	TECHNICAL SPECIFICATION	Nº:	I-ET-3010.00-5520-861-P4X-002		
BR PETROBRAS	CLIENT:			SHEET:	1 of 20
	JOB:				
	AREA:				
	TITLE: SUPERVISION AND OPERATION SYSTEM - SOS			ESUP	
				INTERNAL	

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SUMMARY

1. INTRODUCTION

1.1. Objective

1.1.1. This Typical Technical Specification describes the minimum functional and technical requirements for the design and supply of the Supervision and Operation System (SOS), part of the Automation and Control Architecture of the UNIT.

1.1.2. This document shall be read in conjunction with the documents listed in 2.2.

1.2. Definitions

1.2.1. Refer to I-ET-3010.00-1200-940-P4X-002 - GENERAL TECHNICAL TERMS for the definition of words emphasized in upper case along this document.

1.3. Abbreviations, Acronyms and Initialisms

1.3.1. The following abbreviations, acronyms and initialisms are used in this document:

ACK	Acknowledge
ATS	Automatic Transfer Switch
CCR-EA	Central Control Room – Equipment Ambience
CCR-OA	Central Control Room – Operation Ambience
CSS	Control and Safety System
CPU	Central Processing Unit
D&ID	Duct and Instrumentation Diagram
DVD	Digital Video Disc or Digital Versatile Disc
EMI	Electromagnetic Interference
FAT	Factory Acceptance Test
FGS	Fire and Gas System
HCS	Hull Control System
HDD	Hard Disk Drive
HDS	Historical Data Server
HFGS	Hull Fire and Gas System
HMI	Human Machine Interface
HSD	Hull Shutdown System
HVAC	Heating, Ventilation and Air-conditioning
I/O	Input / Output
KVM	Keyboard, Video, Mouse (remote connection adapter)
LAN	Local Area Network
OLE	Object Linking and Embedding
OPC	Open Platform Communications
P&ID	Piping and Instrumentation Diagram
PAS	PACKAGE UNIT Automation System
PCS	Process Control System
PI®	Plant Information, from OSISoft (AVEVA)
PLC	Programmable Logic Controller
PSD	Process Shutdown System
RAID	Redundant Array of Inexpensive Disks
RTDS	Real Time Data Server
SAT	Site Acceptance Test

SIT	Site Integration Test
SOS	Supervision and Operation System
SPCS	Subsea Production Control Systems
SSD	Solid-State Drive
TCP/IP	Transmission Control Protocol/Internet Protocol
UA	Unified Architecture
UCP	Unit Control Panel
USB	Universal Serial Bus
VCI	Volatile Corrosion Inhibitor

2. REFERENCE DOCUMENTS, CODES AND STANDARDS

2.1. External references

2.1.1. International Codes, Recommended Practices and Standards

IEC – INTERNATIONAL ELECTROTECHNICAL COMMISSION

IEC 62381 AUTOMATION SYSTEMS IN THE PROCESS INDUSTRY-FACTORY ACCEPTANCE TEST (FAT), SITE ACCEPTANCE TEST (SAT) AND SITE ACCEPTANCE TEST (SIT)

2.1.2. Brazilian Codes and Standards

INMETRO - INSTITUTO NACIONAL DE METROLOGIA, QUALIDADE E TECNOLOGIA (THE BRAZILIAN NATIONAL INSTITUTE OF METROLOGY, QUALITY AND TECHNOLOGY)
PORTARIA Nº 115 (21/MARÇO/2022) REQUISITOS DE AVALIAÇÃO DA CONFORMIDADE PARA EQUIPAMENTOS ELÉTRICOS PARA ATMOSFERAS EXPLOSIVAS - CONSOLIDADO

2.1.2.1. All *Secretaria de Inspeção do Trabalho* Regulatory Standards (NRs) shall be followed.

2.1.3. Classification Society

2.1.3.1. Project's Detail Design Phase documents will be submitted to Classification Society's approval and/or certification.

2.1.3.2. The design, installation and operation shall strictly follow the Classification Society's requirements, along with the specific requirements identified in this document, also including all referenced document requirements.

2.2. Internal References

2.2.1. Typical Documents

2.2.1.1. Typical Documents are those that contain functional and technical description of a system or equipment. They shall be used as the main specification for the Project.

2.2.1.2. Typical Document List

I-ET-3010.00-1200-940-P4X-002   GENERAL TECHNICAL TERMS

I-ET-3010.00-5520-861-P4X-001   CONTROL AND SAFETY SYSTEM – CSS

I-ET-3010.00-5520-800-P4X-001   SUPERVISION AND OPERATION SYSTEM (SOS) SCREENS

I-ET-3010.00-1200-800-P4X-002   AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGE UNITS

I-ET-3010.00-5140-700-P4X-003   ELECTRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE UNITS

I-ET-3010.00-5520-888-P4X-001   AUTOMATION PANELS

I-ET-3010.00-5520-861-P4X-003   VIRTUALIZATION OF AUTOMATION SYSTEM COMPUTERS

2.2.2.   Specific Project Documents

2.2.2.1. This section mentions documents that are referenced along the text and that are part of a specific Project. The documents title and number may vary slightly from one Project to another. Project's DOCUMENT LIST shall be consulted in order to verify the correct document number and title.

2.2.2.2. Specific Project Document List

TECHNICAL SPECIFICATIONS (ET)

INSTRUMENTATION ADDITIONAL TECHNICAL REQUIREMENTS

SPECIAL MONITORING SYSTEMS

DRAWINGS (DE)

AUTOMATION AND CONTROL ARCHITECTURE

NETWORK INTERCONNECTION DIAGRAM

CENTRAL CONTROL ROOM LAYOUT

DESCRIPTIVE MEMORANDUM (MD)

AUTOMATION AND CONTROL SYSTEM FUNCTIONS

LISTS (LI)

EQUIPMENT LIST

2.2.3.   PETROBRAS Reference Documents

DR-ENGP-M-I-1.3   SAFETY ENGINEERING GUIDELINE

2.3.   In cases where Brazilian regulatory standards (*Secretaria de Inspeção do Trabalho)* and INMETRO regulations are more restrictive, these shall superpose all codes and regulations listed in item 2, since they are enforced by Brazilian law. Additionally, in cases of conflicting requirements, Brazilian regulatory standards shall be adopted.

3. ENVIRONMENTAL AND OPERATIONAL CONDITIONS

3.1. For environmental and operating conditions and/or any requirements regarding this topic, refer to project's technical specification entitled "INSTRUMENTATION ADDITIONAL TECHNICAL REQUIREMENTS". For the specification of SOS computers, special attention shall be given to the dynamic loads imposed by the vessel motions during tow and on location and to the temperature of the indoor ambient on loss of HVAC.

3.2. The available power supplied by the UNIT to be used by SOS computers and network switches is defined in I-ET-3010.00-5140-700-P4X-003 – ELECTRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE UNITS. The SOS HMIs shall be fed by both UPS via ATS device, which provides redundant power to single-corded equipment.

3.3. SOS and CPU Panels are described in I-ET-3010.00-5520-888-P4X-001 – AUTOMATION PANELS.

3.4. SOS will be used 7 days/week, 24 hours/day.

3.5. Ingress protection and protection against explosive atmosphere, if any, are defined in I-ET-3010.00-5520-888-P4X – 001 – AUTOMATION PANELS.

3.6. For the exact physical location of SOS computers, see project's documents entitled "AUTOMATION AND CONTROL ARCHITECTURE", "CENTRAL CONTROL ROOM LAYOUT" and "EQUIPMENT LIST".

4. GENERAL

4.1. SOS is the "Operation and Supervision" layer concerning the Industrial Automation pyramid and acts as the operator interface facility with the "Control and Safety" and "Field" layers, in order to comply with the philosophies of full integration of the Automation Architecture and supervision and operation from a central location. (See Figure 1).
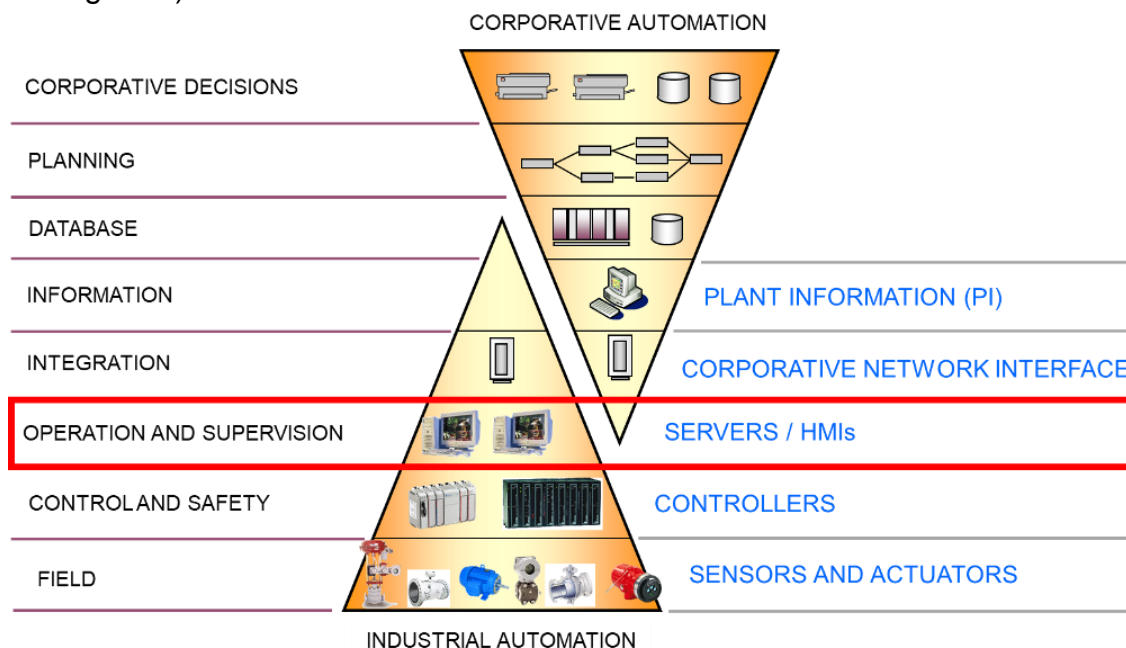

Figure 1 – Industrial and Corporative Automation Pyramids

4.2. As a typical document, this Technical Specification mentions one SOS for Topsides (item 7) and one SOS for Hull (item 8). For definition of the scope to be supplied due to Contract premises, Project documentation shall be consulted.

4.3. The Automation Systems which are part of the Control and Safety Layer of the Automation Architecture are: Control and Safety System (CSS), PACKAGE UNITS Automation Systems (PAS), Subsea Production Control System (SPCS) and Special Automation and Monitoring Systems, which are defined in other Project's specific documentation.

4.4. CSS, PAS, SPCS and Special Automation Monitoring Systems are described in I-ET-3010.00-5520-861-P4X-001 - CONTROL AND SAFETY SYSTEM – CSS, I-ET-3010.00-1200-800-P4X-002 - AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGE UNITS and project's technical specification entitled "SPECIAL MONITORING SYSTEMS", respectively.

4.5. The Automation and Control Architecture, including SOS and its integration with other systems, is represented in Project's Drawing entitled "AUTOMATION AND CONTROL ARCHITECTURE".

4.6. SOS software screens shall be according to I-ET-3010.00-5520-800-P4X-001 - SUPERVISION AND OPERATION SYSTEM (SOS) SCREENS.

4.7. SOS integration with the Industrial Automation Network of the UNIT shall be according to project's drawing entitled "NETWORK INTERCONNECTION DIAGRAM".

4.8. No control, prevention, mitigation or alarm logic shall be implemented on the SOS, as the CSS is responsible for this task.

4.9. Compliance with this Technical Specification shall be presented in the technical proposal, item by item, in a spreadsheet format, and then attested during FAT, SAT and SIT. Deviations shall also be presented in the same spreadsheet.

4.10. Remote access from the Internal Corporate Network to the Supervisory System shall be done through servers installed in the DMZ. In this case, additional Supervisory Software licenses shall be foreseen, and firewall shall be adequately configured. HMI and Workstation licenses shall not be shared with remote access servers. The number of additional licenses for remote access shall be confirmed during project's Detailing Design Phase.

4.11. Data collection shall be synchronized between all SOS components.

4.12. A virtual machine shall be foreseen in PETROBRAS DMZ Cluster in order to publish SOS Screens in HTML5 format so that they can be accessed remotely from Corporate Network for monitoring proposes only. No commands are allowed from published screens to the Supervisory System.

4.12.1. This functionality is not to be mistaken with the functionality described in item 4.10. Item 4.10 describes external remote access for full operational control using the supervisory system itself. Item 4.12 describes a different functionality, for monitoring purposes only, using HTML screens and regular browsers. Both functionalities are required.

4.12.2. Regarding Licenses for access of HTML5 screens:

- Licenses shall be valid for lifetime access;
- Licenses shall allow for at least 10 simultaneous accesses, this number shall be confirmed during Detail Engineering Design;
- PETROBRAS shall be able to change which computers are accessing the HTML5 screen without changes to Licenses (i.e. without additional costs).

5. SOS MAIN COMPONENTS

5.1. SOS shall be based on a Supervisory System, whose main components are described in this section.

5.2. Real Time Data Servers (SOS RTDS)

5.2.1. The RTDS's are responsible for real time process data and alarm acquisition from the Automation Systems. RTDS shall also make this real time information available to the Operators' human-machine interfaces, named SOS HMIs.

5.2.2. The RTDS's shall be supplied in sets of redundant virtual servers in hot standby configuration, implemented using computers with server characteristics, mentioned

in item 6.2.

5.2.3. The RTDS's are logically connected to the Data Acquisition and to the Supervision Layer of the Automation Network.

5.2.4. The quantity of RTDS's is according to the necessity and size of the UNIT.

5.3. Historical Data Servers (SOS HDS)

5.3.1. The HDS's are virtual servers responsible for process data and alarm historical collecting and archiving and acts as interface between the Real Time Data Servers and the Operators concerning historical data/alarms collection and analysis.

5.3.2. The HDS's are logically and physically connected to the Supervision Layer of the Automation Network.

5.3.3. HDS shall also serve historical data to corporate historical database (PI® - Plant Information, from OSISoft).

5.3.4. HDS shall register all data available on SOS screens, as well as other information required to record all operations.

5.4. Human-Machine Interfaces (SOS HMI)

5.4.1. SOS HMIs, also called Operator Workstations, are logically and physically connected to the Supervision Layer of the Automation Network.

5.4.2. The SOS HMI's are the interface between the real time data acquisition and the operators, and are located at the Operators consoles, in Central Control Room-Operation Ambiance (CCR-OA). Through SOS HMIs, it shall be possible for the Operators to:

- Supervise (visualization of real-time process data values, engineering units, quality and visualization of real-time equipment status, alarms and events);
- Operate (changing of equipment status – open/close valves; turn-off/on equipment; changing of control setpoints and parameters and execution of operational / maintenance overrides commands);
- Visualize and Acknowledge Real-time Alarms and Events (Alarm Summary);
- Visualize Historical Alarms and Events (Alarm History);
- Generate Reports (alarms, events, overrides, process data, configuration data etc.) for present time and past time periods;
- Visualize real-time and historical trend graphs;
- Visualize historical process data.

5.4.3. The quantity of SOS HMIs is according to the necessity and size of the UNIT.

5.4.4. SOS HMIs shall be used exclusively for the purpose of supervision and operation. Other applications such as internet browsers and e-mail managers shall not be used. SOS HMIs shall not be used to access the corporative network.

5.5. Engineering Workstation

5.5.1. The Engineering Workstation allows Engineers/Automation technicians to install

SOS software, create/configure screens and database, setup, test, edit, compile, download and upload all SOS components.

5.6. Domain Server

5.6.1. The Domain Server is a virtual server responsible for the management of the Domain and network IP addresses.

6. MINIMUM HARDWARE AND SOFTWARE REQUIREMENTS

6.1. General Requirements for all SOS Computers

6.1.1. Only mission-critical computers and equipment suitable for industrial environment shall be used. Refurbished, used or economy-line equipment are forbidden.

6.1.2. The SOS system shall be virtualized. For further details, refer to I-ET-3010.00-5520-861-P4X-003 – VIRTUALIZATION OF AUTOMATION SYSTEM COMPUTERS.

6.1.3. All SOS software shall be supplied in their most recent versions at purchase time, accompanied by media and manuals, licensed to PETROBRAS and with one year of technical support and maintenance. Demo and under development versions shall not be accepted. Whenever possible, softkeys are preferred over hard keys.

6.1.4. The main software components of SOS are the Operational System and the Supervisory Software Module of each SOS computer, whose modules vary depending on the functions of the computer they are installed in. All modules of SOS Supervisory Software shall be of the same manufacturer and of the same suite version.

6.1.5. SOS supplier is responsible for the adequate memory and software licenses sizing of all SOS equipment (RTDS's, HDS's, HMI's, Engineering Workstations and Domain Server). The need of extra servers other than the depicted in this Specification shall be informed in the Technical Proposal.

6.1.6. Security mechanisms (firewall, antivirus, USB port blocking etc.) shall be supplied and configured for all SOS computers. Antivirus shall be certified and approved by the Supervisory Software manufacturer.

6.1.7. Real Time Data Server and Historical Data Server functions may be split in more than one redundant pair, since it does not compromise functionality, response time and efficiency of the system.

6.1.8. For virtual image / Supervisory Software module sizing, the following estimate shall be considered:

6.1.8.1. For estimating real time TAG quantity of Real Time Data Servers, consider at least: the total amount of CSS I/Os, including PACKAGE UNITS interface signals, with spare and future capacity, plus PACKAGE UNITS network data exchanged with SOS, all with a 20% safety margin.

6.1.8.2. For sizing Historical Data Servers (virtual image and SOS module), consider at least:

30 days of collection and registering of all RTDS' data, alarms, and events, including those from PACKAGE UNITs.

6.1.8.3. Quantity of pop-up windows: quantity of control loops, instruments, on-off valves and pumps.

6.1.8.4. Quantities estimated according to item 6.1.8 shall not be used for estimating Integration Services cost.

6.1.8.5. All HMIs and Engineering Workstations shall be ergonomically positioned as required by NR 17 – *Ergonomia*. Monitors, keyboards, and mice shall be placed as to allow proper sitting posture.

6.1.9. All hardware (including firmware) and software licenses mentioned in this specification shall be updated by purchase time to their most recent versions.

6.2. Real Time Data Servers (RTDS)

6.2.1. RTDS Virtual Image

6.2.1.1. Real time data acquisition shall be performed by at least one set of redundant virtual real time data servers in hot-standby configuration. The RTDS's shall be composed of two (2) independent virtual servers configured to perform the required redundancy.

6.2.1.2. Besides the characteristics mentioned in 6.1, each RTDS shall be supplied as a virtual image to be installed at one of the FPSO's Clusters. Number of Virtual Processors, virtual Hard disk space and virtual RAM shall be according to the use of the necessary software in its maximum performance configuration. For further details, see I-ET-3010.00-5520-861-P4X-003 - VIRTUALIZATION OF AUTOMATION SYSTEM COMPUTERS.

6.2.2. RTDS Software

6.2.2.1. For each RTDS, at least the following modules of software are needed:

- Microsoft Windows® Server Standard Edition latest version or its equivalent at purchase time;
- Real-time Data Acquisition Module of the Supervisory Software;
- Redundancy module of the Supervisory Software;
- Database Runtime tool;
- Communication driver between Supervisory Software and CSS PLCs, based on Ethernet TCP/IP, developed or certified by the Supervisory Software manufacturer;
- OPC-UA client/server for communication with PACKAGE UCP;
- Other specific communication driver(s) necessary to integrate SOS within the Automation and Control Architecture, according to Project's drawing "AUTOMATION AND CONTROL ARCHITECTURE".

6.2.2.2. A dedicated communication driver developed or certified by SOS manufacturer shall be supplied for communication with CSS. OPC-UA shall also be provided.

6.3. Historical Data Servers (HDS)

6.3.1. HDS Virtual Image

6.3.1.1. Historical data, alarms and events collection and archiving shall be performed by one pair of redundant virtual servers in hot-standby configuration.

6.3.1.2. Besides the characteristics mentioned in 6.1, each HDS shall be supplied as a virtual image to be installed at one of the FPSO's Clusters. Number of Virtual Processors, virtual Hard disk space and virtual RAM shall be according to the use of the necessary software in its maximum performance configuration. For further details, see I-ET-3010.00-5520-861-P4X-003 - VIRTUALIZATION OF AUTOMATION SYSTEM COMPUTERS.

6.3.2. HDS Software

6.3.2.1. The Historical Module shall be of the same suite and manufacturer as the Supervisory Software.

6.3.2.2. At least the following software modules are needed for each Historical Data Server:

- Microsoft Windows® Server Enterprise at its latest version or its equivalent at purchase time, since it has disk cluster functionality;
- Microsoft Excel® software latest version or its equivalent at purchase time;
- Historical data collector and archive module of the supervisory software with redundancy capability;
- Database Runtime tool required by the Supervisory Software Historical Module;
- Historical trend charts visualization;
- Historical data report generator / viewer;
- OPC client and server, for communication with Plant Information (PI®). Compatibility between the Supervisory Software Historian Module and PI® version shall be confirmed by Supervisory Software manufacturer.

6.4.   SOS HMIs

6.4.1. SOS HMIs Hardware

6.4.1.1. Besides the characteristics mentioned in 6.1, each SOS HMI shall be a virtual machine with an associated thin client. For further details, see I-ET-3010.00-5520-861-P4X-003 – VIRTUALIZATION OF AUTOMATION SYSTEM COMPUTERS.

6.4.1.2. Virtual machine configuration and memory shall be according to the use of the necessary software in its maximum performance configuration.

6.4.2. SOS HMIs Software

6.4.2.1. At least the following software modules are needed for each SOS HMI:

- Microsoft Windows® Professional at its latest version or its equivalent at purchase time;
- Microsoft Excel® software latest version or its equivalent at purchase time;
- Run-time module of the Supervisory Software;
- Real-time trend graphics module of the Supervisory Software;
- Real-time data graphic display module of the Supervisory Software;
- Alarm Summary and Alarm History functions;

- Historical data reports generator;
- Screens animation module.

6.5. Engineering Workstation

6.5.1. Engineering Workstation Virtual Machine and Hardware

6.5.1.1. Besides the characteristics mentioned in 6.1, Engineering Workstation shall be a virtual machine with an associated thin client. For further details, see I-ET-3010.00-5520-861-P4X-003 – VIRTUALIZATION OF AUTOMATION SYSTEM COMPUTERS.

6.5.1.2. An extra notebook shall be supplied, to be used as Engineering Workstation, whose hardware shall be defined and sized by SOS SUPPLIER.

6.5.1.2.1. This notebook shall be supplied along with a dock station and a 24" monitor.

6.5.1.2.2. The dock station shall be permanently connected to the automation network (via cable) and to the 24" monitor.

6.5.1.2.3. The 24" monitor associated with the notebook shall have adjustable height.

6.5.2. Engineering Workstation Software

6.5.2.1. At least, the following modules of software are needed for each Engineering Workstation:

- Microsoft Windows® Operating System or its equivalent at purchase time;
- Microsoft Word® and Excel® software latest version or its equivalent at purchase time;
- Configuration module of the supervisory software;
- Run-time module of the supervisory software;
- All the communication drivers and OPC client/servers between the Supervisory Software and CSS, with the same characteristics as the RTDS's communication drivers;
- All the communication drivers and OPC client/servers between the supervisory software and PACKAGE UCPs;
- Application Programming Tool for CSS processors and for the PACKAGE UNIT controllers;
- Management of change mechanism (any SOS modification shall be traceable);
- Backup mechanism for the supervisory software and for the engineering workstation as a whole.

6.6. Domain Server

6.6.1. Domain Server Virtual Image

6.6.1.1. Besides the characteristics mentioned in 6.1, Domain Server shall be a virtual machine with an associated thin client. For further details, see I-ET-3010.00-5520-861-P4X-003 – VIRTUALIZATION OF AUTOMATION SYSTEM COMPUTERS.

6.6.2. Domain Server Software

6.6.2.1. At least the following modules of software are needed for Domain Server:

- Microsoft Windows® Server Enterprise at its latest version or its equivalent at purchase time;
- Microsoft Excel® software or its equivalent at purchase time.

6.7. Color Laser Printer

6.7.1. The color laser printer shall be wireless, multifunctional (scanner and printer) and adequate for prints in A3 and A4 formats.

6.7.2. Adequate color laser printer drivers shall be supplied according to SOS Operational System.

6.8. Package Maintenance Workstations

6.8.1. The Package Maintenance Workstations shall be notebooks containing, at least, the following items:

- All P1, P2, P2C, P2S and P2SC software required for programming, configuration, already installed, licensed and operational;
- All software, including Microsoft operational system, on original specific CD/DVD media and licenses. OEM license is not acceptable;
- Microsoft Office Professional licensed and installed. OEM license is not acceptable;
- VMWare installed and licensed;
- All devices (connectors, cables, converters, etc.) required for the connection between the PACKAGE Maintenance Workstation and the equipment located in all PACKAGES.
- Software for computer disk imaging and recovery (Acronis, Ghost or similar) including the original specific CD/DVD media and license.

6.8.2. The Package Maintenance Workstations specifications shall be capable to run virtual machines. The following minimum requirements, at least, shall be met:

- 6 Core Processor with 9 Mbytes Cache;
- 1TB Solid Stated Drive;
- 32 Gigabytes RAM;
- 15,6" (1920x1080) IPS Display;
- Dock station included;
- Ports: Three USB 3.1 Gen 1 (one Always On), two USB Type-C / Thunderbolt 3, Mini DisplayPort 1.4, HDMI 2.0, Ethernet (RJ-45);

6.8.3. All Package documents, after as-built activities, shall be make available, in directories, inside the Package Maintenance Workstations and Automation Maintenance Workstation.

6.8.4. Each Package Maintenance Workstation shall be supplied along with a dock station and a 24" monitor.

6.8.4.1. The dock station shall be permanently connected to the automation network (via cable) and to the 24" monitor.

6.8.4.2. The 24" monitor associated with the notebook shall have adjustable height.

7. TOPSIDES SOS

7.1. All hardware and software (Operational System, Supervisory Software, and additional software) for Topsides SOS shall be supplied according to the following:

7.1.1. Four (04) pairs of redundant virtual RTDS's (Topsides SOS RTDS), in hot-standby configuration, as follows:

- One (01) pair to collect real time data / send commands from/to CSS-PCS;
- One (01) pair to collect real time data / send commands from CSS-PSD;
- One (01) pair to collect real time / send commands data from/to CSS-FGS and from/to CSS-HFGS (see item 7.1.1.1);
- One (01) pair to collect real time / send commands data from/to Topsides PACKAGE UNITS UCPs.

7.1.1.1. In order to comply with the requirement of the Fire and Gas HMI, which shall supervise and operate Fire and Gas of the whole UNIT, Topsides SOS FGS RTDS pair shall collect and send real time data from/to CSS-FGS and from/to CSS-HFGS. Both Hull and Topsides HMIs shall be able to communicate with CSS-FGS and CSS-HFGS, and they both shall have the same application software.

7.1.2. One (01) pair of Topsides SOS virtual Historical Data Servers (Topsides SOS HDS);

7.1.3. Five (05) Topsides SOS HMI's

7.1.4. One (01) Topsides SOS Main HMI and one (01) Fire and Gas HMI with one 55-inch monitor each (CCR-OA). These two HMIs shall be supplied with thin client, keyboard, mouse, and monitor;

7.1.5. Two (02) Topsides SOS HMI's with one 24-inch monitor each (Topsides Operators' Room - Laboratory). These two HMIs shall be supplied with thin client, keyboard, mouse, and monitor;

7.1.6. Two (02) Topsides SOS Engineering Workstations (one workstation with thin client, keyboard, mouse and two 24" monitors; and one notebook);

7.1.7. One (01) virtual Domain Server (if applicable).

7.2. A specific HMI, named Fire and Gas HMI, whose function is to allow exclusive Fire and Gas operation and supervision (screens, alarms) of the whole UNIT, is part of the Topsides SOS HMIs and shall display all the data from CSS-FGS and CSS-HFGS, through Topsides SOS FGS RTDS.

8. HULL SOS

8.1. All hardware and software (Operational System, Supervisory Software, and additional software) for Hull SOS shall be supplied according to the following:

8.1.1. Four (04) pairs of redundant virtual RTDS's (Hull SOS RTDS), in hot-standby configuration, as follows:

- One (01) pair to collect real time data / send commands from/to CSS-HCS;
- One (01) pair to collect real time data / send commands from CSS-HSD;
- One (01) pair to collect real time / send commands data from/to CSS-HFGS;
- One (01) pair to collect real time / send commands data from/to Hull PACKAGE UNITS UCPs.

8.1.2. One pair of Hull SOS virtual Historical Data Servers (Hull SOS HDS).

8.1.3. Five (05) Hull SOS HMI's with dual 24-inch monitors each (CCR-OA).

8.1.4. One (01) Hull SOS Main HMI with one 55-inch monitor (CCR-OA).

8.1.5. These HMIs shall be supplied with thin client, keyboard, mouse, and monitor.

8.1.6. One (01) virtual Domain Server (if applicable).

9. SUPERVISORY SOFTWARE TECHNICAL REQUIREMENTS

9.1. The supervisory software shall have built-in facilities to implement servers' hot standby function.

9.2. Because of logic implementation standard, the supervisory software shall have built-in facility to implement individual processor (PLC) bit writing due to alarm/event acknowledgment.

9.3. The supervisory software shall have built-in facility to perform alarm/event acknowledgement from one workstation to all other workstations.

9.4. The supervisory software shall be native OPC UA Client/Server (Universal Access).

9.5. The supervisory software shall carry out real-time data synchronization among all servers/workstations.

9.6. The supervisory software shall carry out real-time alarm/event synchronization among all servers/workstations.

9.7. The supervisory software shall permit configuration of at least seven (07) levels of alarm priorities, in different colors – critical, high, medium, low, alert, event and Package Unit's Alarm.

9.8. The Supervisory Software shall have at least the following Access Levels, in order to associate a personal login to a corresponding privilege:
- <u>VIEWER</u>: Allows visualization of screens and real time and historical data and alarms. This access level does not permit Operational System access;
- <u>OPERATOR</u>: the same privileges as Viewer, plus operations such as modifications of equipment status, setpoint values, control loops parameters, alarm acknowledgment, generation of real time trend and historical graphs/reports. This access level does not permit Operational System access;
- <u>SUPERVISOR</u>: the same privileges as OPERATOR level, plus modifications in alarm limits and priorities and operational and maintenance overrides

commands. This access level does not permit Operational System access;

- ENGINEER: the same privileges as SUPERVISOR, plus changes in Supervisory System configuration (screens and database);
- ADMINISTRATOR: the same privileges as ENGINEER, plus Operational System access.

9.9. The supervisory software shall be able to order alarm/event annunciation at least by chronological order and by priority.

9.10. The supervisory software shall have built-in mechanisms for identification of bad quality data.

9.11. Additional software and scripts shall be certified or approved by Supervisory Software manufacturer. Hot stand-by functionality between data servers and alarm acknowledgement with interaction with field devices (writing of bits to CSS subsystem processor) shall be intrinsic to the Supervisory System Software, i.e. shall not be implemented by means of additional scripts.

9.12. The dedicated communication driver with CSS shall only be defined in the Detail Engineering Design Phase, after the definition of the CSS manufacturer.

9.13. All supervisory software shall be compatible with the 64-bit architecture.

9.14. In SOS HMIs and Workstations, it shall be possible to run commercial software external to the Supervisory Software (e.g. Microsoft Office) without interrupting its execution.

9.15. It shall be possible to import/export database configuration data by means of CSV files (and other Microsoft Excel compatible file formats).

9.16. Supervisory Software shall be available in English.

9.17. Supervisory Software shall have a button to allow alarm/event acknowledgement individually, by groups and of all alarms/events ("ACK ALL").

9.18. Supervisory Software shall be capable of importing/exporting graphic files compatible with Microsoft Windows Operating System in at least the following formats: GIF, BMP, JPG, JPEG, PNG and TIF.

9.19. Supervisory Software shall be compatible with CAD software. Importing/exporting files in DXF, DWG and DGN formats without converting these to the formats listed in item 9.18 is desirable.

9.20. Supervisory Software TAGs shall have at least 20 characters.

9.21. Supervisory Software shall have the following facilities: screen graphics edition, database configuration, scalability according to screen size and window dimensions, symbols library, with predefined symbols and the capacity to create new ones, capacity to create configurable standard blocks and symbols, color palette configuration (at least 256 colors).

10. SUPERVISORY SOFTWARE PERFORMANCE REQUIREMENTS

10.1. Hot standby switchover time between redundant RTDS's shall not exceed five (05) seconds. During switchover, Supervisory Software shall not be unavailable for more than five (05) seconds.

10.2. Data reading by the communication drivers shall be executed in configurable time intervals equal to or less than one (01) second.

10.3. The following response time shall be achieved:
- HMI update from field inputs: maximum 2 seconds;
- Operator outputs to field, from HMI to output terminal: maximum 2 seconds;
- Bad quality data indication: maximum 2 seconds;
- Delay from requesting a screen display to its appearance at the HMI: maximum 3 seconds;
- Update time for dynamic data in an already open display: maximum 2 seconds;
- Time delay between operator keyboard input and data display at HMI: 0.1 second.

10.4. All servers (RTDS's and HDS's) shall operate with processor loading and memory usage below 40% under normal operation and with no more than 70% when under system stress, such as during alarm storm, simultaneous accesses from all clients or a high amounts of alarm acknowledgment ("ACK ALL").

10.5. It shall be possible to configure SOS (screens and database) without interrupting running applications.

10.6. Supervisory software shall have built-in mechanisms of alarm shelving according to IEC 62682.

11. ACCEPTANCE TESTS

11.1. All deviations and anomalies found during Factory Acceptance Test (FAT), Site Acceptance Test (SAT) and Site Integration Test (SIT) shall be adequately registered according to punch list control system defined in contract.

11.2. The acceptance tests shall be according to IEC-62381 – AUTOMATION SYSTEMS IN THE PROCESS INDUSTRY – FACTORY ACCEPTANCE TEST (FAT), SITE ACCEPTANCE TEST (SAT) AND SITE INTEGRATION TEST (SIT).

11.3. Detailed FAT, SAT and SIT proceedings shall be submitted to PETROBRAS for approval according to the informed schedule.

11.4. Factory Acceptance Tests (FAT)

11.4.1. The following tests shall be performed at Factory (FAT), besides the tests required at I-ET-3010.00-5520-888-P4X-001 - AUTOMATION PANELS, where applicable, prior to delivery:

- Mechanical inspection;
- Hardware inventory check;

- Software licensing check;
- Wiring and Termination inspection;
- Start-up Test;
- Visualization/operation;
- General System functions including hardware redundancy and diagnostic check;
- Functional test (including item 9 of this document);
- Subsystems interface test;
- Screens and logic test.

11.4.2. FAT shall be witnessed, to be agreed between PETROBRAS and Panel SUPPLIER during Project. FAT report tests shall be signed and sent to PETROBRAS.

11.4.3. Prior to the witnessed FAT, SUPPLIER shall send the Tests proceedings to PETROBRAS, according to Project's schedule, and shall execute previous tests and present the documentation to PETROBRAS, in order to reduce repairs and/or modifications during FAT.

11.4.4. The FAT shall be fully documented, including any equipment failure, repairs or replacements. The FAT procedure shall include handling over all records made during the construction period such as test results, list of changes, as-built drawings, calibration certificates and any other documentation.

11.4.5. All documentation (project and tests) shall be sent in digital media.

11.4.6. Testing methods and accuracy of measurements shall be subject to the Classification Society and PETROBRAS approval.

11.4.7. Any malfunctions of the equipment shall be rectified and tested again, at SOS SUPPLIER'S expenses, and be submitted to PETROBRAS approval. Evidence of the correction shall be presented.

11.4.8. In FAT location, all facilities such as redundant external power supplies shall be available. Ambiance temperature shall be controlled. The FAT facility shall include adequate air conditioning to ensure that the testing environment (where there are numerous screens and other equipment generating large amounts of heat) is maintained at a comfortable temperature (less than 25 °C).

11.4.9. Electrical and RFI & EMI Immunity tests shall be according to project's "INSTRUMENTATION ADDITIONAL TECHNICAL REQUIREMENTS" technical specification.

11.4.10. Functional Tests shall be as described below:

- Complete system functional test, with simulation of all input situations and observation of expected outputs; the overall reaction time shall be verified;
- Input / Output Tests;
- Devices shall be tested according to test and operation device manuals.

11.4.11. FAT report shall include a punch list with all non-impeditive deviations and anomalies that will be treated in field, including the date for treatment deadline.

11.4.12. During FAT, all Ex certificates of each component and of the assembly shall be

verified and validated.

11.4.13. During FAT, inventory shall be kept of all SOS components and spare parts in order to guarantee traceability and availability.

11.5.   Site Acceptance Test (SAT)

11.5.1. All tests performed at the factory (FAT) shall be repeated at the installation site (SAT). IEC 62381 requirements shall also be taken into account.

11.5.2. During SAT, any necessary design modifications after FAT shall be tested and FAT punch list items shall be treated.

11.5.3. After the SOS installation at the site, at least the following tests (SAT) shall be provided in order to assure that the equipment is correctly installed:

- Mechanical Inspection;
- Hardware and Software inventory check;
- Start-up/Diagnostic Check;
- Software downloads and functional tests.

11.6.   Site Integration Test (SIT)

11.6.1. For Site Integration Tests (SIT) refer to IEC-62381 – AUTOMATION SYSTEMS IN THE PROCESS INDUSTRY – FACTORY ACCEPTANCE TEST (FAT), SITE ACCEPTANCE TEST (SAT) AND SITE INTEGRATION TEST (SIT).

11.6.2. During SIT, Topsides SOS's capability of reading / writing to HFGS shall also be tested.

11.6.3. The tests shall include all interconnection and communication tests between SOS and the Automation systems.

12.   PACKING REQUIREMENTS

12.1.   On completion of FAT, all equipment shall be prepared for shipment and storage.

12.2.   Equipment supplied loose shall be packed and crated for transportation. In addition, if some rack equipment is susceptible to transportation damage, it shall be removed from the system rack for separate packing and crating.

12.3.   In order to prevent corrosion, VCI shall be used adequately, where applicable, as part of preparation for shipment and storage instead of desiccants such as silica gel. The latter shall be used only in cases where VCI is not applicable. Both VCI and desiccants shall not be used together for protecting the same compartment.