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INDEX OF REVISIONS

REV.	DESCRIPTION AND/OR REVISED SHEETS
0	ORIGINAL ISSUE
A	GENERAL REVISION
B	REVISED WHERE INDICATED
C	REVISED WHERE INDICATED
D	REVISED WHERE INDICATED
E	REVISED WHERE INDICATED

	REV. 0	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE	MAR/14/19	OCT/25/19	JAN/11/21	JUN/11/21	NOV/24/21	AUG/22/22			
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SUMMARY

1 INTRODUCTION 3

1.1 Objective 3

1.2 Definitions 3

1.3 Abbreviations, Acronyms and Initialisms 3

2 REFERENCE DOCUMENTS, CODES AND STANDARDS 4

2.1 ISA – International Society of Automation 4

2.2 ISO – International Organization for Standardization 4

2.3 NAMUR – User Association of Automation Technology in Process Industries 4

2.4 Brazilian Codes and Standards 4

2.5 Project Documentation 4

3 ASSET MANAGEMENT SYSTEM 5

3.1 Objectives 5

3.2 General Design Details 5

3.3 Diagnostic And Preventive Maintenance Requirements 8

3.4 Connectivity of the AMS 10

4 CONFIGURATION, SUPPORT AND USER TRAINING 11

4.1 General 11

1 INTRODUCTION

1.1 Objective

1.1.1 The main objective of this specification is to describe the requirements of Asset Management System (AMS) for all the instrumentation connected to the CSS, SOS, subsystems and packaged equipment PLCs.

1.1.2 The scope of supply includes all the necessary hardware, software and services to implement the Asset Management System.

1.1.3 All deviations from the requirements of this specification shall be stated in the quotation and are subject to approval. In the absence of a deviation statement, it shall be understood that all requirements of this specification will be adhered to without exception.

1.1.4 This specification defines the minimum requirements for the AMS and related services.

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

- AMS – Asset Management System
- CCR – Central Control Room
- CCR-OA – Central Control Room – Operation Ambiance
- CCR-EA – Central Control Room – Equipment Ambiance
- CCR-ATR – Central Control Room – Automation and Turbomachines Room
- CSS – Control and Safety System
- DD – Device Description
- DDL - Device Description Language
- DTM – Device Type Manager
- EDDL - Electronic Device Description Language
- FDT – Field Device Tool
- FGS – Fire and Gas System
- HART – “Highway Addressable Remote Transducer”. Hybrid analog + digital industrial automation open protocol
- HCS – Hull Control System
- HFGS – Hull Fire and Gas System
- HSD – Hull Shutdown
- OPC – Open Platform Communications
- PCS – Process Control System
- PSD – Process Shutdown System
- SOS – Supervisory and Operation System
- UCP – Unit Control Panel

2 REFERENCE DOCUMENTS, CODES AND STANDARDS

2.1 ISA – International Society of Automation

- ISA-95.00.01: ENTERPRISE CONTROL SYSTEM INTEGRATION PART 1: MODELS AND TERMINOLOGY.
- ISA TR 108: INTELLIGENT DEVICE MANAGEMENT

2.2 ISO – International Organization for Standardization

- ISO 55000: ASSET MANAGEMENT - OVERVIEW, PRINCIPLES AND TERMINOLOGY

2.3 NAMUR – User Association of Automation Technology in Process Industries

- NAMUR NE 91: REQUIREMENTS FOR ONLINE PLANT ASSET MANAGEMENT SYSTEMS
- NAMUR NE 107: SELF-MONITORING AND DIAGNOSIS OF FIELD DEVICES
- NAMUR NE 129: PLANT ASSET MANAGEMENT

2.4 Brazilian Codes and Standards

All Applicable Brazilian Standards and Codes.

2.5 Project Documentation

- I-ET-3010.00-1200-800-P4X-002 – AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGE UNITS
- I-ET-3010.00-5520-861-P4X-003 – VIRTUALIZATION OF AUTOMATION SYSTEM COMPUTERS
- I-ET-3010.00-5140-700-P4X-003 – ELECRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE UNITS
- I-ET-3010.00-5520-800-P4X-004 - AUTOMATION NETWORK REQUIREMENTS

2.5.1 Names below and respective document codes may vary according to each project but, in general, the following documents shall be considered along with this technical specification.

- AUTOMATION AND CONTROL ARCHITECTURE
- FIELD INSTRUMENTATION
- AUTOMATION INTERFACE OF PACKAGE UNITS

3 ASSET MANAGEMENT SYSTEM

3.1 Objectives

3.1.1 The Asset Management System objective is to monitor field instrumentation health status and all the available data from Hart devices, including transmitters and final control elements (control valves) related to preventive maintenance and improvement in performance.

3.1.2 The Asset Management System makes primary condition information accessible wherever it is generated and permits access to business administration systems and document systems that provide working documents, and thus supports the preparation and performance of measurements and maintenances.

3.1.3 The core functions of a process control system shall never be put at risk through the Asset Management System. These core functions are monitoring, signaling, operating and controlling. Regardless of the way asset management functions are linked with the control system, they require additional information from field instruments and the control system itself. Additional data flows shall never result in network overload or perceptible lengthening of response times, or in any other way interfere the core functions of the control system.

3.2 General Design Details

3.2.1 The following field instruments of critical equipment, including also Packages, shall be integrated in the AMS to the full extent:

- All transmitters and valve positioners connected to CSS-PCS or CSS-HCS, including the ones that are part of P0 type Packager;
- All transmitters connected to CSS-PSD or CSS-HSD, including the ones that are part of P0 type Packager;
- All Fire and Gas sensors connected to CSS-FGS or CSS-HFGS, including ones that are part of P0 type packager;
- All transmitters and valve positioners connected to Packages type P2, P2C, P2S and P2SC;
- All Fire and Gas detectors connected to Packages, exception to those connected to an addressable system. In the latter case, those may be connected if capable.

3.2.2 NOTE 1: All instruments connected to AMS system shall comply with HART FOUNDATION.

3.2.3 NOTE 2: For Package type P2, P2C, P2S and P2SC, PACKAGER shall use its UCP controller with analog modules with HART capability allowing AMS data access through Single Ethernet link. In case UCP's controller I/O module does not possess HART capability, it shall be submitted to PETROBRAS approval the installation of HART multiplexers with Ethernet converter. The usage of instruments that furnishment in compliance with HART FUNDATION is not possible shall be submitted to PETROBRAS approval.

3.2.4 NOTE 3: For all Package types (including P0 and P1 packages), PACKAGER shall supply DD/FDT/DTM drivers to all instruments and valves of its package, so that all devices may be accessed and tested using handhelds during commissioning phase.

3.2.5 The AMS shall be capable of performing Client/Server operations and shall be capable of allowing multiple client stations being connected simultaneously to a single server application.

3.2.6 The AMS server 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.

3.2.7 AMS Workstations shall be thin clients that perform Remote access / remote communication with the AMS Server virtual image.

3.2.8 3 (three) temporary AMS client licenses shall be installed at Topsides HMI located at CCR-OA. These client licenses shall be operational during Unit commissioning, being removed after this phase.

3.2.9 Asset Management System shall seamlessly link to exchange data via the following interfaces:

- Connection to CSS Data Acquisition Lan (Topsides and Hull switches) to gather status of all Hart instrumentation data for field instruments connected to CSS I/O Modules.
- Connection to Package Unit Lan (Topsides and Hull Layer 3 switches) to gather status of all Hart instrumentation data for field instruments connected to packaged UCP I/O Modules.
- Temporary Connection to SOS LAN (Topsides and Hull switches). This connection will be used during commissioning phase in order to connect (via SOS LAN) the additional temporary commissioning AMS Clients (of item 3.2.8) to AMS server and to allow for tests/configurations to be performed in instruments from CCR.
- Logical Connection to Automation Firewall, via CSS Data Acquisition Lan (described in the first bullet), in order to allow traffic to onshore installations.

AMS server's virtual machine shall be supplied with at least 6 (six) virtual Network Interface Cards so that all the connections above may be done simultaneously and redundantly.

3.2.10 Three handheld devices shall be supplied for usage in conjunction with the AMS system. They shall be used during commissioning and during the Unit's whole lifecycle. These handhelds shall be classified for Zone 0 and shall have internal loop supply.

3.2.11 The AMS shall have the capacity to transfer data between all portable hand held devices, or the field communicator and the AMS database.

3.2.12 The development goal shall be to minimize the effort required to incorporate the field instruments by suitable standardization. It shall be possible to connect or disconnect instruments of different vendors to the system complying with the same standard (interoperability) without any impairment of the overall function. The Asset Management System shall with minimal configuration recognize the new instrument and allocate it to the corresponding instrument description.

3.2.13 It shall be supplied all the client/server software required to interface the HART signals, connected directly to CSS Data Acquisition Lan (Topsides and Hull), Package Unit Lan (Topsides and Hull) and Automation Firewall. Each Asset Management Servers/workstation shall be supplied with licenses to perform detailed AMS tasks including the following software as a minimum:

- Software to perform calibration and configuration of all HART devices connected to the AMS system.
- Software to perform automated functional checks of the devices using HART protocol, connected to the AMS, by changing the device output.
- Audit trail software to track any configuration changes made including the time, date and person making the change.
- Alarming for abnormal conditions, such as low pressure in control valves pneumatic supply lines.
- Capability to produce and export spreadsheet showing instruments status summary.
- Interface licensed to communicate with handhelds
- License to make internal database (OPC) available to other UNIT applications
- FDT/DTM based or licensed to communicate with FDT/DTM applications
- Summary screen (s) with overview of all device alerts

3.2.13.1 It shall be supplied the following number of the AMS licenses as a minimum:

- One AMS server license;

- Three (3) temporary AMS client licenses, to be used during the commissioning and pre-operation phase. These licenses shall be valid for three (3) years, with possibility of extension;

- Three (3) permanent AMS client licenses: one meant for an onshore client and two meant for the offshore thin client (CCR-ATR and Instrumentation Workshop).

3.2.13.2 The number of points covered by the licenses shall be capable of covering all applicable instruments and equipment. It shall be provided all adequate licenses without additional costs to PETROBRAS.

3.2.14 All configuration and calibration changes to smart instruments shall automatically record the following:

- Tag of Instrument;
- As found / as left value (before/after change);
- Client / Server PC from which the change was made;
- Date and time of change;

- Logon Account name of the person performing the change;
- Reason for change.

3.2.14.1 The information mentioned in the previous item shall be recorded by the AMS in a database in order to provide Audit trail reports. The database and the reports shall be exported at any moment in Excel format.

3.2.15 Changes to Instrument diagnostic status shall automatically record the following:

- Tag of Instrument;
- Date and time of change;
- Detail of diagnostic status change.

3.2.16 The Asset Management System shall provide historical data about a field instrument at its physical location in the form of a logbook. This covers parameterization, function checks, other local verifications and status reports.

3.2.17 The AMS shall be able to roll back to a given date and restore previous configurations to the instrument. Configurations from one instrument shall be able to be transferred to another instrument.

3.2.18 All condition data are signaled to the AMS online and thus without delay.

3.2.19 The asset management shall include the NAMUR functions as described in NAMUR recommendation NE 91, “Requirements for Online Plant Asset Management Systems” and the types of diagnostic functions and status reports (NE 107, “Self Monitoring and Diagnosis of Field Devices”).

3.2.20 The AMS System shall be able to perform complete remote loop test on 4 to 20 mA + HART instruments through AMS Workstations.

3.3 Diagnostic And Preventive Maintenance Requirements

3.3.1 A primary objective of the AMS shall be to improve maintenance processes. Particular emphasis shall be placed on alerting the user of potential trouble source with plant assets before they become serious problems. Diagnosis shall be timely. All the relevant diagnostic parameters shall be readable. To accomplish this goal, the AMS shall provide the following preventive and predictive diagnostic capabilities:

3.3.1.1 Control and On/Off Valve Diagnostics

The AMS shall include for all valves of all vendors a Predictive Control and On/Off Valve Diagnostic Capability that can perform as a minimum the following diagnostic checks:

- Generate a complete valve signature
  - The sampling rate and transmitter resolution required to generate a complete valve signature will be provided by the valve manufacturer. This shall ensure the quantity of sampled points and quality of the valve signature is sufficient;
  - The valve shall be out of service so that there is no impact to production;

- Signatures are compared to baseline signatures on file.

- Perform a dynamic error band test.
- Drive signal test.
- Step response analysis and overlay.
- Smart Positioner Test.
- Travel deviation test / Alert.
- Supply Pressure test / Alert - Applicable for pneumatic or hydraulic valves with supply pressure.
- Relay Adjustment.
- Air Volumetric Flow test.
- Valve Friction test / Analysis.
- Cycle Counter.
- Travel Accumulator.

3.3.1.2 Transmitter Diagnostics

The AMS shall be capable of reporting and displaying all smart transmitter diagnostic conditions detected by every smart transmitter connected to the AMS. When there is an anomaly, the health of the asset is downgraded and reported in the AMS.

3.3.1.3 Loop Diagnostics

The AMS shall include the ability to monitor all control loops, including complete flow and level control loops, and alert the operator of the root cause of a particular loop problem. As a minimum, this predictive diagnostics shall be capable of detecting and reporting the following loop conditions:

- Control Saturation.
  - If controller is set up to exceed 4-20 mA, as some analog controllers are, the circuit can saturate either high or low and the end device, e.g. a control valve, shall have a delay in response when saturation is removed.

- Control Wind Up, if the problem occurs in the control loop.

- Measurement Sensor Drift.

- Valve Problem, including but not limited to:

  - Increase in force necessary to open/close
  - Slow to respond
  - Open/Close timing

These conditions shall present an alert to the user and record the condition in the AMS.

3.3.1.4 Diagnostic Event Reporting

An enhanced polling feature shall be provided to ensure fast identification of device status changes and alerts. The software shall allow an increased frequency of polling of a selected subset of instruments, classified as critical, during operation.

All diagnostic conditions detected by the AMS shall be presented as alert conditions to the maintenance and operations personnel, as appropriate.

3.4 Connectivity of the AMS

3.4.1 The preferred method of connecting the AMS to the instruments shall be to utilize the control system's I/O infrastructure, with the AMS connected as a node on the Plant Automation Network. Messages to/from the instruments shall pass through the control system from/to the AMS with NO EFFECT on the control system's process control capability.

3.4.2 In addition, the AMS shall provide connectivity to the following types of I/O systems:

- Remote I/O Systems
- Devices using HART Protocol
- Multiplexers/Modems using HART Protocol
- Handheld Intelligent Instrument Configuration and Diagnostic Tool (Field Communicator)

3.4.3 Support for HART

3.4.3.1 The AMS shall provide full support for HART instruments. A comprehensive library of HART devices from all major manufacturers shall be contained in the AMS. The AMS shall support continuous updates and additions to the library. It shall be provided the most updated versions of DD/FDT/DTM archives for all hart devices to Unit start-up.

3.4.4 Device Description Language (DDL) and FDT/DTM Technology

3.4.4.1 The AMS shall be compatible with FDT/DTM technology. The technologies Device Description Language (DDL) and Electronic Device Description Language (EDDL) are also acceptable. Alternative technologies or compiled executable derivatives of DDL and FDT/DTM technologies are not acceptable. It shall be listed which Instrument device descriptions have full configuration, diagnostic and documentation support. The AMS shall be able to use enhancements to the DD and FDT/DTM languages.

3.4.5 Support for Open Platform Communications (OPC)

3.4.5.1 The AMS shall include a communication interface using Open Platform Communications (OPC) Unified Architecture (OPC-UA). This shall enable an OPC client application to access HART device data and interact with connected devices through the AMS.

3.4.6 The OPC client shall utilize the Windows PC user account information for security purposes. The AMS username and Windows username shall correspond when Device Write permission is needed, otherwise the user can only view information. The OPC client application shall be able to access live devices, and it shall be able to directly or indirectly change device configuration or parameter information.

3.4.7 Access Rights

3.4.7.1 The system shall allow customer-specific allocation of access rights for user groups. It shall have a basic structure, which the respective system users can customize and extend, including the following:

a. Viewing rights for data;

b. Change rights within the system, including allocation of subcategories;

c. Change rights for the system itself (e.g. changing the structure, new modules).

4 CONFIGURATION, SUPPORT AND USER TRAINING

4.1 General

4.1.1 AMS Service Support shall be provided, including the following:

- System design, installation and commissioning support;
- Advanced Diagnostic interpretation support;
- Support for integration with other systems.

4.1.2 All applicable instrument and equipment TAGs in the AMS database during commissioning phase shall be configured individually. Chapter 3.2 describes which instruments and equipment are applicable. AMS supplier shall provide support and provide any configuration files required in order to allow access to such equipment and instruments. The logic tree format (i.e., the grouping of the Instruments and equipment in folders) shall be discussed with PETROBRAS during Detailed engineering design and during commissioning phases.

4.1.3 The AMS shall support connections to off-site users over internet/intranet to allow remote interrogation and diagnosis of instruments by specialist personnel. The remote off site user shall be assigned with an User Account in order to access the AMS. The remote user's connection shall be a fully functional interface to the AMS package and associated instruments in order to support preventive maintenance and fault diagnosis.

4.1.4 A self-paced user training package shall be included with the AMS, plus details of the Manufacturer's scheduled training courses updated through website.