECT HYDRAULIC CONTROL SYSTEM.

6.2.4 SPCS interfaces shall be integrated with CSS.

6.2.5 All screens of subsea system shall be accessible from SOS HMIs to allow implementations defined in I-ET-3010.00-1200-800-P4X-002 - AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGE UNITS and I-ET-3010.2Q-1200-800-P4X-014 - AUTOMATION INTERFACE OF PACKAGED UNITS.

6.2.6 For further details regarding SPCS, refer to I-ET-3500.00-1500-800-PEK-005 - SUBSEA PRODUCTION CONTROL SYSTEM FOR FPSO.

6.2.7 Direct Hydraulic Control System - General Description

6.2.7.1 Direct Hydraulic Control System is a type of control system used for actuating some subsea hydraulic valves. In this system, the solenoids that actuate each of the submarine valves are placed in the Topsides of the Unit (FPSO). The Direct Hydraulic Control System consists of actuating these solenoids and sending the hydraulic power directly to the actuated valve.

6.2.7.2 Hydraulic Power Unit (UH-1210001 - HYDRAULIC POWER UNIT FOR SUBSEA SYSTEMS) is responsible for generating the required hydraulic power. Well Control Racks and SESDV racks distribute the hydraulic fluid to the submarine valves' umbilical, being, respectively, PN-1210012A/D - PRODUCTION WELL CONTROL RACK and PN-1210013 - SESDVS CONTROL RACK.

6.2.7.3 Regarding documentation describing the Well control Racks and SESDV racks refer to:

I. For Well Control Racks, for both production and Injection: I-DE-3010.00-1210-888-P4X-001 PRODUCTION WELL CONTROL RACK - LAYOUT, I-DE-3010.00-1210-888-P4X-002 PRODUCTION WELL CONTROL RACK - FUNCTIONAL DIAGRAM and I-ET-3010.00-1210-888-P4X-001 PRODUCTION WELL CONTROL RACK.

II. For SESDV controls rack: I-DE-3010.00-1210-888-P4X-005 SESDVs CONTROL RACK - LAYOUT, I-DE-3010.00-1210-888-P4X-006 SESDVs CONTROL RACK - FUNCTIONAL DIAGRAM and I-ET-3010.00-1210-888-P4X-003 SESDVS CONTROL RACK.

6.2.7.4 Signal Acquisition System (SAS) is responsible, among other uses, for acquiring data relative to Wet Christmas Trees using Direct Hydraulic Control System. The SAS module is provided by BUYER and shall be installed in PN-5524001A/B - SUBSEA INTERFACE PANEL.

6.2.8 Electrohydraulic Multiplex Subsea Control System─EHMUXSCS─General Description

6.2.8.1 EHMUXSCS System is a type of control system used for actuating subsea equipment hydraulic valves and for monitoring subsea sensors. It consists in sending electrical signals and hydraulic power supply in a single umbilical departing from topsides to one or more "subsea control modules" or "control pods". The control pods are responsible for decoding (demultiplexing) the electric signals and for actuating the corresponding subsea valves. Those "control pods" shall be hereafter referred as SCM. To accomplish the demultiplexing, each SCM have its own internal electronics and directional (solenoid) control valves.

6.2.8.2 The EHMUXSCS requires topside equipment, control cabinets, known as Master Control Station or MCS, to provide power for the SCMs and communication between those and the SOS HMIs and CSS. The MCSs (PN-1210001-008A/B - SUBSEA MASTER CONTROL STATION) are 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 is superimposed in the same pair of

wires that power the SCMs (so called power line carrier subsystem). Optical communication channels are used as well. Each MCS, one cabinet, provides power and communication for a SCM. The MCSs work in pairs, providing redundancy power and communications for SCMs in the same manifold or WCT-MUX. The two matched MCS cabinet shall be referred as “Channel A or 1” and “Channel B or 2” or MCS A and MCS B.

6.2.8.3 The MCSs shall be connected with the main Automation System─CSS─ through the following interfaces:

I. Connection with the FPSO PCS system by the Package Unit LAN communications network (CSS), via Ethernet Switches located in Subsea Interface Panel (PN-5524001A/B).

II. Connection with the FPSO PSD system by hardwired (PSD) interfaces.

III. Connection with the FPSO FGS system by hardwired (FGS) interfaces.

6.2.8.3.1.1 Although the primary (main) means of operator’s interface with the EHMUXSCS shall be through the SOS HMIs, a given number of MCS pairs shall be also connected to a dedicated Operator Workstation provided by BUYER. These dedicated Operation Workstations (OWS) allow the operation of the subsea equipment fitted with EHMUXSCS, independently of the SOS HMIs. Each MCS Cabinet also have a dedicated Engineering Workstation (EWS) for internal configuration and display of “housekeeping” parameters not related to the control application.

6.2.8.4 A typical subsea Wet Christmas Tree with EHMUXSCS (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 EHMUXSCS fitted, typically with one or more SCM installed in the manifold itself for its own control and monitoring functions.

6.2.8.5 To provide interconnection between signals from umbilical slot hang-off to MCS Panels, rearrangement (marshalling) panels shall be supplied at AEPR and panels with the purpose of interconnection located at M-09. These panels (PN-1210016A/B and PN-1210019A/B) are called, respectively, “Topsides Electrical-Optical Assignment Panel (TEOAP)” and “Field Topsides Electrical-Optical Assignment Panel (TEOAP)”.

6.2.9 SPCS sizing

6.2.9.1 The following types of equipment listed below, from the seabed to the Unit (FPSO), comprise the EHMUXSCS part of the SPCS:

I. Subsea Production Manifold (MSP).

II. Subsea Injection Manifold (MSIA).

III. Subsea Gas Manifold (MSG) for gas exportation.

IV. One (1) Umbilical for each position on riser for EHMUXSCS (and their interconnections).

V. Rearrangement panels (Topsides Electrical-Optical Assignment Panel – TEOAP).

VI. Field rearrangement panels (Topsides Field Electrical-Optical Assignment Panel – TEOAP).

VII. MCSs, the Control Cabinets for EHMUXSCS .

VIII. MCS Operation Workstation for EHMUXSCS, also known as OWS.

IX. Topsides Umbilical Terminal Units─TUTUs.

X. Hydraulic Power Unit (UH-1210001- HYDRAULIC POWER UNIT FOR SUBSEA SYSTEMS).

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

I. Wet Christmas Tree with Direct Hydraulic Control System (hereafter referred as WCT-HD). It is foreseen 7 WCT-HD for production wells and 2 WCT-HD for water injection wells.

II. Umbilical for Direct Hydraulic Control System.

III. CSS/SAS umbilical junction box.

IV. SAS Marshalling junction box.

V. CSS WCT-HD Marshalling junction box.

VI. Signal Acquisition System (SAS) for WCT-HD.

VII. A shared CSS remote panel for reading WCT-HD monitoring signals.

VIII. Solenoid Well Control Racks (WCR) for WCT-HD valves and Block Valves of Chemical Injection.

IX. Hydraulic Power Unit (UH-1210001- HYDRAULIC POWER UNIT FOR SUBSEA SYSTEMS).

6.2.9.3 The default quantities of the above equipment that the SPCS shall be able to control is:

I. Up to 7 (seven) Satellite Production Wells, each with direct hydraulic control.

II. Up to 2 (two) Satellite Injection Wells, each with direct hydraulic control.

III. Up to 9 (nine) Production Manifold.

IV. Up to 5 (five) Manifold for water injection.

V. One (1) SESDV with Direct Hydraulic Control.

6.2.9.3.1 Maximum of 4 (four) SESDV valves for Direct Hydraulic Control from the FPSO. The exact quantity shall be confirmed during the Detail Engineering Design Phase.

6.2.9.3.2 The SPCS shall be designed to interface with different types of MCS pairs according to the EHMUXSCS standard. 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. The types of MCSs are defined by Subsea design.

6.2.9.4 The SPCS shall be designed to provide monitoring and operation of the EHMUXSCS part of the SPCS from the FPSO's SOS HMIs in the CCR through a total of 8 (eight) pairs of MCSs, total of 16 (sixteen) individual MCS.

6.2.10 SPCS – Umbilical connection

6.2.10.1 The umbilicals have electrical cables and optical fiber optics cables that shall be interconnected with:

I. MCS panels located at AEPR (M-17).

II. DHSV-E control panels located at AEPR (M-17).

III. SBMS Control panels (PN-B-1240001/004-01 - SBMS CONTROL PANEL) located at M-16B.

IV. Frequency Converter for SBMS (CF-B-1240001/004 - Frequency Converter for SBMS MSP-1#MSP-3#MSP-4#MSP-6) at M-16B.

V. SAS Cabinet inside PN-5524001A/B - SUBSEA INTERFACE PANELS at AEPR (M-17).

VI. CSS Remote Panel ─ closest panel.

VII. SESDV Monitoring System inside PN-5524001A/B - SUBSEA INTERFACE PANELS at AEPR (M-17).

VIII. BCSS VSDs (CF-B-1243001/2) ─ Scope of Electrical Discipline.

6.2.10.2 All electrical and optical cables shall be routed from each umbilical hang off interface junction boxes to the room(s) where the MCSs and DHSV-E Control Cabinets shall be located. There shall be two (2) junction boxes for MCS cables, one (1) for MCS A interconnection and one (1) for MCS B interconnection. These shall be one (1) junction box for to interconnect cables to control 4 DHSV-E.

6.2.10.3 It shall be provided electrical and optical junction boxes next to each umbilical top connector, depending on the type of service:

I. Electric: To interconnect the umbilicals of multiplexed subsea equipment, (manifolds MSP, MSIA and MSG) with MCS panels, it shall be provided two (2) junction boxes for each umbilical, one (1) dedicated to MCS A (JB_UEH_MCS-A) and on (1) dedicated to MCS B (JB_UEH_MCS-B).

II. Electric: To interconnect the umbilicals of multiplexed subsea equipment (manifolds MSP and MSIA) and the umbilicals of all satellite wells to DHSV-E Control Panels, it shall be provided one (1) junction box (JB_UEH_DHSV_E) for each umbilical.

III. Electric: To interconnect the umbilicals of production satellite wells with SAS Cabinet and with CSS Remote panel, for satellite wells, it shall be provided two (2) junction boxes for the WCT-HD monitoring signals (JB_UEH_SAS/CSS).

IV. Electric: To interconnect the umbilical of gas export manifold/SESDV, it shall be provided one (1) junction box for the SESDV monitoring signals (JB_UEH_SESDV).

V. Optical: To interconnect the umbilical of gas export manifold/SESDV, it shall be provided two (2) junction boxes to interconnect with MCS panels PN-1210009A/B - SUBSEA MASTER CONTROL STATION, the JB_FO_UEH_MSG-A and JB_FO_UEH_MSG-B.

VI. Information. Electric: See Electrical discipline documentation for the interconnection of umbilicals of BCSS to CF-B-1243001/002 - Frequency Converter.

VII. Optical: To interconnect the umbilicals of each MSP to respective MCS via TEOAP panels PN-1210016A/B - TOPSIDES ELECTRICAL-OPTICAL ASSIGNMENT PANEL (TEOAP) and PN-1210019A/B - TOPSIDES ELECTRICAL-OPTICAL ASSIGNMENT PANEL (TEOAP), it shall be provided two (2) junction boxes, one (1) dedicate to each MCS (JB_FO_UEH_MSP-A and JB_FO_UEH_MSP-B).

VIII. Electric: To interconnect the umbilicals of SBMS to PN-B-1240001/004-01 – SBMS CONTROL PANEL, four (4) junction boxes (JB_LV_UEH_SBMS) will be provided by Buyer for LV circuit, one (1) for each system.

IX. Optical: To interconnect the umbilicals of SBMS to PN-B-1240001/004-01 – SBMS CONTROL PANEL, four (4) junction boxes (JB_FO_UEH_SBMS) will be provided by Buyer, one (1) for each system.

X. Information. Electric: See Electrical discipline documentation for the interconnection of SBMS umbilicals to CF-B-1240001/004 - Frequency Converter for SBMS MSP-1#MSP-3#MSP-4#MSP-6.

XI. Optical: There shall be an optical junction box to interconnect an umbilical for Control. The service, quantity and type of fiber optic cables shall be defined during Detail Engineering Design Phase.

6.2.10.4 All electrical junction boxes from item 6.2.10.3 shall have a metallic breather drain to prevent condensation and drain moisture. Every junction box shall be certified according to hazardous area classification and when located in open areas they shall be certified to at least Zone 2 Group IIA T3 Gb, even when the installation area is a non classified Zone. Junction boxes shall have individual ground terminals.

6.2.10.5 The interconnection between Junction Boxes at umbilical slot hang off ─JB_UEH_MCS-A, JB_UEH_MCS-B, JB_UEH_DHSV_E and JB_LV_UEH_SBMS─ shall be done with 100% installed spare. Each interconnection is implemented with a twisted shielded pair and the installed spare is another twisted shielded spare cable. In the case of SBMS there is one (1) Junction Box interconnecting two (2) control systems at subsea equipment. Therefore, there shall be 2 cables for the first system, one (1) operational and one (1) spare, and other two (2) cables for the second control system, one (1) operational and one (1) spare, totalizing four (4) cables for each SBMS.

6.2.10.6 The cables for the interconnection of Junction Boxes at umbilical slot hang off ─JB_UEH_MCS-A, JB_UEH_MCS-B, JB_UEH_DHSV_E, and JB_LV_UEH_SBMS─shall comply with I-ET-3010.00-5140-700-P4X-002 - SPECIFICATION FOR ELECTRICAL MATERIAL FOR OFFSHORE UNITS, incorporating the following additional requirements, and definitions on options of this specification:

I. Voltage Designation: 0.6/1.0 (1.2) kV.

II. Conductor cross-section: 6 mm^2.

III. Two (2) cable with one (1) twisted shielded pair, one (1) for operation and one (1) as installed spare. The twist pitch shall be less or equal to 60mm. Conductor identification by black and white and with printed numbers.

IV. For every pair there shall be a PE conductor for grounding. Conductor identification by green and yellow stripes.

V. Outer Sheath (non-metallic ~ outer jacket) in SHF2. Color shall be gray.

VI. Rated operating frequency (power): 60 Hz.

VII. Rated operating frequency (signal): 0 to 100 kHz.

VIII. Minimum insulation resistance: 1000 MΩ.km @ 1000 V (DC).

IX. Maximum reference line attenuation: 0.40dB/km at 1kHz; 0.83 dB/km at 10kHz and 1.35 dB/km at 30kHz.

X. Maximum cross talk between cables and between multicables: -60dB at 10kHz.

XI. Test for attenuation: A sample of the completed cable, with minimum length of 10 meters, shall have its attenuation measured and shall be lower or equal to the values listed in "Max. reference line attenuation " specified in every frequency.

XII. Test for Crosstalk: The crosstalk shall be measured between two cables in parallel with the length of designed cable routing of greater distance. The value shall be less or equal to value specified in "Max. cross talk ".

XIII. Cable shall be type approved by Classification Society of the Unit (FPSO).

6.2.10.7 TEOAP and TWAP panels

6.2.10.7.1 These panels provide means to easily reconnect the circuits for MCS and DHSV-E circuits.

6.2.10.7.2 At AEPR (M-17) there are the marshalling panels PN-1210016A/B - TOPSIDES ELECTRICAL-OPTICAL ASSIGNMENT PANEL (TEOAP) for MCS interconnections and PN-1210017 - TOPSIDES WELL ASSIGNMENT PANEL (TWAP) for DHSV-E circuits.

6.2.10.7.3 In the field, at M-09, shall be installed 3 panels that function as a junction boxes for the circuits of MCS panels and DHSV-E Control Panels, being PN-1210019A/B - TOPSIDES ELECTRICAL-OPTICAL ASSIGNMENT PANEL (TEOAP) and PN-1210018 - TOPSIDES WELL ASSIGNMENT PANEL (TWAP). Their purpose is to settle a point close to the riser balcony where interconnection is aloof from riser balcony slot sequence definition and, therefore, all cabling from M-17 to M-09 is able to be detailed, installed and tested.

6.2.10.7.4 The panels PN-1210016A/B - TOPSIDES ELECTRICAL-OPTICAL ASSIGNMENT PANEL (TEOAP) PN-1210017 - TOPSIDES WELL ASSIGNMENT PANEL (TWAP) shall facilitate connection modifications without the need for cable repositioning. There shall be a fixed connection to MCS panels and to DHSV-E Control Panels and also a fixed connection to the cables from, respectively, PN-1210019A/B - TOPSIDES ELECTRICAL-OPTICAL ASSIGNMENT PANEL (TEOAP) and PN-1210018 - TOPSIDES WELL ASSIGNMENT PANEL (TWAP).

6.2.10.7.5 In PN-1210016A/B - TOPSIDES ELECTRICAL-OPTICAL ASSIGNMENT PANEL (TEOAP) PN-1210017 - TOPSIDES WELL ASSIGNMENT PANEL (TWAP) there shall be pig tails with Heavy Duty Connectors with locking mechanism to guarantee a perfect connection. At input of cables from PN-1210019A/B - TOPSIDES ELECTRICAL-OPTICAL ASSIGNMENT PANEL (TEOAP) and PN-1210018 - TOPSIDES WELL ASSIGNMENT PANEL (TWAP) the terminals shall be separated with earthed metal plates to minimize crosstalk between circuits.

6.2.10.7.6 See in figures Figure 6.2-I, Figure 6.2-II and Figure 6.2-III simplified sketches that shows the idea for the TEOAP and TWAP panels. The interconnections of fiber optics are not represented in these figures.

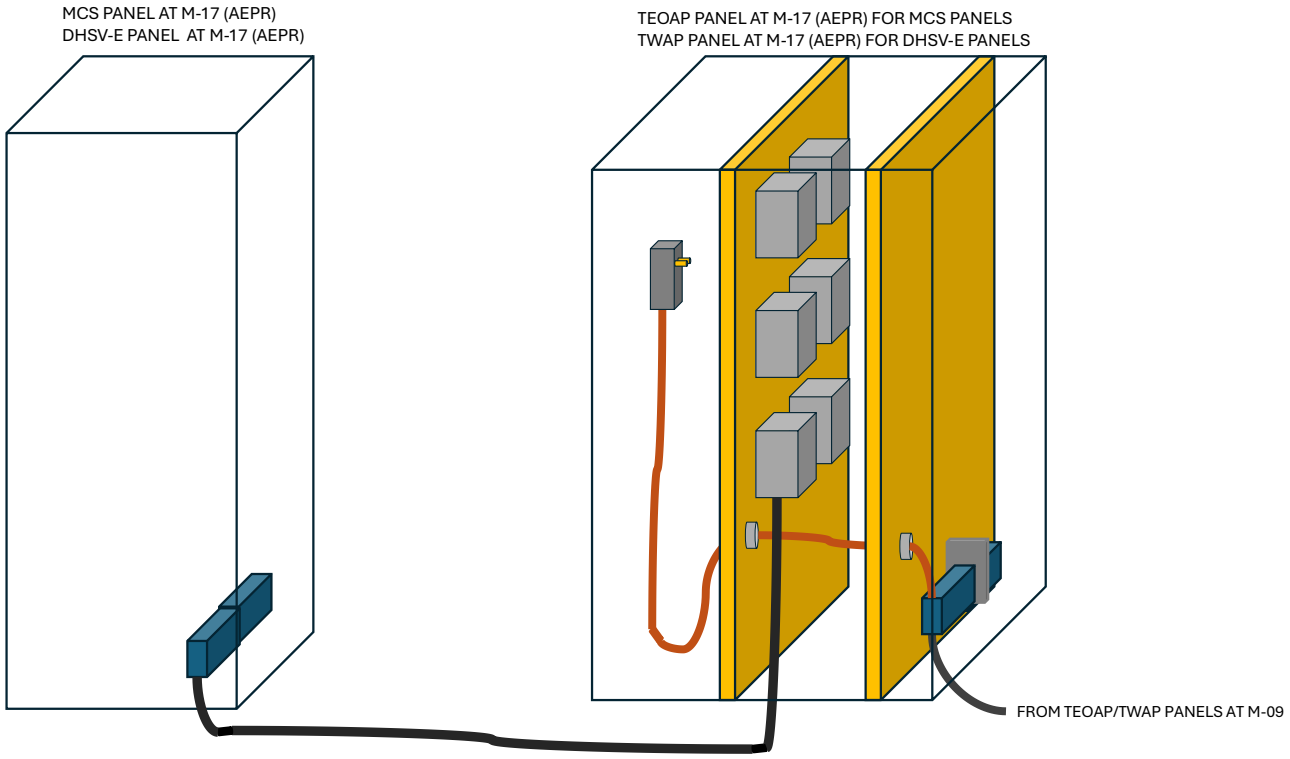

Figure 6.2-I – Overview of MCS/DHSV-E circuit interconnection: From TEOAP/TWAP to MCS/DHSV-E Control Panel

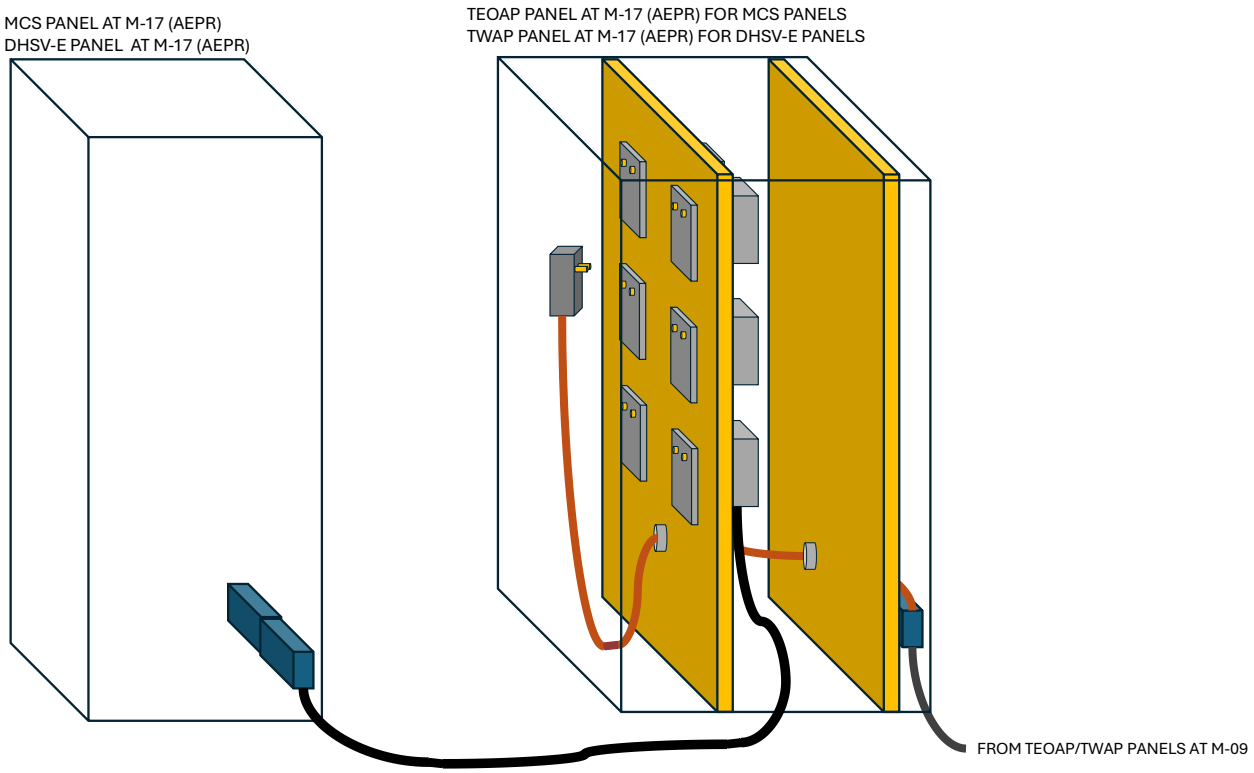

Figure 6.2-II - Overview of MCS/DHSV-E circuit interconnection: From TEOAP/TWAP to MCS/DHSV-E Control Panel (another angle of Figure 6.2-I)

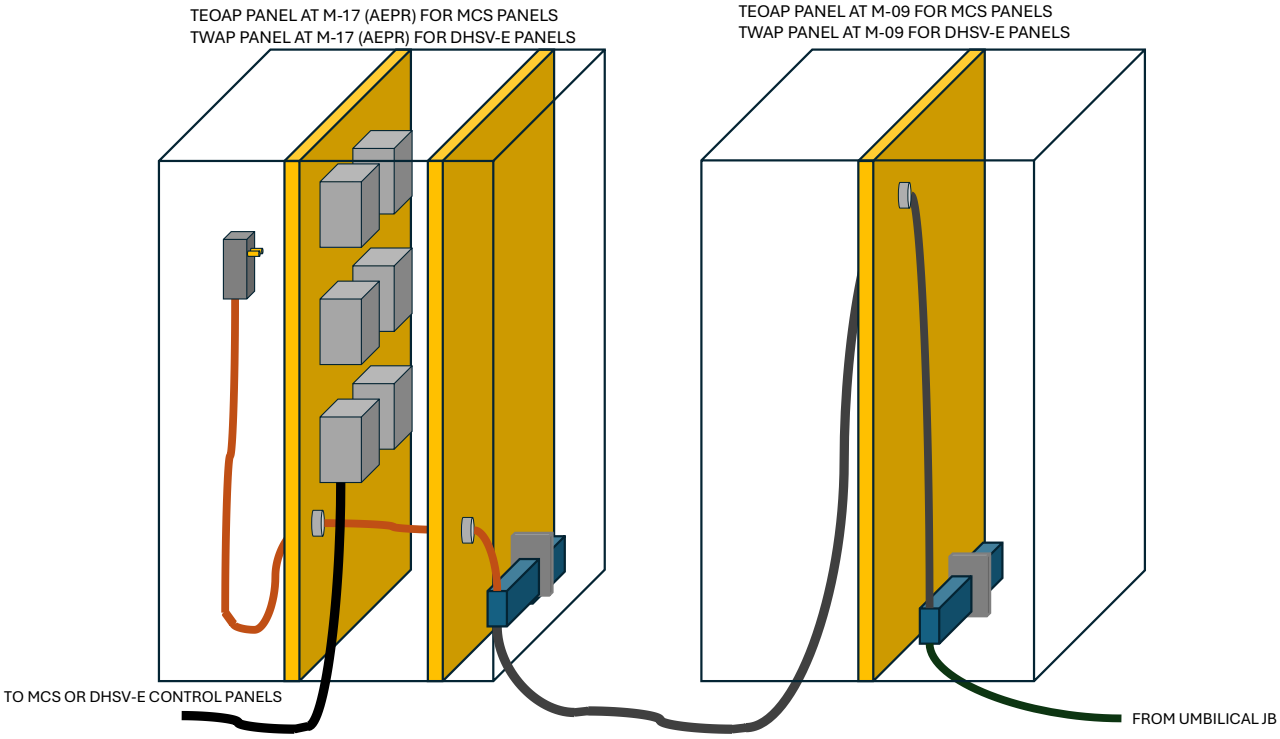

Figure 6.2-III - Overview of MCS/DHSV-E circuit interconnection: From FIELD TEOAP/TWAP at M-09 to respective M-17 TEOAP/TWAP

6.2.10.8 Each of the two (2) interconnections from JB_FO_UEH_MSG-A/B (2 JBs) to PN-1210009A/B - SUBSEA MASTER CONTROL STATION shall be done with fiber optic cables with following specification: Single-mode fiber optic cable (ITU-G.652), 3 cables, each containing 24 individual fibers with 9/125 µm rating, 1550 nm wavelength.

6.2.10.9 Each of the two (2) interconnections from JB_FO_UEH_MSP-A and JB_FO_UEH_MSP-B to PN-1210001/008A/B - SUBSEA MASTER CONTROL STATION, via TEOAP panels PN-1210016A/B - TOPSIDES ELECTRICAL-OPTICAL ASSIGNMENT PANEL (TEOAP) and PN-1210019A/B - TOPSIDES ELECTRICAL-OPTICAL ASSIGNMENT PANEL (TEOAP) shall be done with fiber optic cables with following specification: Single-mode fiber optic cable (ITU-G.652), 3 cables, each containing 24 individual fibers with 9/125 µm rating, 1550 nm wavelength.

6.2.10.10 Each of the four (4) interconnections from JB_FO_UEH_SBMS (4 JBs) to PN-B-1240001/004-01 – SBMS CONTROL PANEL shall be done with fiber optic cables with following specification: Single-mode fiber optic cable (ITU-G.652), 3 cables, each containing 24 individual fibers with 9/125 µm rating, 1550 nm wavelength.

6.2.10.11 It shall be foreseen two Pressure Gauges rated to 12,000 psi for testing the umbilicals during commissioning.

6.2.10.12 For requirements regarding the TUTU plates, refer to I-ET-3000.00-1519-29B-PZ9-012 - TOPSIDE ARRANGEMENT AND INTERFACES WITH SUBSEA UMBILICAL SYSTEMS.

6.2.11 MCS Related Requirements and Characteristics

6.2.11.1 The MCSs, the Control Cabinets, are provided by BUYER.

6.2.11.2 Regarding cabinet access, each MCSs have:

I. Bottom cable access.

II. Frontal and back accesses.

6.2.11.3 Each MCS, the cabinet, is based on 19” type standard.

6.2.11.4 All 18 MCSs (PN-1210001/009A/B - SUBSEA MASTER CONTROL STATION) shall be located at AEPR, with air conditioning ambiance.

6.2.11.5 The layout of Automation and Electrical Panels Room –AEPR– shall also be designed to allow marshalling the interconnections between each umbilical electrical and optical cables with all MCSs Control Cabinets. At AEPR the marshalling of MCSs shall be done through TEOAP panel (PN-1210016A/B - TOPSIDES ELECTRICAL-OPTICAL ASSIGNMENT PANEL (TEOAP)) and at FIELD the interconnection of cables from umbilical junction boxes to the cables to TEOAP panel (PN-1210016A/B - TOPSIDES ELECTRICAL-OPTICAL ASSIGNMENT PANEL (TEOAP)) shall be done through FIELD TEOAP panel (PN-1210019A/B - TOPSIDES ELECTRICAL-OPTICAL ASSIGNMENT PANEL (TEOAP)).

6.2.11.5.1 The cables from riser balcony to TEOAP shall be respective to MCS channel, i.e., cables for MCS A are interconnected to TEOAP A and cables for MCS B are interconnected to TEOAP A.

6.2.11.5.2 The interconnection from TEOAPs to MCSs shall be done respectively to MCS Channel, i.e., TEOAP A is interconnected to MCSs A and TEOAP B is interconnected to MCSs B

6.2.11.6 Each pair of MCS shall be fed according to I-ET-3010.00-5140-700-P4X-003 – ELECTRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE UNITS. Whenever necessary, power converters and AC/DC stabilized power supplies shall be included in the panel in order to make all appropriate conversions between the power supplied by the Electrical System and the panel’s internal components power requirements.

6.2.11.7 For further details regarding MCS, refer to I-ET-3500.00-1500-800-PEK-005 - SUBSEA PRODUCTION CONTROL SYSTEM FOR FPSO.

6.2.12 Direct Hydraulic Control - Interfaces

6.2.12.1 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 OWSs.

6.2.12.2 The CSS subsystems PSD and FGS shall be in charge of generating commands to the Production Well Control Rack Direct Hydraulic (PN-1210012A/D -

PRODUCTION WELL CONTROL RACK) in order to permit that all WCT valves and VHIF valves are operated and monitored from CSS HMIs.

6.2.12.3 The WCT-HD shall be direct hydraulically controlled from Production Well Control Rack (PN-1210012A/D - PRODUCTION WELL CONTROL RACK) installed in M-09. These racks shall be electrically interconnected to a CSS Remote I/O Panel, located near the racks, and to an FGS remote panel located at AEPR to operate the solenoids dedicated to SCSSVs (DHSVs).

6.2.12.4 The gas pipeline emergency valve (SESDV) is controlled by the gas export manifold MSG-MLS-001. As a contingency for the dynamic nature of Subsea flow lines arrangement, an SESDV Solenoid Control Rack (PN-1210013 - SESDVS CONTROL RACK) shall be provided. The TUTU for the SESDV slot hang-off position shall be designed to accommodate both hydraulic multiplexed control and hydraulic direct control.

6.2.12.5 The hydraulic power fluid for Production Well Control Rack (PN-1210012A/D - PRODUCTION WELL CONTROL RACK) and for SESDV Control Rack (PN-1210013 - SESDVS CONTROL RACK) shall be provided by the common Hydraulic Power Unit for Subsea System (UH-1210001- HYDRAULIC POWER UNIT FOR SUBSEA SYSTEMS).

6.2.12.6 Opening/closing logic sequences for the WCRs valves shall be carried out by PSD and FGS. As for the SESDV Control Rack (PN-1210013 - SESDVS CONTROL RACK), the SESDV solenoid shall be connected to CSS-PSD Subsystem.

6.2.13 Supervision and HMIs of the SPCS

6.2.13.1 A number of 4 (four) dedicated Operating Workstations for the EHMUXSCS part of the SPCS (PN-1210010A/D - SUBSEA OPERATION WORKSTATION (OWS)) shall be installed at CCR. Specifications of how to interconnect the MCSs to OWSs, including specifications of cables and connectors, shall be provided by BUYER during the Detail Engineering Design Phase.

6.2.13.2 The SPCS shall be operated from Subsea Operation Workstations (OWS), PN-1210010A/D - SUBSEA OPERATION WORKSTATION (OWS), 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. To avoid repeating in below definitions, every WCT representation shall be done with and without DHSV-E. So that, when defined the type of DHSV, electrical or hydraulic, the screen can be readily updated:

I. Satellite Production WCT-HD and Chemical Injection Block valves.

II. Satellite Production WCT-HD with BCSS and Chemical Injection Block valves.

III. Satellite Water Injection WCT-HD and VHIF.

IV. Subsea Production Manifolds—MSPs—and respective WCT-HD and WCT-MUX.

V. Subsea Production Manifolds—MSPs—with SBMS and respective connected WCTs in any combination of WCT-HD and WCT-MUX.

VI. Subsea Water Injection Manifolds—MSIAs—and respective connected WCT-HD and WCT-MUX.

VII. Subsea Gas Manifold—MSG—for gas export and equipment connected to it. It shall also be implemented screens for SESDVs with hydraulic direct control that shall be enabled if SESDV is implements as hydraulic direct control during Detail Engineering Design Phase.

VIII. HPU monitoring.

6.2.13.3 The PDG installed at the satellite production and water injection 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. Refer to item 6.4 for wiring interconnection requirements.

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

6.2.13.5 BUYER 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. SELLER shall liaise with Subsea equipment manufacturers for information on how configure CSS/SOS to read Subsea data.

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

I. WCT Valves statuses opened/closed, including for VHIF valves.

II. Chemical Injection Block Valves statuses

III. Pressures from WCT instruments.

IV. Temperatures from WCT instruments.

V. Downhole pressures.

VI. Downhole temperatures.

NOTE: For valves actuated by Well Control Rack (PN-1210012A/D - PRODUCTION WELL CONTROL RACK) and by SESDV Control Rack (PN-1210013 - SESDVS CONTROL RACK) the statuses are obtained monitoring the pressure of valve control line. For more details refer to I-DE-3010.00-1210-888-P4X-002 - PRODUCTION WELL CONTROL RACK - FUNCTIONAL DIAGRAM

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

I. Valve opened/closed statuses of manifold valves and connected WCT valves.

II. Pig detection.

III. Pressures from manifold instruments.

IV. Temperatures from manifold instruments.

V. Injection flow rates from manifold instruments (water and gas).

VI. Corrosion monitoring from manifold or pipeline instruments (refer to I-ET-3010.00-1200-859-P4X-001 - AUTOMATION REQUIREMENTS FOR CORROSION MONITORING SYSTEM (CMS)).

VII. Choke actuation and position feedback.

6.2.13.8 The HPU UH-1210001 - HYDRAULIC POWER UNIT FOR SUBSEA SYSTEMS shall be monitored from the SOS HMIs using dedicated screens and pop-up menus. The reservoirs levels, the pressure at the HPU UH-1210001- HYDRAULIC POWER UNIT FOR SUBSEA SYSTEMS outlet headers, the pumps statuses (on/off) and the pressure of main header (hydraulic pumps outlet), shall be displayed locally and at the SOS HMIs.

6.2.13.9 The SESDV Control Rack (PN-1210013 - SESDVS CONTROL RACK) shall be operated from the SOS HMIs using dedicated screens and pop-up menus that shall be enabled if SESDV is confirmed to be implemented as hydraulic direct control during Detail Engineering Design Phase.

6.2.13.10 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.

6.2.13.11 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 BUYER.

6.2.13.12 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 BUYER.

6.2.13.13 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 fluid cleanliness.

6.2.14 Services related to SPCS

6.2.14.1 The integration between all topside equipment of the SPCS and the Unit (FPSO) shall be provided. This comprises assembly, hook-up, cabling, tubing, junction boxes, etc required to interface each well control umbilical with the Well Control Racks, HPU for Subsea, Subsea SESDV control panel, MCS panels, DHSV-E control panels, SBMS control panels, BCSS panels and the Unit's (FPSO) systems (SOS, CSS and others).

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

6.2.15 Interfaces between MCS and CSS

6.2.15.1 The communication network between each MCS with the FPSO CSS system shall be through OPC protocol over Gigabit Ethernet.

6.2.15.2 Each Control Cabinet rack shall have available 32 (thirty two) digital inputs (0 - 24 Vdc) for interface with PSD and FGS, such as ESDs levels. The exact functions and Cause & Effect Diagram shall be agreed together with BUYER during the Detail Engineering Design Phase.

6.2.15.3 Each MCS receive 5 digital signals to be actuated by CSS in abnormal process condition restricted to a well or manifold, ESD-1 (PSD), Total process shutdown, ESD-2 (PSD), emergency conditions due to Fire or Gas confirmation, ESD-3 (FGS), and Prepare to Abandon Unit (FPSO), ESD-4 (FGS). Since there are 16 MCSs, the total of digital outputs in CSS dedicated to MCS is 32 in CSS-PSD and also 32 in CSS-FGS.

6.2.15.4 See in Table 6.2-I and in Table 6.2-II the signals from CSS to one (1) MCS and the actions that MCS performs.

Table 6.2-I – Hardwired Signals from CSS to MCS (1) that Controls a MSP

Signal	Action	CSS I/O Type	PN-1210001/008A/B SUBSEA MASTER CONTROL STATION
ESD-4	Closure of SCSSV (DHSV)	DO	1
ESD-3	Close Wings (2) and Masters (2) WCT valves	DO	1
ESD-2	Closure of XO and P-XO (MCS)	DO	1
ESD-1	Individual Actuation for each WCT	DO	2
Total of I/Os per 1 MCS			5

Table 6.2-II – Hardwired Signals from CSS to MCS (1) that Controls a MSIA

Signal	Action	CSS I/O Type	PN-1210001/008A/B SUBSEA MASTER CONTROL STATION
ESD-4	Closure of SCSSV (DHSV)	DO	1
ESD-3	Close Wing (1) and Master (1) WCT valves	DO	1
ESD-2	Closure of XO and P-XO (MCS)	DO	1
ESD-1	Individual Actuation for each WCT	DO	2
Total of I/Os per 1 MCS			5

6.3 Subsea Interface Panels

6.3.1 The Subsea Interface Panels shall be installed at AEPR, an air-conditioned environment, and shall comply with I-ET-3010.00-5520-888-P4X-001 – AUTOMATION PANELS. The panels TAGs shall be PN-5524001A/B.

6.3.2 The Subsea Interface Panels (PN-5524001A/B) shall house the SAS modules and Subsea Interface LAN switches.

6.3.3 The LAN Switches shall have the same brand and model of L3 switches in the Package Unit LAN.

6.3.4 Quantity of LAN switches is preliminary and shall be confirmed in Detail Engineering Design Phase in order to interconnect all SAS and Package Unit LAN equipment.

6.3.5 Gigabit L3 managed ethernet switches (rack mounted) shall also be supplied by SELLER, at least one for each section. For each ethernet switch, a rack mounted patch panel shall be supplied.

6.3.6 These LAN switches shall have at least 32 ports and shall also be the pathway to communicate other subsea systems to Package Unit LAN, as depicted in I-DE-3010.2Q-5520-800-P4X-002 - AUTOMATION AND CONTROL ARCHITECTURE.

6.3.7 Subsea Interface Panels (PN-5524001A/B) shall be supplied with standard 19-inch racks (42 u), 800mm (W) x 800mm (D) x 2100mm (H), and all panel accessories (including circuit breakers, lighting, thermostats, limit switches, terminal strips, DIN rails, earth fault detectors, two internal 24 Vdc/40A stabilized power supplies, ventilation, two 24 Vdc redundancy modules, cable glands, 220Vac/300W auxiliary power outlet – both in NEMA 5-15 standard and in ABNT 14136 standard etc).

6.3.8 Subsea Interface Panels (PN-5524001A/B) shall be powered according to I-ET-3010.00-5140-700-P4X-003 - ELECTRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE UNITS. Whenever necessary, power converters and AC/DC stabilized power supplies shall be included in the panel in order to make all appropriate conversions between the power supplied by the Electrical System and the panel's internal components power requirements.

6.3.9 SELLER shall also provide and install any devices included in sections 6.1.1.

6.3.10 All cabling, including electrical cables from riser balcony and all cables ─ instrumentation, signal, power ─ with suitable connectors and terminations.

6.3.11 Installation, Integration, Configuration, Commissioning and Tests of SAS equipment are also under SELLER scope.

6.3.12 SELLER shall provide enough terminal strips inside PN-5524001A/B – Subsea Interface Panel to interconnect the pairs of wires from WCT-HD sensors. All wires shall be fully identified. The dimensions of devices and the quantity of SAS equipment, as well as interconnection requirements, shall be confirmed at Detail Engineering Design Phase.

6.3.13 Patch panels, DIOs, and any other accessories required for panel correct interconnection shall also be supplied and installed by SELLER. Internal connections of these panels shall also be SELLER scope.

6.3.14 Subsea Acquisition System─SAS

6.3.15 The SAS equipment consists of servers and converters to read PDGs. Each Subsea Interface Panel shall accommodate SAS modules to read 10 PDGs.

6.3.16 The SAS modules shall communicate with MCS panels via L3 redundant switches installed in PN-5524001A/B – Subsea Interface Panel.

6.3.16.1 SAS has the following features:

I. Visualization of data, such as: selected sensor, selected unit, date and time, sensor voltage, sensor drained current, all other sensor data, etc.

II. Communication interface: EIA-485 with MODBUS-RTU communication protocol for PDG digital signal.

III. SAS programming: insertion of date and time (and external date and time setting using SNMP), configuring sensor types, configuring sensor factors (and other parameters), acquisition of stored process data at memory, etc.

IV. SAS shall have an internal memory for storing process data. Storage interval shall be programmable and defined by user.

6.3.17 BUYER will supply SAS modules.

6.4 Signals from WCT-HD (TPT-P, TPT-T, PTs and PDG)

6.4.1 The Subsea Signal Acquisition System (SAS) shall be responsible for monitoring pressure sensor (PDG) of each satellite well with WCT-HD.

6.4.2 The CSS-PCS is responsible for monitoring the 4 sensors: TPT-P, TPT-T, PT (WCT annular bore), PT (WCT production/injection bore).

6.4.3 In order to enable the SAS equipment installation, cables shall be provided by SELLER to connect PDG signals from umbilical junction boxes of the direct control satellite production wells to PN-5524001A/B - Subsea Interface Panel.

6.4.4 TPT and PT signals from Direct Control WCTs shall be wired from umbilical junction box to the CSS. A number of 6 (six) continuous variable signals shall be foreseen to be wired to CSS – PCS. These signals are interconnected as Analog inputs of 4-20 mA.

6.4.5 For further details see I-ET-3000.00-1516-823-PEK-006 - SPU PROJECT DETAILS WET MONITORING SIGNALS (TPT, PT and PDG).

6.4.6 Electrical Interconnections from umbilical to SAS and to CSS

6.4.6.1 The wiring interconnection of every satellite well with WCT-HD shall be done to be prepared to read the following signal types. Spare and reserves are specified further.

I. Analog sensors (4x 4-20mA): TPT-P, TPT-T, PT (WCT annular bore) and PT (WCT production/injection bore).

II. Digital (1x network) sensor: PDG (installed inside the well).

6.4.6.2 One Junction Boxes on each umbilical hang off position shall be provided. This junction box is named SAS/CSS umbilical JB.

6.4.6.2.1 The SAS/CSS umbilical JB is to interconnect:

I. UEH conductors of PDG to SAS modules inside Subsea Interface Panels (PN-5524001A/B), for PDG reading.

II. UEH conductors for TPT-P, TPT-T, PT – WCT annular bore, PT – WCT production/injection bore) to a CSS-PCS remote panel.

6.4.6.3 Each SAS/CSS umbilical JB shall be interconnected to Marshalling junction boxes, one for SAS signals (SAS Marshalling JB) and one marshalling junction for CSS/PCS signals (CSS WCT-HD Marshalling JB).

6.4.6.4 SAS/CSS umbilical JB and SAS Marshalling JB shall be interconnected with 2 x 2.5 mm^2 twisted shielded pairs, with either cables or multicable with individual and general shield.

6.4.6.5 SAS/CSS umbilical JB and CSS Marshalling JB shall be interconnected with 4 x 2.5 mm^2 twisted shielded pairs, with either cables or multicable with individual and general shield.

6.4.6.6 Subsea Interface Panels (PN-5524001A/B) and SAS Marshalling JB shall be interconnected with multicables to fulfill SAS capacity, accounting the reserve pairs as defined in I-ET-3010.00-1200-800-P4X-013 - GENERAL CRITERIA FOR INSTRUMENTATION PROJECTS and I-ET-3010.2Q-1200-800-P4X-005 - FIELD INSTRUMENTATION.

6.4.6.7 A CSS/PCS remote panel and CSS WCT-HD Marshalling JB shall be interconnected with multicables for all 4 analog sensors times the number of WCT-HD, accounting for reserve pair as defined in I-ET-3010.00-1200-800-P4X-013 - GENERAL CRITERIA FOR INSTRUMENTATION PROJECTS and I-ET-3010.2Q-1200-800-P4X-005 - FIELD INSTRUMENTATION.

6.4.6.8 The Figure 6.4-I shows an overview for interconnection described in items 6.4.6.1 through item 6.4.6.7.

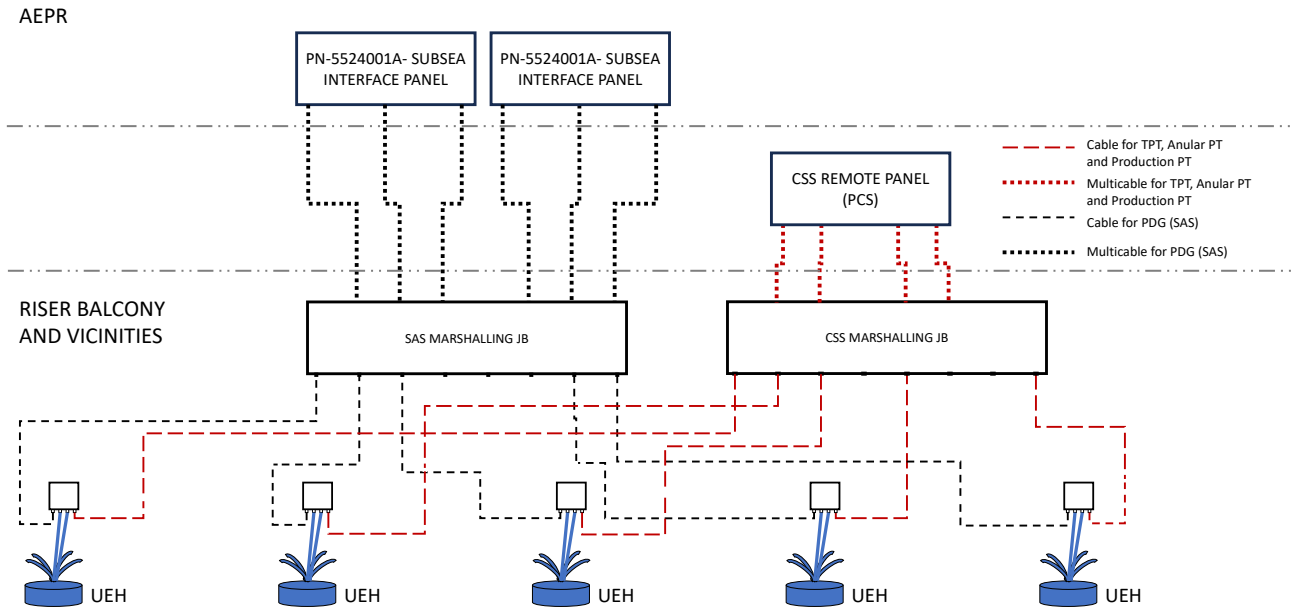

Figure 6.4-I – Overview of interconnection from umbilical junction box Subsea Interface Panel and CSS Remote Panel via respective marshalling junction boxes

6.4.6.9 The signals from the four analog signals are transmitted through umbilical by five conductors. One (1) conductor is used for common supply (+24 Vdc). The remaining conductors are used to obtain the signal from each sensor The umbilical electrical conductors shall be connected as depicted in Figure 6.4-II

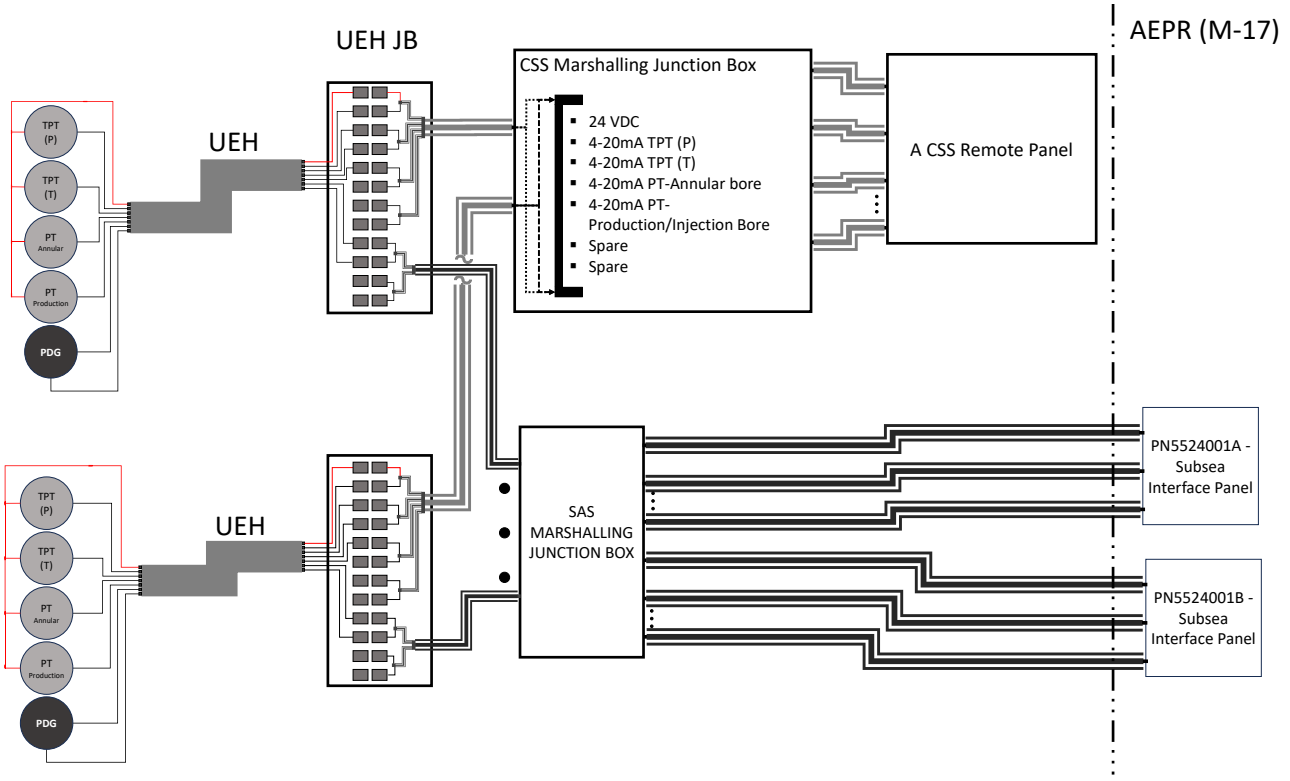

Figure 6.4-II – Connection of signals TPT, PT of WCT annular, PT of WCT production column and PDG.

6.5 Monitoring Signals from SESDV

6.5.1 The gas export riser has, within the export Subsea Gas Manifold (MSG), a submerged shutdown valve, the SESDV. The Unit (FPSO) control system, CSS, shall interface with SESDV to read its signals and then send to CSS.

6.5.2 Inside PN-5524001A/B – SUBSEA INTERFACE PANEL, SELLER shall provide a module to read, process, analyze and interface with CSS, providing all infrastructure and equipment. This module is named SESDV Monitoring System.

6.5.3 The electrical interconnection to monitor the signals from SESDV is shown in Figure 6.8-I. There shall be a junction box to interconnect the cable from umbilical slot hang-off junction box (JB_UEH_SESDV) to the SESDV Monitoring system inside PN-5524001A/B – SUBSEA INTERFACE PANEL. This junction box may be the same junction box used for the interconnection of signals of satellite wells WCT-HD (JB CSS/SESDV MARSHALLING).

6.5.4 From the junction box described in 6.5.3, the cables are connected to a SESDV system. Then, SESDV System shall interface with CSS.

6.5.5 The SESDV monitoring is described I-ET-3000.00-1510-854-PEK-002 - MONITORING SYSTEM FOR SUBSEA EMERGENCY SHUT-DOWN VALVE

(SESDV) - FPU SCOPE. Nevertheless, there are differences in some terms used in Topsides and Subsea and table below shows the correlations:

Table 6.5-I – Equivalent terms between Topsides and Subsea

Term used in this specification	Equivalent term used in specification cited in item 6.5.5
CSS	ICSS
SELLER	FPU CONTRACTOR
BUYER	PETROBRAS | Petrobras
PN-5524001A/B - SUBSEA INTERFACE PANEL	SUBSEA Interface Cabinet
AEPR	Electrical Module
Package Unit LAN	Petrobras Corporative Network
JB UEH SESDV	SESDV Electrical JB

6.5.6 In I-ET-3000.00-1510-854-PEK-002 - MONITORING SYSTEM FOR SUBSEA EMERGENCY SHUT-DOWN VALVE (SESDV) - FPU SCOPE the option that shall be implemented is the Option A, with 4 pairs of cables.

6.6 Electrical DHSV (DHSV-E)

6.6.1 DHSV-E is one of the two possibilities of actuation foreseen for the DHSVs, also known as SCSSV. The other one is Hydraulic actuation, which is carried out by MCS panels or a well control rack (PN-1210012A/D - PRODUCTION WELL CONTROL RACK) with hydraulic energy from UH-1210001 - HYDRAULIC POWER UNIT FOR SUBSEA SYSTEMS).

6.6.2 DHSV-E is a P2C Package type and will have 6 (six) associated panels (PN-1210011A/F - DHSV-E PANEL). Each panel supports up to 5 (five) DHSV-E from the same supplier. All panels shall be installed at AEPR in Module 17. The signals from these packages shall be integrated with the CSS and with MCSs through the Ethernet Switches of PN-5524001A/B – Subsea Interface Panel.

6.6.3 DHSV-E panels shall have the following main characteristics:

I. Ethernet Communication via OPC-UA protocol.

II. Bottom cable access and frontal access.

6.6.4 These panels shall be powered as according to I-ET-3010.00-5140-700-P4X-003 – ELECTRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE UNITS. Whenever necessary, power converters and AC/DC stabilized power supplies shall be included in the panel in order to make all appropriate conversions between the power supplied by the Electrical System and the panel's internal components power requirements.

6.6.5 These panels shall be supplied by BUYER.

6.6.6 In an ESD-4 event the valves of a WCT are commended to close in a specific order and the DHSVs being the last ones, a period of time after the previous valve is commended to close. In the case of electrical DHSVs, these are controlled by DHSV-E panel and CSS shall send a dedicated command for requesting DHSV-E closure. The ESD-4 signals from CSS to MCSs and from CSS to DHSV-E panels are sent simultaneously and temporization to close DHSV-E is to be implemented by DHSV-E panel. Nevertheless, this premise shall be confirmed during Detail Engineering Design Phase and if temporization is not implemented by DHSV-E panel another solution shall be proposed in conformity with Classification Society rules.

6.6.7 SELLER scope consists of retrieving the panels in BUYER warehouse, transport them to their final location in the Unit (FPSO), install and connect them to appropriate systems, commission and test. Any accessories, converters, cables, trays etc necessary for the correct connection of the panels shall be supplied and installed by SELLER.

6.6.8 At AEPR the marshalling for DHSV-E shall be done through panel PN-1210017 - TOPSIDES WELL ASSIGNMENT PANEL (TWAP). At FIELD and the marshalling for DHSV-E shall be done through panel PN-1210018 – TOPSIDES WELL FIELD ASSIGNMENT PANEL (FIELD TWAP).

6.7 Submerged production Pumping Systems

6.7.1 BCSS

6.7.1.1 It is a submerged centrifugal pumping system to boost production of a satellite production well with a WCT-HD. Therefore, from the perspective of the well, it has the same hydraulic controls for WCT-HD valves, the same hydraulic controls for chemical injection block valves, the same number of chemical injection lines, a junction box for SAS communication, a junction box for a DHSV-E cables and a junction box for following signals TPT-P, TPT-T, PT (WCT annular bore) and PT (WCT production/injection bore). Additionally, from the perspective of BCSS, it has a connection/junction box for the electric cables, which shall be consulted in Electrical discipline documentation.

6.7.1.2 There are two (2) types of trips from CSS to VSD, RAMP trip and COAST trip. These trips are exclusive for each BCSS, i.e., there is one trip of each type from CSS to respective VSD of each BCSS pump.

6.7.1.2.1 The RAMP trip is sent only from CSS remote panel to BCSS Control Panel. In PN-1243001 – BCSS CONTROL PANEL it starts a trip where BCSS motor speed decreases from 100% to 0% during a time frame. There are 2 RAMP trips from CSS remote panel to BCSS Control Panel.

6.7.1.2.2 The COAST trip is sent from CSS remote panel to both BCSS Control Panel and also to respective VSD. In VSD the action is to stop at once the power feed to BCSS motor. The signal from CSS remote panel to BCSS Control Panel is to

notify PN-1243001 - BCSS CONTROL PANEL that a COAST trip is activated. There are 2 COAST trips from CSS remote panel to BCSS Control Panel and 1 COAST trip from CSS remote panel to each VSD.

6.7.1.2.3 The exact logic for RAMP and COAST trips shall be determined during Detail Engineering Design Phase and related documents shall be updated.

6.7.1.3 See in Figure 6.7-I a schematic only from BCSS perspective, where fluid lines and cables related to WCT-HD are not represented. For an explanation of each numbered item refer to Table 6.7-I.

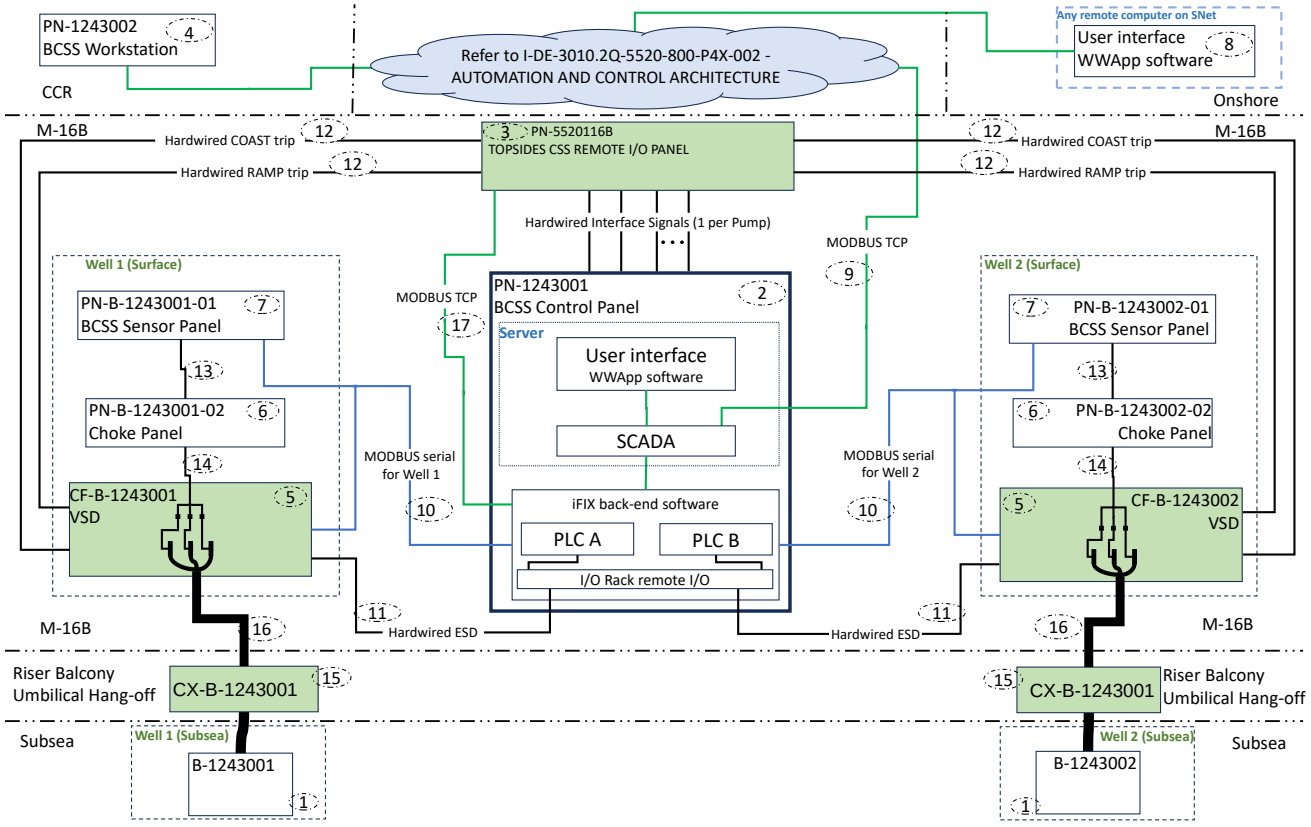

Figure 6.7-I – Architecture of Control and Monitoring of BCSS for two (2) Production Wells

Table 6.7-I – Description of items of Figure 6.7-I – Architecture of Control and Monitoring of BCSS for two (2) Production Wells

Item	TAG	Name	Description	Input	Specify	Supply	Install	Supervision	NOTE
1	B-1243001 B-1243002		Electrical Submersible Pump (ESP) + Sensor.	B	BCS	BCS	BCS	BCS	
2	PN-1243001	BCSS Control Panel	New EMS Panel (800x800x2100]) including: EMS HMI, EMS PLC; EMS SCADA Server + EMS WWApp; EMS WellWatcher Connect for data transmission to onshore historian;		BCS	BCS	BCS S B		
3	PN-5520116B	TOPSIDES CSS REMOTE I/O PANEL	CSS Remote Panel.	BCS B	S	S	S	B	
4	PN-1243002	BCSS Workstation	EMS WWaApp HMI in Control Room for efficient Remote Control; only one WWapp able to control ESPs in maintenance mode, only monitoring available for other users.			BCS	S	BCS	
5	CF-B-1243001 CF-B-1243002	Frequency Converter for BCSS#1 - P9 Frequency Converter for BCSS#2 - MLL-8	Variable Speed Drive (VSD).	B	S	S	S	B	
6	PN-B-1243001-02 PN-B-1243002-02	BCSS Choke Panel BCSS Choke Panel	Choke Panel to be mounted in VSD output terminal chamber.		BCS	BCS	S	BCS	
7	PN-B-1243001-01 PN-B-1243002-01	BCSS Sensor Panel BCSS Sensor Panel	BCSS Sensor Panel.		BCS	BCS	S	BCS	
8			Multiple EMS WWApp for Onshore Remote Monitoring Access only.		BCS	BCS	BCS	B/BCS	
9			Redundant Modbus TCP link between EMS PLC (PN-1243001) Subsea Interface LAN (I-DE-3010.2Q-5520-800-P4X-002 - AUTOMATION AND CONTROL ARCHITECTURE)		BCS B	S	S	B	NOTE 1
10			Two Modbus Serial links (EIA/TIA-485) from EMS PLC (PN-1243001 / Master) to BCSS Sensor panesl and VSDs (Daisy Chain).		BCS B	S	S	B	
11			Hardwired Ramp Trip Signals from EMS PLC to VSD		BCS	S	S	B	
12			Hardwired Signals for RAMP and COAST trips. Refer to I-ET-3010.2Q-1200-800-P4X-014 - AUTOMATION INTERFACE OF PACKAGED UNITS		BCS	S	S	B/BCS	
13			Cables between Choke Panels to BCSS Sensor Panels	BCS	BCS	BCS	BCS	B	
14			Cables between Choke Panels to VSDs (CF-B-1243001/002)	BCS	BCS	BCS	BCS	B	
15	CX-B-1243001 CX-B-1243002	BCSS Medium-Voltage Interface Junction Box	Junction Boxes to interconnect UEH cable to VSD (CF-B-1243001/002)						NOTE 2
16			Cable between UEH JB BCSS and VSD (CF-B-1243001/002)						NOTE 2
17			Redundant Modbus TCP link between EMS PLC (slave) and CSS Topsides Remote I/O Panel (master)	BCS	S	S	S	B/BCS	

Legend: S=SELLER; B=BUYER;BCS=BCSS Supplier

NOTE 1: Refer to I-DE-3010.2Q-5520-800-P4X-002 - AUTOMATION AND CONTROL ARCHITECTURE

NOTE 2: Scope of Electrical Discipline.

6.7.1.4 Due to technical reasons (signal to noise ratio, signal degradation), the following equipment shall be installed in relative positions to minimize the length of each interconnection cables between them (items 13 and 14 in Figure 6.4-I and Table 6.7-I):

6.7.1.4.1 Group 1: For Well 1

I. CF-B-1243001 - Frequency Converter for BCSS#1 - P9

II. PN-B-1243001-01 - BCSS Sensor Panel

III. PN-B-1243001-02 - BCSS Choke Panel

6.7.1.4.2 Group 2: For Well 2

I. CF-B-1243001 - Frequency Converter for BCSS#1 - P9

II. PN-B-1243001-01 - BCSS Sensor Panel

III. PN-B-1243001-02 - BCSS Choke Panel

6.7.2 SBMS

6.7.2.1 This system if the Submerged Multiphase Pumping System and works together with an MSP. The SBMS receives the production from an MSP and pumps to Topsides of the Unit (FPSO). It is foreseen 4 SBMSs.

6.7.2.2 There are two (2) umbilicals, one (1) for the respective MSP and one (1) dedicated to the SBMS. Therefore, there shall be two (2) sets of TUTUs and Junction Boxes, one (1) set dedicated to each umbilical.

6.7.2.3 For cable/multicable and fiber optical interconnection and definitions refer to item 6.2.10.

6.7.2.4 For further information and requirements see I-MD-3500.00-1500-610-PEK-002 - SUBSEA MULTIPHASE BOOSTING SYSTEM DESCRIPTION AND INTERFACES WITH TOPSIDE FACILITIES. Any divergence Bu

6.8 Simplified Schematics of Types of Subsea Controls

6.8.1.1 For figures from Figure 6.8-II through Figure 6.8-VIII, refer to Table 6.8-I for cables and tubing definitions.

Table 6.8-I Description of numbered items from Figure 6.8-I to Figure 6.8-VIII

Item	Type	Definition	Material	NOTE:
1	Cables	Cables for DHSV-E		See item 6.2.10.6
2	Cables	Cable for MCS		See item 6.2.10.6
3	NOTE	NOTE	NOTE	See documentation of Piping Discipline
4a	Tubing	Nx1/2" OD Wall Thickness 0.095”	Super Duplex (25Cr Super Duplex SS–ASTM:A789/A789M, UNS:S32750/S32760)	-The installation shall be for 10.000 psi, even if actual working pressure is lower. -Material as per I-ET-3010.00-1200-800-P4X-015, I-ET-3010.00-1200-800-P4X-013 and I-ET-3010.2Q-1200-800-P4X-005
4b	Tubing	Same as 4a	Same as 4a	Same as 4a
5	NOTE	NOTE	NOTE	See documentation of Piping Discipline
6	Tubing	Same as 4a	Same as 4a	Same as 4a
7	Cables	Cable or Multicable for SBMS LV circuits	NOTE	See item 6.2.10.6
8	Fiber Optic	Fiber Optic for SBMS/MSP/MSG	NOTE	See item 6.2.10.10
9	Cables	NOTE	NOTE	See documentation of Electrical Discipline
10	Multicables	4Px2.5mm2+SCHI/C	NOTE	I-ET-3010.00-1200-800-P4X-013 and I-ET-3010.2Q-1200-800-P4X-005
11	Multicables	2Px2.5mm2+SCHI/C	NOTE	I-ET-3010.00-1200-800-P4X-013 and I-ET-3010.2Q-1200-800-P4X-005
12	Multicables	N.Px2.5mm2+SCHI/C	NOTE	I-ET-3010.00-1200-800-P4X-013 and I-ET-3010.2Q-1200-800-P4X-005 Number of pairs to be defined at Detail Engineering Design Phase.
13	Multicables	N.Px2.5mm2+SCHI/C	NOTE	I-ET-3010.00-1200-800-P4X-013 and I-ET-3010.2Q-1200-800-P4X-005 Number of pairs to be defined at Detail Engineering Design Phase
14	Multicables	SESDV signal monitoring	NOTE	See item 6.5
15	Multicables	SESDV signal monitoring	NOTE	See item 6.5
16	NOTE	NOTE	NOTE	See documentation of Electrical Discipline
17	Tubing	Same as 4a	Same as 4a	Same as 4a

6.8.1.2 Gas Export Manifold with SESDV

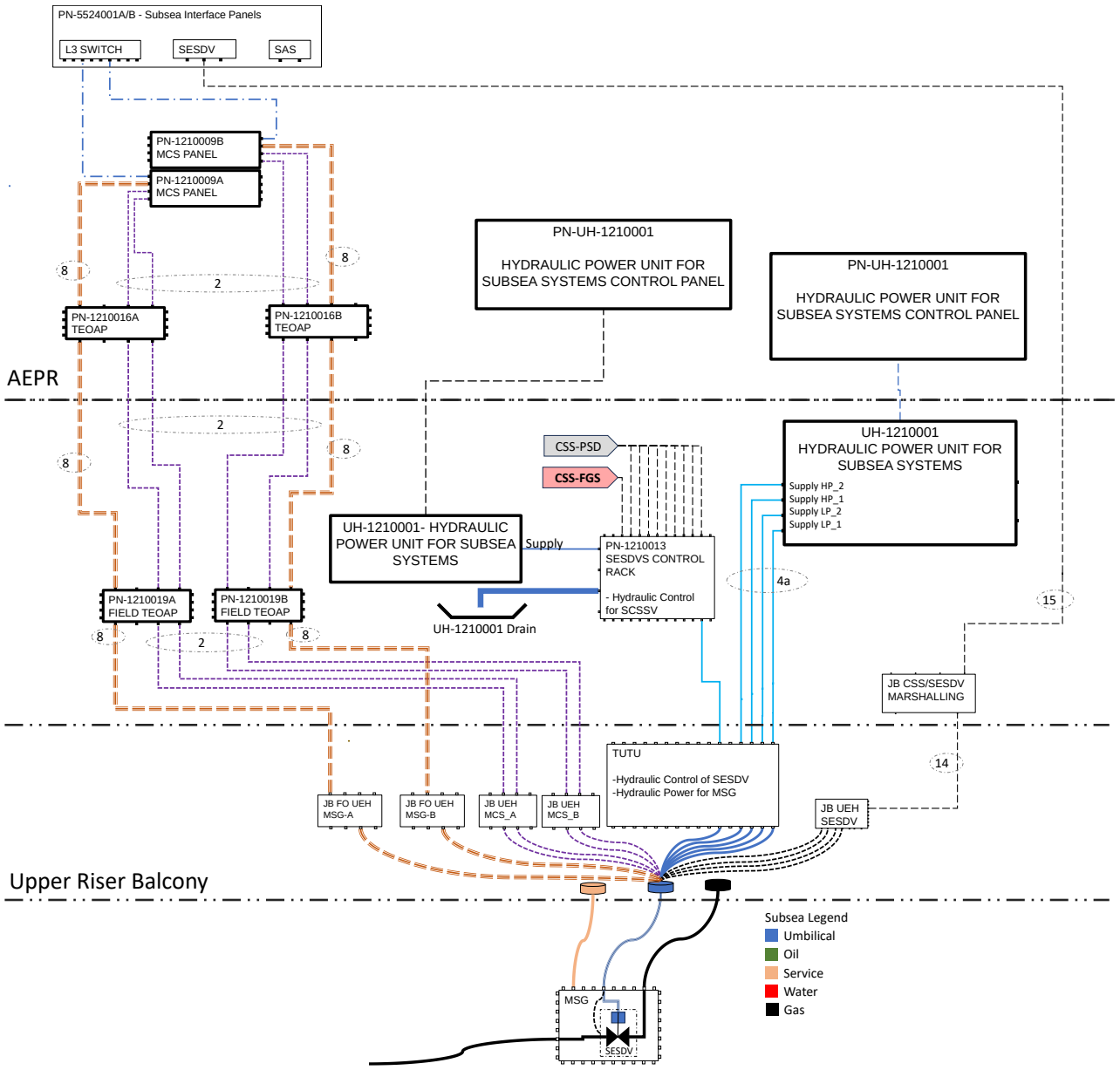

Figure 6.8-I – Schematics for Gas Exportation Manifold with embedded SESDV

6.8.1.3 Satellite Production Well with WCT-HD

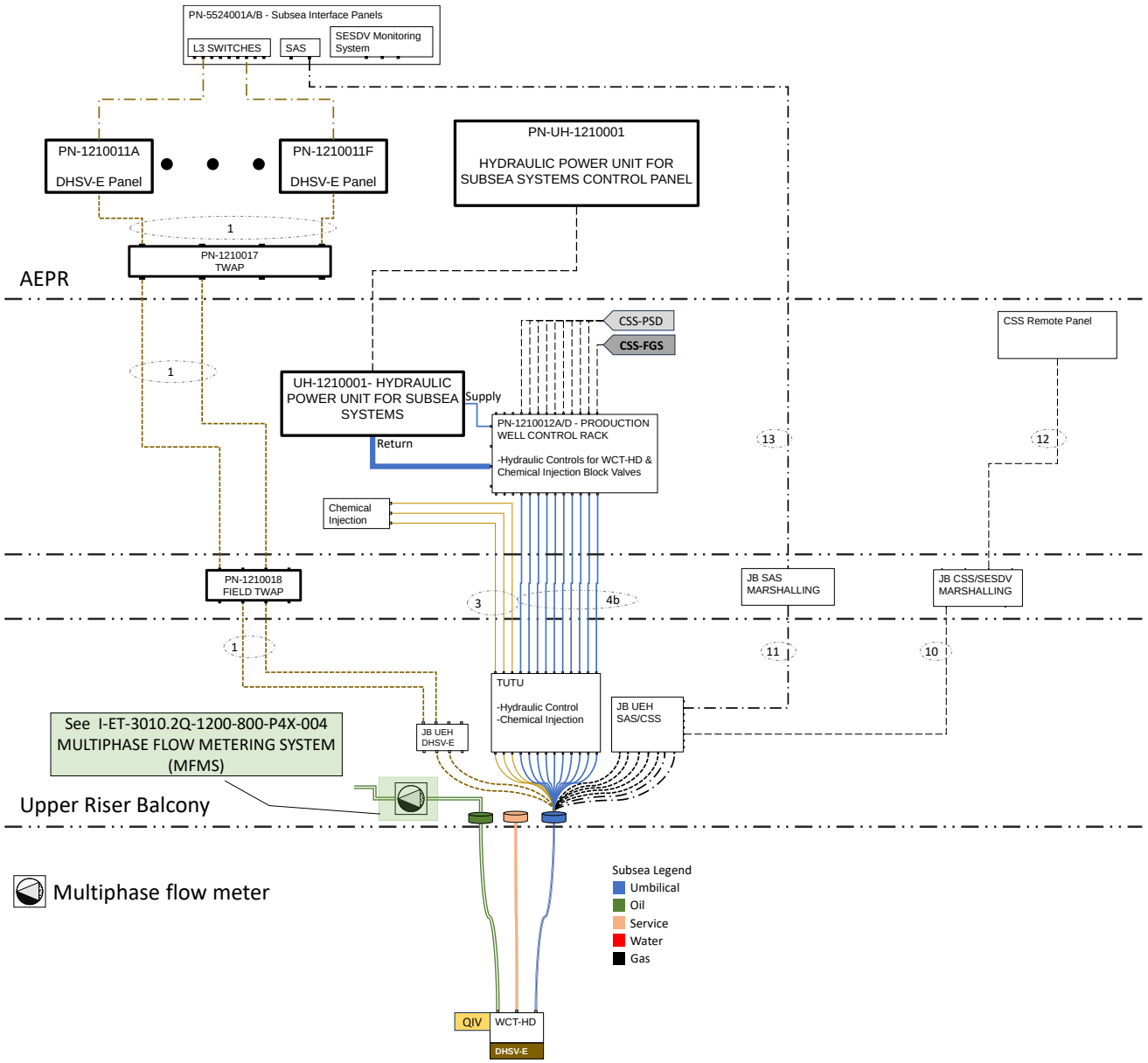

Figure 6.8-II – Schematics for Satellite Production Well with WCT-HD

6.8.1.4 Satellite Production Well with WCT-HD and BCSS

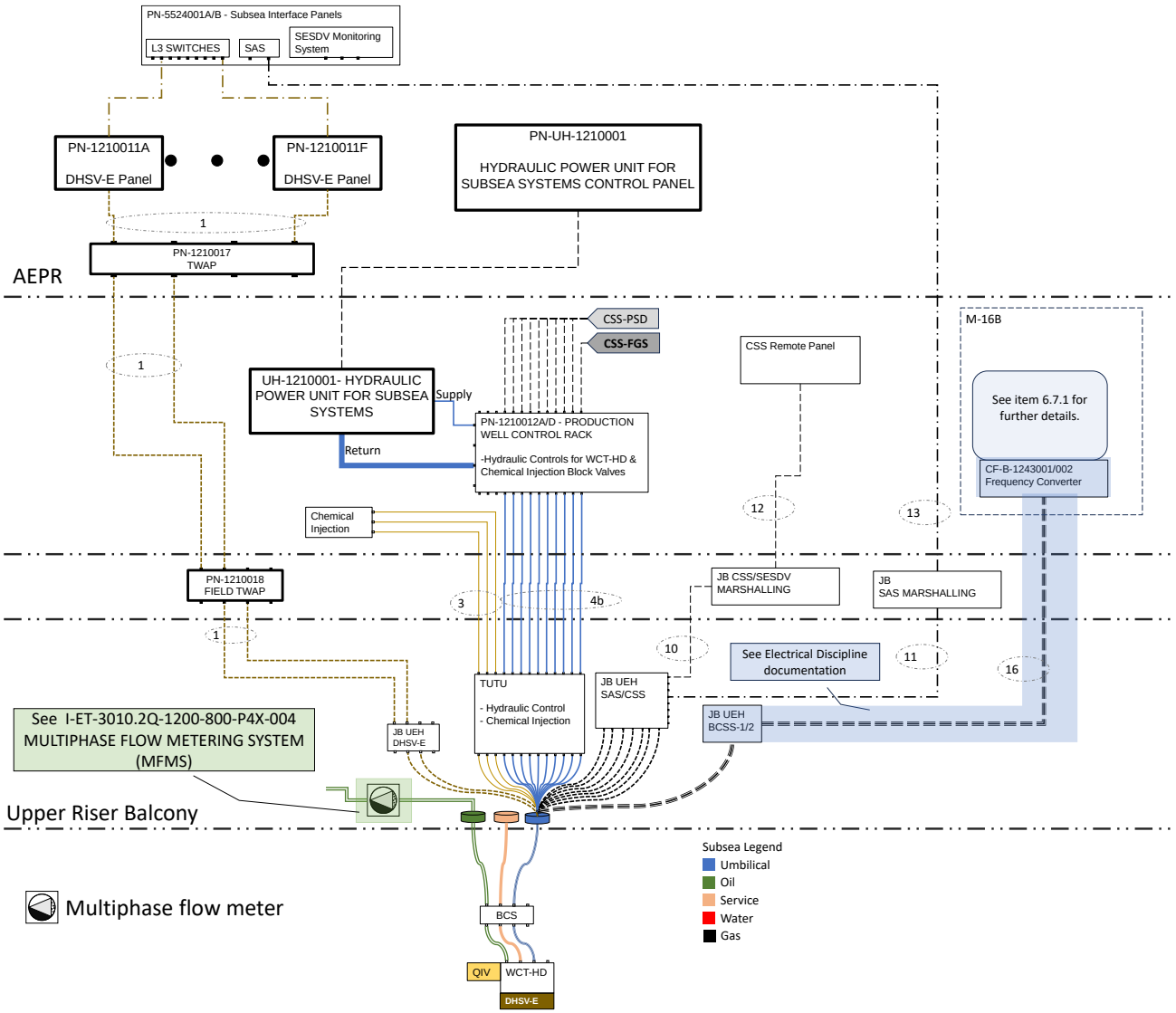

Figure 6.8-III – Schematics for Satellite Production Well with WCT-HD and BCSS

6.8.1.5 Satellite Water Injection Well with WCT-HD

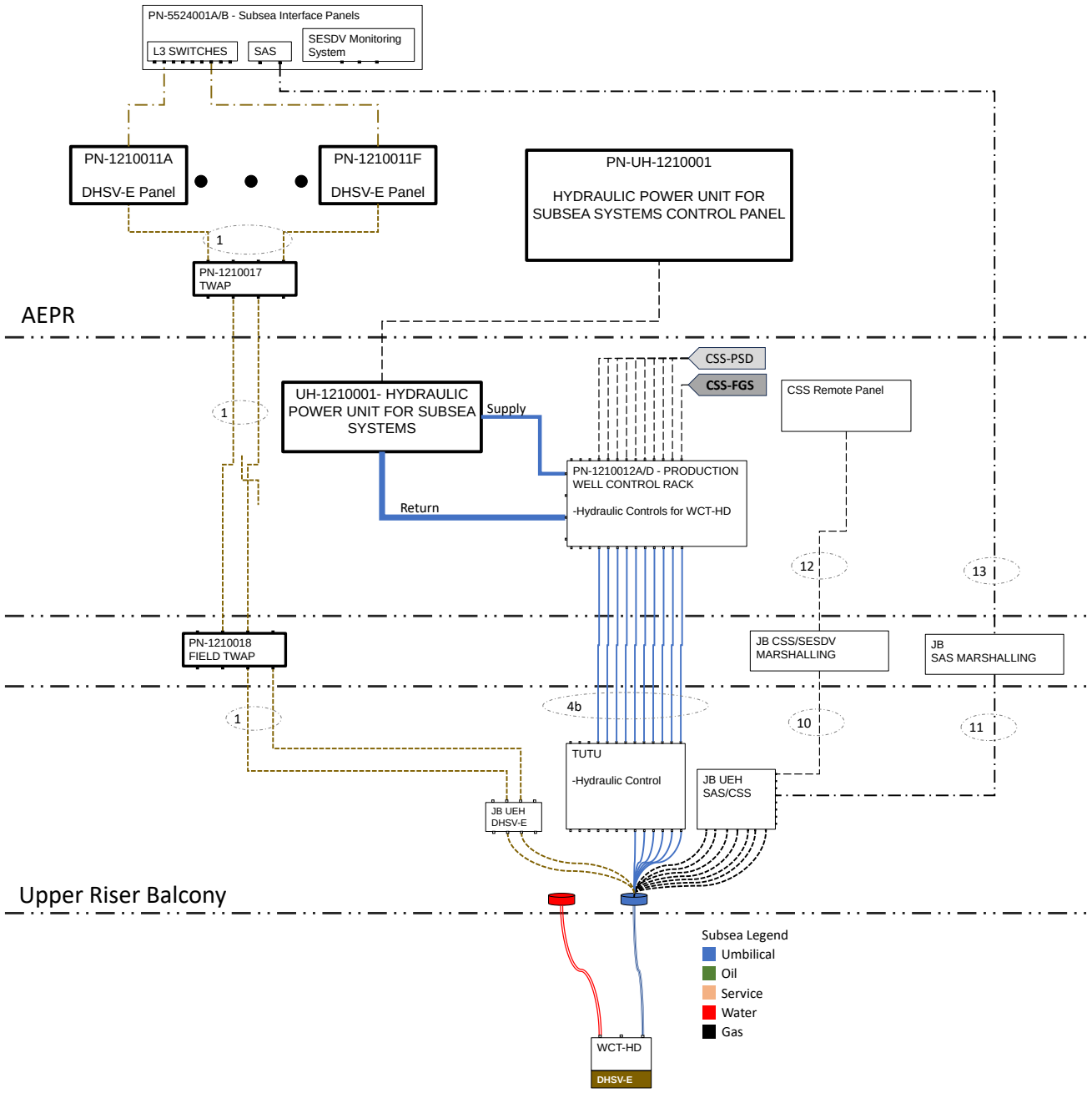

Figure 6.8-IV – Schematics for Satellite Water Injection Well with WCT-HD

6.8.1.6 Production Manifold without Pumping System

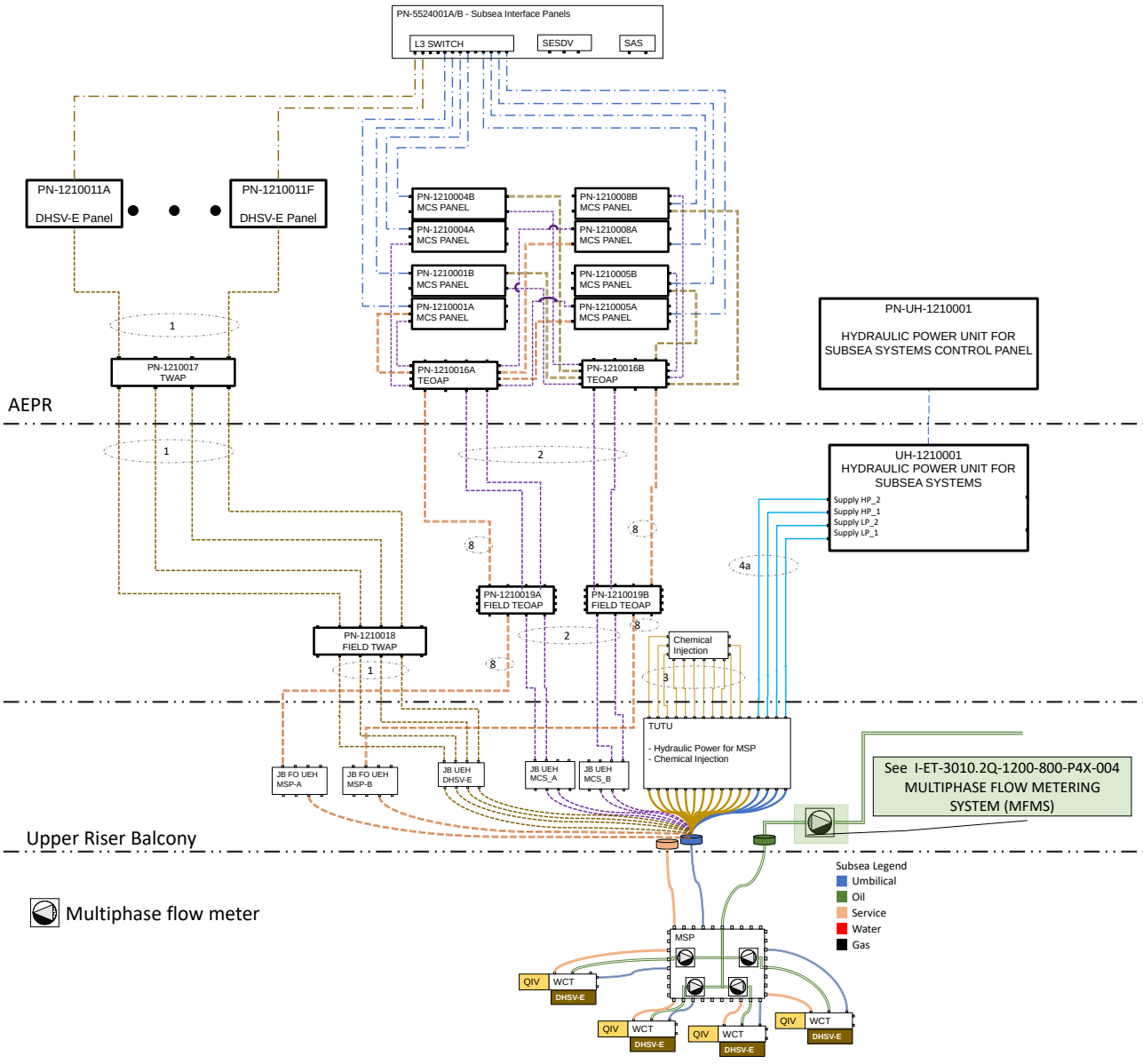

Figure 6.8-V – Schematics for Production Manifold—MSP—with no Pumping System

6.8.1.7 Production Manifold without Pumping System and two (2) production risers

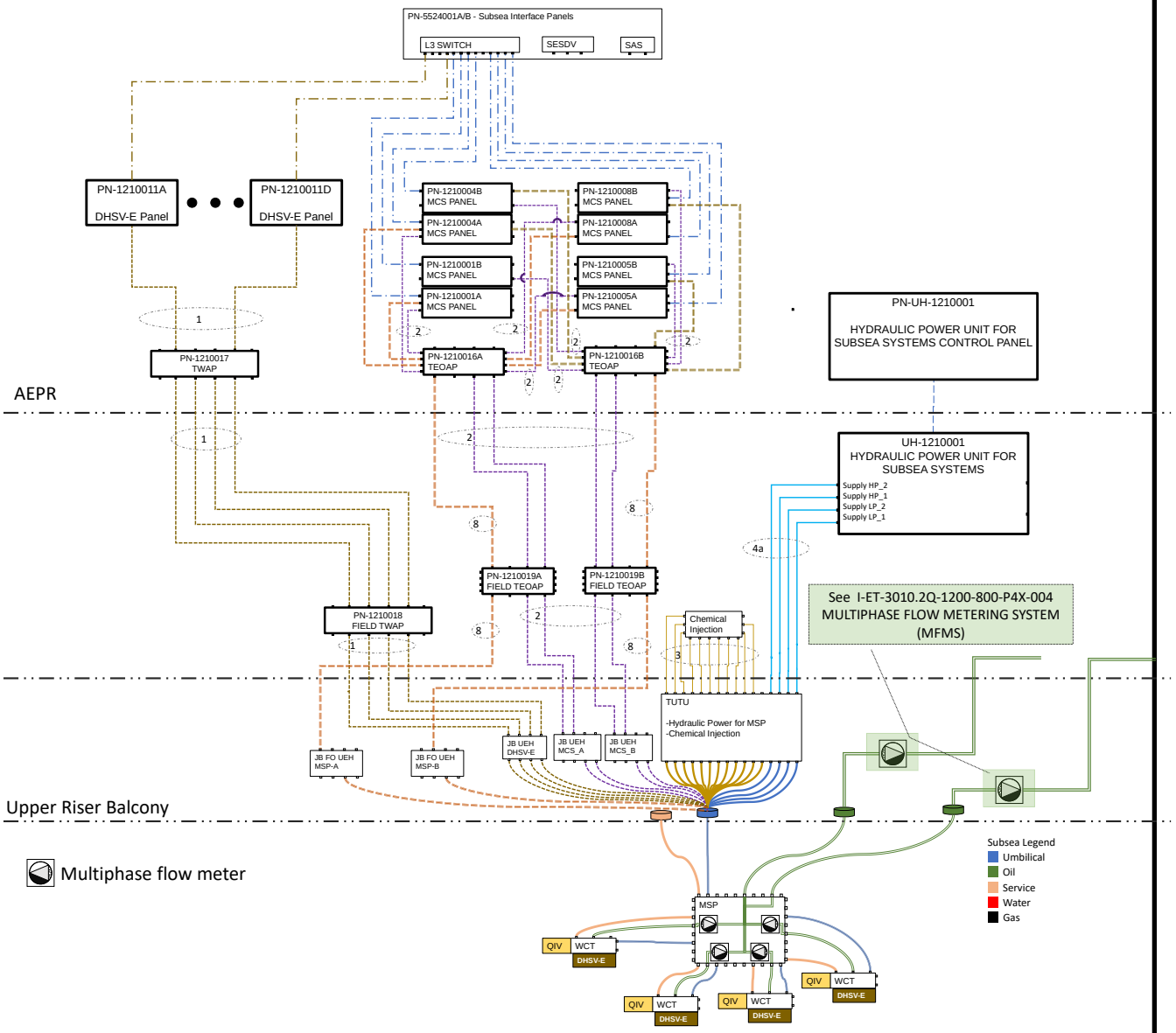

Figure 6.8-VI – Schematics for Production Manifold–MSP–with no Pumping System and two (2) production risers

6.8.1.8 Production Manifold with SBMS

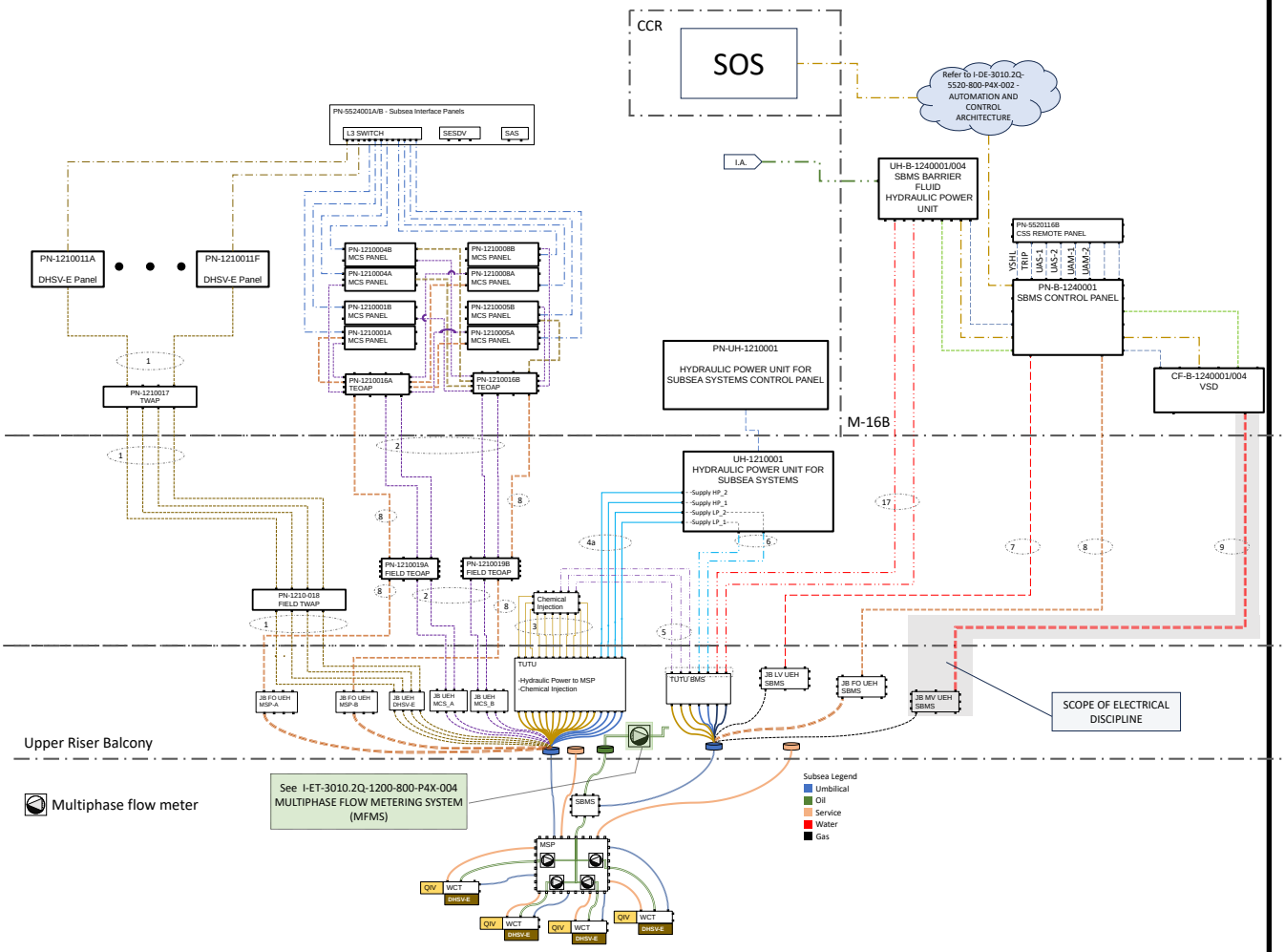

Figure 6.8-VII – Schematics for Production Manifold–MSP–with SBMS

6.8.1.9 Water Injection Manifold

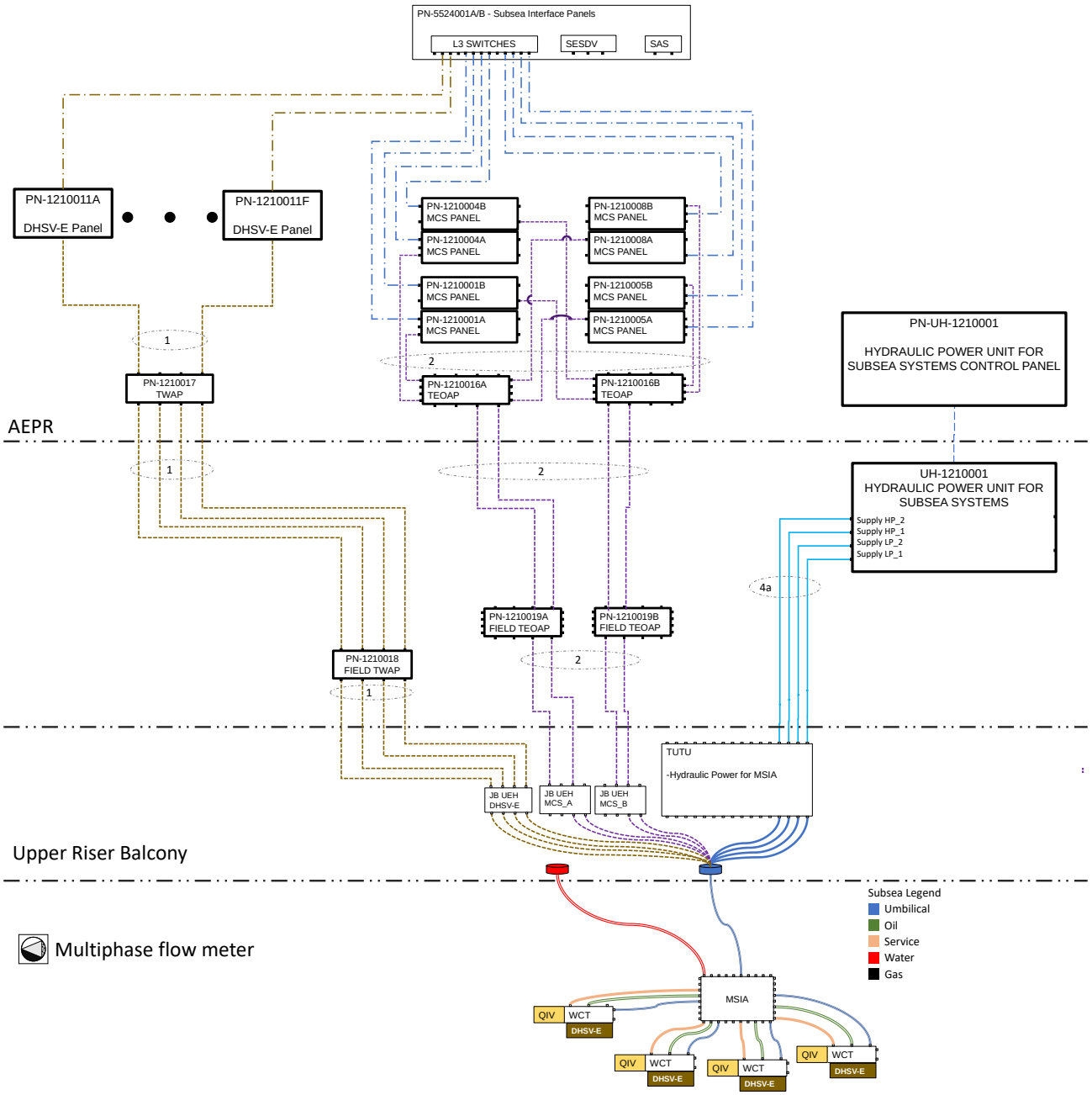

Figure 6.8-VIII – Schematics for Water Injection Manifold–MSIA