	<b>TECHNICAL SPECIFICATION</b>		Nº I-ET-3010.00-5500-854-P4X-001									
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	JOB:								--			
	AREA:											
DP&T-SUP	<b>MACHINERY MONITORING SYSTEM (MMS)</b>								NP-1		ESUP	
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PRELIMINARY

# 1 INTRODUCTION

## 1.1 Object

1.1.1 This specification describes the minimum requirements for the supply of equipment, software and integration service of the MACHINERY MONITORING SYSTEM (MMS), to be installed at the UNIT, covering all equipment, material, software, licenses, interconnections, documentation, system configuration, tests, installations and training.

## 1.2 Definitions

UNIT	FPSO (Floating Production Storage and Offloading), FSO (Floating Storage and Offloading), SS (Semi-Submersible) or Fixed Offshore Unit.
PACKAGED UNIT	An assembly of equipment supplied interconnected, tested and operating, requiring only the available utilities from the UNIT for the operation of the PACKAGED UNIT.
PACKAGER	Entity responsible for project assembly, construction, fabrication, test and furnishing of the PACKAGED UNIT.
PURCHASER	The Company designated as such in the Contract or the Purchase Order.
MANUFACTURER	Entity responsible for fabrication of equipment or components.
MMS SUPPLIER	Entity responsible for the whole supply of MMS described herein specification.
MMS INTEGRATOR	Entity responsible for ensuring integrity of the MMS system as a whole, which involves, among other activities, reading of information from monitored equipment (including those of PACKAGED UNITS) and signal exchange between MMS and CSS. The MMS INTEGRATOR may be the PURCHASER, one of the MMS SUPPLIERS or a third party.

## 1.3 Abbreviations

AC/DC	Alternating Current/Direct Current
CPU	Central Processing Unit
CSS	Control and Safety System
DAM	Dynamic Acquisition Module
DAS	Data Acquisition Server
FAT	Factory Acceptance Test
FFT	Fast Fourier Transform
FGRU	Flare Gas Recovery Unit
FPSO	Floating, Production, Storage and Offloading
GDU	Gas Dehydration Unit
GIOp	Gerenciamento Integrado de Operações
HCS	Hull Control System
HDD	Hard Disk Drive

HSD	Hull Shutdown System
I/O	Input / Output
LAN	Local Area Network
LCD	Liquid Crystal Display
LED	Light-Emitting Diode
MMS	Machinery Monitoring System
MPS	Machinery Protection System
MTE	Ministry of Labour and Employment ( <i>Portuguese: Ministério do Trabalho</i> )
OPC UA	Open Platform Communications Unified Architecture
PAP	Protection and Acquisition Panel
PAS	Package Automation System
PCS	Process Control System
PLC	Programmable Logic Controller
PSD	Process Shutdown System
RTDS	Real Time Data Server
SAT	Site Acceptance Test
SIT	Site Integration Test
SOS	Supervision and Operation System
SRU	Sulphate Removal Unit
SSD	Solid State Drive
TAP	Performance Acceptance Test
TCP/IP	Transmission Control Protocol/Internet Protocol
UCP	Unit Control Panel (Package Control Panel)
USB	Universal Serial Bus
VAC	AC voltage
VCI	Volatile Corrosion Inhibitor
VDC	DC voltage

## 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

IEC 60092-350                ELECTRICAL INSTALLATIONS IN SHIPS – PART 350 - GENERAL CONSTRUCTION AND TEST METHODS OF POWER, CONTROL AND INSTRUMENTATION CABLES FOR SHIPBOARD AND OFFSHORE APPLICATIONS

IEC 60092-376                ELECTRICAL INSTALLATIONS IN SHIPS – PART 376 - CABLES FOR CONTROL AND INSTRUMENTATION CIRCUITS

150\_250 V (300 V)

- IEC 60092-504 ELECTRICAL INSTALLATIONS IN SHIPS - PART 504: SPECIAL FEATURES - CONTROL AND INSTRUMENTATION
- IEC 60533 ELECTRICAL AND ELECTRONIC INSTALLATIONS IN SHIPS - ELECTROMAGNETIC COMPATIBILITY
- IEC 61000 ELECTROMAGNETIC COMPATIBILITY (EMC) SERIES - ALL PARTS
- IEC 61086 COATINGS FOR LOADED PRINTED WIRE BOARDS (CONFORMAL COATINGS) – ALL PARTS
- IEC 62381 AUTOMATION SYSTEMS IN THE PROCESS INDUSTRY - FACTORY ACCEPTANCE TEST (FAT), SITE ACCEPTANCE TEST (SAT) AND SITE INTEGRATION TEST (SIT)

**ISO - INTERNATIONAL ORGANIZATION FOR STANDARDIZATION**

- ISO 13372 ENVIRONMENTAL TESTING
- ISO 13373-1 CONDITION MONITORING AND DIAGNOSTICS OF MACHINES - VIBRATION CONDITION MONITORING - PART 1 - GENERAL PROCEDURES
- ISO 17359 CONDITION MONITORING AND DIAGNOSTICS OF MACHINES - GENERAL GUIDELINE

2.1.1 Brazilian Codes and Standards

**INMETRO - INSTITUTO NACIONAL DE METROLOGIA, NORMALIZAÇÃO E QUALIDADE INDUSTRIAL**

PORTARIA Nº 179 (18/MAIO/2010) REGULAMENTO DE AVALIAÇÃO DA CONFORMIDADE DE EQUIPAMENTOS ELÉTRICOS PARA ATMOSFERAS POTENCIALMENTE EXPLOSIVAS, NAS CONDIÇÕES DE GASES E VAPORES INFLAMÁVEIS E POEIRAS COMBUSTÍVEIS

PORTARIA Nº 89 (23/FEVEREIRO/2012) ALTERAÇÃO DA PORTARIA INMETRO Nº 179, DE 18/MAIO/2010.

**MTE - Ministério de Estado do Trabalho e Emprego**

- NR 10 SEGURANÇA EM INSTALAÇÕES E SERVIÇOS EM ELETRICIDADE
- NR 17 ERGONOMIA
- NR 26 SINALIZAÇÃO DE SEGURANÇA
- NR 30 ANEXO II – PLATAFORMAS E INSTALAÇÕES DE APOIO

2.1.2 Classification Society

2.1.2.1 The DETAIL DESIGN PHASE shall be submitted to approval by Classification Society. The design and installation shall take into account their requirements and comments.

2.1.2.2 The design, installation and operation shall strictly follow the classification society requirements, along with the specific requirements identified in this document, including also all referenced documents' requirements.

2.2 Internal References

2.2.1 Project Documents

- I-ET-3010.00-1200-800-P4X-002 AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGED UNITS
- I-ET-3010.00-5520-800-P4X-001 SUPERVISION AND OPERATION SYSTEM (SOS) SCREENS
- I-ET-3010.00-5520-888-P4X-001 CSS/SOS PANELS
- I-ET-3010.00-5140-700-P4X-003 ELECTRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE UNITS

2.2.2 PETROBRAS Reference Documents

- DR-ENGP-M-I-1.3 ENGENHARIA DE SEGURANÇA
- DR-ENGP-M-I-1.5 CRITERIOS GERAIS PARA PROJETO DE INSTRUMENTAÇÃO

2.3 Brazilian regulation (MTE section) and INMETRO regulation superpose all codes and regulations listed in item 2.2, since they are enforced by Brazilian law.

**3 ENVIRONMENTAL AND OPERATION CONDITIONS**

3.1 For operational and environmental conditions additional to this section see specific project documentation.

3.2 All materials used shall be non-hygroscopic, flame retardant and resistant to corrosion caused by marine environmental and hydrocarbon continuous contact.

3.3 Equipment shall be suitable to withstand the dynamic loads imposed by the vessel motions during tow and on location.

3.4 The available power supply is 220 VAC (HOLD) as defined in I-ET-3010.00-5140-700-P4X-003 – ELECTRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE UNITS. VENDOR shall convert and distribute the different power supplies inside the panel, including where necessary power supply unit for the cabinet internal distribution of 24 VDC. For further details, see I-ET-3010.00-5520-888-P4X-001 – CSS/SOS PANELS.

3.5 All panels, materials and equipment proper to be used in hazardous areas, shall have conformity certificates complying with “PORTARIA INMETRO Nº 179, de 18/maio/2010”, and its annexes, changed by “PORTARIA INMETRO Nº 89, de 23/fevereiro/2012” and its annexes, and shall be approved by Classification Society. All equipment installed in outdoor areas shall be suitable for Zone II, T3 IP 56. All equipment installed in indoor areas shall have ingress protection of IP 42.

3.6 All electrical and electronic devices, beyond mechanical parts of the equipment, shall be designed and constructed in a tropicalized version. Tropicalization process comprises application of reinforced protective resin Class 2 according to IEC 61086 and fungus proof according to ASTM G21 in all printed circuit boards, use of anti-rust materials and accessories and other implementations according to MANUFACTURERS’ experiences and related rules, aiming to provide a robust and reliable construction.

## 4 SYSTEM DESCRIPTION

### 4.1 General

4.1.1 MMS shall collect all measurement data, including vibrations, temperature and operating/running hours, from Critical Rotating Machines and provide information for diagnostic on the condition of the assets and fault identification.

4.1.2 The Machinery Monitoring System shall have the following functions:

- Data logging and event/variable recording and storing;
- Listing of all incoming alarms chronologically;
- Historical and predictive trending (all variables);
- Real-time measurements in order to allow diagnostics of fault detection and analysis;
- Display of equipment schematic layout;
- Measurements covering the widest possible range of machine faults;
- Data available for use over local area network.

4.1.3 MMS system shall be capable of predicting or anticipating deterioration in rotating equipment with sufficient lead time to permit corrective action prior to failure providing resources for predictive maintenance program.

4.1.4 MMS shall provide performance, condition and behavior monitoring of various parts of rotating equipment by acquiring and analyzing signals and data which will be continuously monitored and historized to achieve the following:

- Increase machine availability and reliability;
- Reduce or eliminate unscheduled downtime;
- Reduce operation and maintenance costs;
- Provide basis for defining inspection and maintenance activity schedules;
- Provide failure analysis in the event of an incident.

4.1.5 MMS system shall provide tools for detecting the equipment defects and degradation, so that preemptive action may be taken to reduce system outages due to equipment failure.

4.1.6 The MMS will be installed indoors and shall consist of:

- MMS Server Panels;
- MMS Workstation;
- MMS Protection and Acquisition Panel (PAP) and its internal MPS and DAM;
- Machinery Protection System (MPS) of PACKAGED UNITS (supplied by others).

4.1.7 All measurements points shall have its electrical and mechanical characteristics configured (e. g. direction of rotation, bearing type, bearing clearance etc.).

#### 4.2 MMS Server Panel

4.2.1 The MMS Server Panel shall house the Data Acquisition Servers (DAS), rack mounted monitor and keyboard, managed industrial network switches and any other hardware required for the system.

4.2.2 Data is exchanged between the MMS Server Panel and the other system components through the following LANs:

- Machinery Protection Systems (MPS) of P2 type PACKAGED UNITS through the HULL / TOPSIDE PACKAGED UNIT LAN;
- MMS Protection and Acquisition Panel (PAP) through the MMS LAN;
- PCS / HCS RTDS through the HULL / TOPSIDE CSS DATA ACQUISITION LAN.

4.2.3 MMS Data Acquisition Servers shall be capable of interfacing multiple machine protection racks, and the data acquisition network shall take in account the worst-case situation of a simultaneous plant shutdown and guarantee no loss on data integrity. Supplier of the MMS Data Acquisition Servers shall describe in their proposed design how this is to be addressed.

4.2.4 MMS Data Acquisition Server shall allow archiving the data over a period of at least five years using HDD / SSD (hard disk drive / solid state drive) hybrid as the long term media storage device. Retrieving / analyzing stored data, and the execution of backups, shall be easily done without interrupting the current data acquisition.

4.2.5 The MMS asset condition monitoring software shall be responsible for managing data acquisition and storage from critical rotating machines and carry out monitoring and event diagnostics. This software shall communicate with:

- Machinery Protection System (MPS) of PACKAGED UNITS (supplied by others) as specified in item 4.5;
- MMS Protection and Acquisition Panel (PAP) as specified in item 4.4 below;
- MMS Workstation, as specified in item 4.3;



- Up to 5 (five) simultaneous remote clients, connected through the GIOP Firewall (only the licenses to be provided by supplier of the MMS Server Panel);
- CSS-PCS and CSS-HCS.

4.2.6 MMS switches shall have enough ports available to establish direct communication with MMS Servers, Protection and Acquisition Panel (PAP), MMS Workstation and every MPS to be monitored. MMS Server Panel supplier shall be responsible for the adequate sizing of its system, including switches, servers and software licenses, evaluating the monitored projects of PACKAGED UNITS during detailing phase, noting that a PACKAGED UNIT may have more than one MPS.

4.2.7 MMS shall support full data monitoring as well as transient and dynamic data analysis plots and trending. The data acquisition while a machine is being started or stopped must be done at a higher rate to allow significant insight into the rotor and structural dynamics. Time stamping of data, alarms and events must have a resolution of one millisecond.

4.2.8 MMS shall acquire the following process variables via OPC UA:

Table 1- Process variables that shall be made available via OPC UA for each monitored equipment.

PUMPS	GAS COMPRESSORS	GAS TURBINES	ELECTRIC MOTORS AND GENERATORS
Suction Pressure	Lube oil return temperature for each bearing	Inlet Air pressure drop	Apparent electric power
Discharge Pressure	Suction pressure for each stage	Exhaust duct pressure drop	Active electric power
Lubrication Oil Pressure	Suction temperature for each stage	Inlet Air temperature	Reactive Electric power
Lubrication Oil Temperature	Discharge pressure for each stage	Air compressor discharge Pressure	Electric current
Pump Individual flow	Discharge temperature for each stage	Air compressor discharge Temperature	
	Orifice plate flow differential pressure for each stage	Fuel gas flow orifice plate differential pressure	
	Anti-surge valve opening for each stage	Fuel gas pressure	
		Gas Generator speed	

4.2.9 The MMS Server Panel will collect data from two types of PACKAGED UNITS, as described in the Technical Specification I-ET-3010.00-1200-800-P4X-002-AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGED UNITS:

- P0 Type PACKAGED UNIT has no dedicated Unit Control Panel and the control and safety functions, where required, are being performed by UNIT's Control and Safety System (CSS). The vibration and temperature monitoring for those types of equipment shall be integrated in the PAP as specified in item 4.4.
- P2 Type PACKAGED UNIT has its own Machinery Protection System, installed in the PAS Unit Control Panel, as described in item 4.5.

#### 4.2.10 Data Acquisition Servers (DAS)

4.2.10.1 DATABASE architecture for the MMS shall be centralized.

4.2.10.2 Server cabinet shall be:

- Appropriate to house computers CPUs, Ethernet switches and network accessories;
- Composed of 2 (two) sub-sections for better panel organization: one sub-section shall house the Ethernet switches and the other sub-section shall house the computers.

4.2.10.3 Minimum characteristics of server cabinet:

- Vertically subdivided into 1.75 inches (u), totalizing 42u, with labeled "u" positions;
- Dimensions: Height 2,000 mm, Length 800 mm (19 inches internally), Width 800 mm;
- Rapid rail;
- Perforated door;
- Locking doors and side panels;
- Support approximately 900 kg capacity;
- Forced air ventilation;
- Split rear doors;
- Leveling feet;
- Open bottom.

#### 4.2.11 Minimum Hardware Requirements:

4.2.11.1 The Server shall be supplied as an industrial computer for use in offshore environment. Supplier of the MMS Server Panels shall provide 3-year on-site warranty. Use of refurbished, used or economy-line equipment is forbidden.

4.2.11.2 Panels that house DAS shall be supplied with built-in rack console (1u), composed of retractable monitor, keyboard, mouse and an 1u console switch (or kvm) in order to allow its configuration and maintenance. The computer CPUs and the above mentioned video monitor, keyboard and mouse shall be connected to the internal console switch.

4.2.11.3 The retractable video monitor shall be 15" with a minimum of 1280×1024 resolution.

4.2.11.4 The internal keyboard shall be USB 104-key ABNT-2.

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4.2.11.5 The retractable monitor, keyboard and mouse shall be ergonomically placed in order to allow their use by a person in standing position (typically with keyboard 1.3 m above floor).

4.2.11.6 Cabinets shall have internal shock absorbers to protect the hard disks from balance movements and vibration.

4.2.11.7 The Server shall have 01 (one) CD/DVD-R unit, USB interfaces, and at least 04 (four) Gigabit Ethernet network interface ports.

4.2.11.8 The Server shall be powered by essential 220 VAC external source.

4.2.11.9 Processor type, hard disk or SSD type/space and memory shall be according to the use of the necessary software in its maximum performance configuration. Supplier of the MMS Server Panel shall be responsible for the adequate memory sizing. Hard disks / SSDs shall be sized adequately to store system data (such as log files). The memory sizing shall take into account the requirements of MMS. Hard drives shall be redundant, capable of recover from failure of 1 disk.

4.2.11.10 All hardware shall be of the most recent model at purchase time.

#### 4.2.12 Minimum Software Requirements:

4.2.12.1 Operating System: Microsoft ® Windows Server or its equivalent at most recent certified version at purchase time.

4.2.12.2 Microsoft ® Office at most recent certified version at purchase time.

4.2.12.3 Network security mechanisms (firewall, antivirus, etc) for server.

4.2.12.4 The MMS supervisory software shall be native OPC UA Client and OPC UA Server.

4.2.12.5 All software shall be furnished in their most recent versions at purchase time, accompanied by their corresponding licensing, installation media(s) and manuals, as well as with one year (after TAP) of technical support and maintenance.

#### 4.3 MMS Workstation

4.3.1 The MMS Workstation shall be provided with required software to perform, at least, analysis of the following parameters:

- Mechanical: all machinery protection system signals (with possibility to make analysis like FFT, full spectrum, Bode plot, waterfall diagram, shaft average center line, orbit, X-Y plot and experience-based vibration analysis) and auxiliary system signals (lube, seal, etc.);

#### 4.3.2 Minimum Hardware Requirements:

- 4.3.2.1 The Workstation shall be supplied as an industrial Microcomputer for use in offshore environmental conditions with 1 (one) 21" LCD video monitor, ABNT2 Keyboard and Mouse (both wired) and Gigabit Ethernet network interface card. Processor type, SSD (Solid State Drive) type/space and memory shall be according to the use of the necessary software in its maximum performance configuration. Supplier of the MMS Workstation shall provide a 3-year on-site warranty. Use of refurbished, used or economy-line equipment is forbidden.
- 4.3.2.2 The Workstation shall have 01 (one) CD/DVD-R unit, USB interfaces, at least 02 (two) Gigabit Ethernet network interface ports.
- 4.3.2.3 The Workstation shall be powered by essential 220 VAC external source.
- 4.3.2.4 Supplier of the MMS Workstation shall be responsible for the adequate memory sizing. SSDs shall be sized adequately to store system data. The memory sizing shall take into account the requirements of MMS.
- 4.3.2.5 All hardware shall be of the most recent model at purchase time.

#### 4.3.3 Minimum Software Requirements:

- 4.3.3.1 Operating System: Microsoft ® Windows Professional or its equivalent at the last certified version at purchase time.
- 4.3.3.2 Microsoft ® Office or its equivalent at the last certified version at purchase time.
- 4.3.3.3 Network security mechanisms (firewall, antivirus, etc) for the workstation.

#### 4.4 MMS Protection and Acquisition Panel (PAP)

4.4.1 MMS Protection and Acquisition Panel shall house any hardware needed for protection and / or data acquisition of vibration and bearing temperature of equipment that are not being supplied with Machinery Protection Systems.

4.4.2 The following P0 type PACKAGED UNITS shall be integrated in MMS System, unless the MANUFACTURER indicates that there are no vibration sensors (see item 4.4.4):

- Sea Water Lift Pumps;
- Cooling Water Circulation Pump - Classified Area;
- Booster Injection Water Pumps;
- Butterworth Pump;
- Pump Room Stripping Pump;
- Ballast Pump;
- Emergency Sea Water Lift Pump;
- Slop Tank Water Pump.

4.4.3 P0 type PACKAGED UNITS will be provided with temperature and vibration sensors and transducers as defined in the project's CENTRIFUGAL PUMPS SPECIFICATION document.

Sensors type, position and quantities indicated in the above mentioned Technical Specification are the minimum requirement and should be confirmed by pump MANUFACTURER during project detailing phase. Supplier of the PAP shall evaluate the projects of all PACKAGED UNITS, being responsible for properly dimensioning MMS to monitor all the available points, and provide shutdown signals for the pumps with vibration trip indicated.

The sensors of the pumps for which the MANUFACTURER indicates the need of vibration trip shall be forwarded to a Machine Protection System at PAP, which will monitor the variables and be responsible for the shutdown. MMS will monitor this MPS, in the same way as the MPS from P2 PACKAGED UNITS as described in item 4.5.

The sensors of the pumps for which the MANUFACTURER do not indicates the need of vibration trip shall be forwarded to a Dynamic Acquisition Module at PAP, which will monitor the variables (acquiring dynamic waveforms) without been responsible for the shutdown. MMS will monitor this DAM, in the same way as the MPS from P2 PACKAGED UNITS as described in item 4.5.

4.4.4 If, during project detailing phase, the pump MANUFACTURER indicates that there are no vibration sensors installed at a pump, this machine's other sensors (e.g. temperature) shall be connected to the CSS, and the equipment not be integrated in MMS.

4.4.5 Process variables and data related to winding temperature of electrical motors related to those pumps shall be acquired, via Gigabit Ethernet TCP/IP connection (OPC UA), from the Supervisory and Operation System Data Acquisition LAN (see Table 1).

4.4.6 All variables acquired by MMS shall be available to SOS via Gigabit Ethernet TCP/IP connection (OPC UA) through the CSS – HULL / TOPSIDE DATA ACQUISITION LAN. For more information on how MMS information will be displayed on the SOS see I-ET-3010.00-5520-800-P4X-001 - SUPERVISION AND OPERATION SYSTEM (SOS) SCREENS.

#### 4.5 Machinery Protection System (MPS)

4.5.1 The Machinery Protection System (which consist of sensors, transducers and monitor) MPS of P2 type critical rotating machine are included in the scope of work of PACKAGER and will be installed in the Control Panel of the PACKAGED UNIT.

4.5.2 Supplier of the MMS Server Panel shall evaluate all projects of PACKAGED UNITS, being responsible for properly dimensioning MMS to monitor all the available points in all the MPS of all the PACKAGED UNITS listed in this item. All the vibration and displacement variables shall be collected and stored as dynamic data (waveforms). Variables associated with phase or rotation sensors

shall be configured to have its acquisition rate increased during machine speed transients. The following equipment shall have the MPS Monitors integrated in MMS System:

- Main Injection Water Pumps;
- Main Turbogenerator Units;
- Vapor Recovery Units;
- Main Gas Compression Units ;
- Exportation Gas Compression Units;
- Injection Gas Compression Units;
- Dewpoint Compressor;
- CO2 Compression Units;
- FGRU Compressor;
- GDU Blower;
- SRU booster pump;
- Pumps monitored and/or tripped by CSS / PAP

4.6 Process variables from PLCs of PACKAGED UNITS and data related to winding temperature of electrical motors and generators (see Table 1), as well as other electrical data will be available for MMS, from the HULL / TOPSIDE PACKAGE UNITS LAN by means of one Gigabit Ethernet TCP/IP connection (OPC UA). For further detail see the project's AUTOMATION AND CONTROL ARCHITECTURE drawing.

#### 4.7 Communication

4.7.1 All Panels will be installed indoors, in the same ambience and interconnections shall be done by means of twisted pair cable.

4.7.2 In order to connect the MPS to the MMS, the following interfaces are required:

4.7.2.1 For P0 type PACKAGED UNITS, the rotating machines will be provided with vibration and temperature sensors/transducer connected to junction boxes installed at field. Cables from the junction box to the PAP will connect the sensor signals to their respective MPS or DAM in the MMS Protection and Acquisition Panel.

4.7.2.2 For P2 type PACKAGED UNITS, the MPS are furnished with communication resource and shall be connected to MMS Server Panel through dedicated MMS protocol.

#### 4.8 General Requirements

4.8.1 Cabinet mechanical characteristic shall follow I-ET-3010.00-1200-800-P4X-002 - AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGED UNITS.

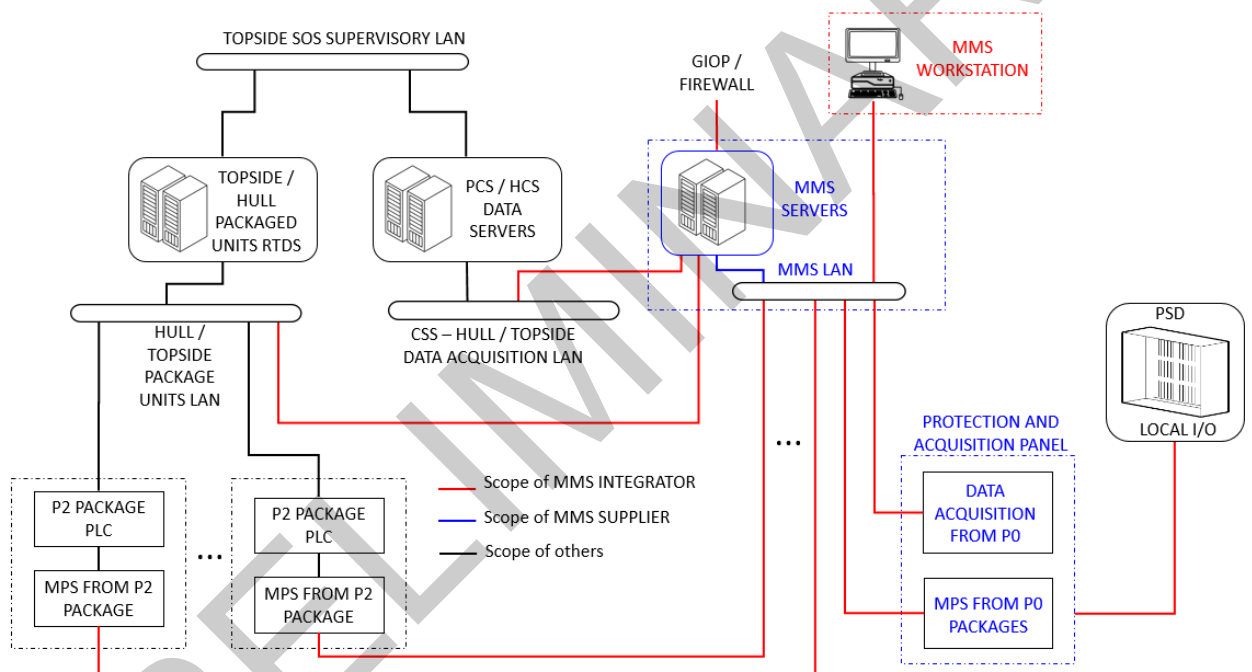
4.8.2 All equipment having electronic components or circuits shall be immune to electro-magnetic and radiofrequency (EMI-RFI) interference according to IEC 60533.

4.8.3 All equipment shall operate without loss of reliability, availability or performance within a voltage variation of 10% above or below rated voltage.

4.8.4 All materials and equipment with mechanical protection shall have test certificates issued by an authorized and duly identified laboratory.

4.8.5 Two (2) 220 VAC (HOLD) power supplies will be provided from the essential control panels distribution panel 220V. All suppliers shall be responsible for converting and distributing the different power supplies within MMS devices, including, where necessary, a AC/DC stabilized power supply unit for cabinet internal distribution of the 24 VDC.

#### 4.9 MMS Automation Diagram



## 5 DOCUMENTATION

5.1 Complete documentation of the MMS covering all devices, softwares and services shall be supplied with the proposal for approval and for final acceptance.

5.2 There shall be supplied with the proposal, in the number of copies defined at PURCHASER's documents, at least the following technical documents:

- Technical specifications, comprising: system, equipment, accessories, cables, materials and software;
- Design calculation reports;
- Data-sheets and drawings of all equipment;
- Installation drawings including general arrangement, detailed lay-out, electrical diagrams, wiring diagrams, cable list, material list, equipment list and interconnection diagrams;
- Test procedures, training course program, services schedule;
- Programming tools and manuals, system reports, system diagnosis, etc.

- 5.3 It shall be provided detailed information regarding the asset condition monitoring software for technical evaluation. A list of all capability items shall be provided with diagnosis description for technical evaluation.
- 5.4 Complete MMS certified documentation, including operation manual, installation manual and maintenance manual shall be provided, in the number of digital media (DVD-ROMs or USB flash drive) copies requested at Bid documents, including all programming and configurations tools.
- 5.5 MMS SUPPLIER shall provide all keys, drivers, manuals and licenses of all software inside scope of MMS. No software access restrictions will be accepted by PETROBRAS.

## 6 ACCEPTANCE TESTS

- 6.1 The following tests, besides the tests required at I-ET-3010.00-1200-800-P4X-002 – AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGED UNITS, where applicable, shall be performed at supplier installations (FAT) prior to delivery:
  - Input and output signal verification;
  - Communication within panels.
- 6.2 MMS SUPPLIER shall provide a Design Calculation Report demonstrating that the system will perform adequately under various conditions of ventilation, covering all possible severe operation conditions of the UNIT. This document shall be submitted to and approved by PETROBRAS.
- 6.3 SIT shall be executed with the MMS interconnected with the CSS LANs, MPS of PACKAGED UNITS and field sensors.
- 6.4 MMS SUPPLIER shall submit to PETROBRAS, for approval, detailed FAT, SAT and SIT programs.

## 7 TRAINING

- 7.1 MMS SUPPLIER shall provide training to qualify technicians indicated by PETROBRAS to operate and maintain (install, dismantle, replace parts, make adjustments, etc.) each piece of equipment. The training shall encompass all items necessary to its understanding.
- 7.2 The training shall be performed at the construction yard or another onshore facility, after completion of the FAT and prior to PETROBRAS approval of the UNIT's Acceptance Term.
- 7.3 MMS SUPPLIER shall provide all documentation and materials required for the training program (including the latest revision of the as built documentation, brochures, booklets, material for presentations, transparencies, etc.).



- 7.4 The training program shall encompass all operation and maintenance aspects. All trainees will be operation and maintenance professionals. The participants shall be awarded certificates after the completion of the training course.
- 7.5 The training course shall be delivered in Brazilian Portuguese for at least 10 technicians (indicated by PETROBRAS) per training module (see item 7.5) and shall be performed using identical equipment as supplied.
- 7.6 MMS SUPPLIER shall take full responsibility for the professionals teaching the training course, including for their transportation and lodging.
- 7.7 MMS SUPPLIER shall submit the detailed training program for approval.
- 7.8 MMS SUPPLIER shall provide 2 (two) copies of the Brazilian Portuguese training course in digital media (DVD-ROMs or USB flash drive).
- 7.9 The training plan shall cover, at least, the following items:
- Complete description of equipment;
  - Technical and operational characteristics;
  - Operating principles;
  - Operating cautions;
  - Aspects of construction;
  - Operating procedures and routines;
  - Identification of operational problems and possible causes (troubleshooting);
  - Preventive maintenance routines;
  - Signaling and warning devices;
  - Protection and adjustment;
  - Presentation of drawings and diagrams.
- 7.10 MMS SUPPLIER shall provide training services considering the number of technicians indicated in item 7.5 and the topics listed in item 7.9, where applicable, for the following training program modules:
- Instrumentation – Fundamentals of Vibration and Transducers (16h duration);
  - Mechanics – Operation and Maintenance of Asset Condition Monitoring Software (24h duration);
  - Mechanics – Machine Diagnostics (40h duration);
  - Mechanics – Fundamentals of Machine and Applied Diagnosis (24h duration);
  - Operation – Basics of MMS (16h duration).
- 7.11 MMS SUPPLIER shall consider, for quotation, the number of 03 (three) classes per each specific training module.
- 7.12 For the cases in which there is more than one MMS SUPPLIER, there will be as many MMS Workstations as the number of suppliers and the technical specifications presented in this document shall apply to each workstation.

## 8 WARRANTY

- 8.1 Warranty shall be provided for all MMS components, even for equipment or device furnished by others, for up to 24 (twenty four) months from delivery or 12 (twelve) month operation, whichever occurs later.
- 8.2 This warranty shall cover fabrication or installation problems, as well as any service included in the scope of supply.
- 8.3 Furnisher shall warranty the supply of spare parts, at least, for up to 10 years after the acceptance test date, and technical assistance at installation site performed by qualified and certified maintenance staff, when requested.
- 8.4 During warranty period, any defective part shall be changed for a new one, within one week, after the problem report by PETROBRAS.

## 9 PACKING REQUIREMENTS

- 9.1 On completion of FAT all equipment shall be prepared for shipment and storage.
- 9.2 Equipment supplied loose shall be packed and crated for transport. In addition, if some rack equipment is susceptible to transport damage, it shall be removed from the system rack for separate packing and crating.
- 9.3 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 later shall be used only in cases where VCI is not applicable. Both VCI and desiccants must not be used together for protecting the same compartment.

## 10 SCOPE OF SUPPLY

- 10.1 There may be more than one MMS SUPPLIER (different P2 type PACKAGED UNITS may have MPS from different MANUFACTURERS). In this case, there will be as many MMS Server Panels as the number of MANUFACTURERS and the technical specifications presented in this document shall apply to each panel.
- 10.2 Each MMS SUPPLIER is responsible for providing its own MMS Server Panel and defining the communication protocol that will be established between the Server Panel and the MPS of the P2 type PACKAGED UNIT.
- 10.3 The MMS INTEGRATOR is responsible for supplying the MMS Workstation.
- 10.4 Each MMS SUPPLIER shall provide its own software and licenses in order to be installed at the MMS Workstation.
- 10.5 The MMS INTEGRATOR is responsible for installing the software provided by each MMS SUPPLIER on the MMS Workstation.

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- 10.6 One of the MMS SUPPLIERS will supply the PAP, along with its internal MPSs and DAMs. The MMS Server Panel of this MMS SUPPLIER is the only one to establish communication with the PAP. This may be done using proprietary protocol.
- 10.7 Switches of panels shall be supplied by panel suppliers.
- 10.8 The MMS INTEGRATOR shall provide the cables for network connections between:
- MMS Workstation and the MMS Server Panels;
  - MMS Server Panel of the chosen MMS SUPPLIER and PAP;
  - MMS Server Panels and P2 type PACKAGED UNIT's MPSs of the same MANUFACTURER;
  - MMS Server Panels and CSS-HULL DATA ACQUISITION LAN switches;
  - MMS Server Panels and CSS-TOPSIDE DATA ACQUISITION LAN switches;
  - MMS Server Panels and HULL PACKAGE UNIT LAN switches;
  - MMS Server Panels and TOPSIDE PACKAGE UNIT LAN switches;
  - MMS Server Panels to Automation Firewall (for connection to GIOp).
- 10.9 The MMS INTEGRATOR shall provide cables for connections between:
- PAP (MPS from P0 type PACKAGED UNITS) and PSD Local I/O;
  - PAP Local I/O and junction boxes of P0 type field equipment.
- 10.10 In order to connect the MPS to the MMS, for P0 type PACKAGED UNITS, PURCHASER shall provide the cable specification for field instrument interconnection to the PAP. These cables will be supplied by MMS INTEGRATOR in accordance with provided cable specification. The scope of MMS SUPPLIER stops at the communication port of the MPS and DAM located in the PAP. The scope of MMS INTEGRATOR is from the I/O in the PAP up to the junction boxes installed at field.
- 10.11 In order to connect the MPS to the MMS, for P2 type PACKAGED UNITS, the MMS SUPPLIER shall define the dedicated MMS protocol. The scope of MMS SUPPLIER is up to the communication port of the protection rack for type P2 PACKAGED UNITS.
- 10.12 Any other interface required to connect the MPS up to MMS that was not covered by items 10.10 and/or 10.11 shall be engineered and supplied by MMS INTEGRATOR, in accordance with PURCHASER recommendation.
- 10.13 The MMS SUPPLIER shall furnish all devices that are necessary for the system, such as intrinsic safety barriers, terminal blocks, spare parts set etc.

## 11 SCOPE OF SERVICE

- 11.1 Any discrepancy observed by MMS SUPPLIER between specification documents shall be informed to PURCHASER and MMS INTEGRATOR. MMS SUPPLIER shall not proceed with any such aspect of the work until receiving an answer from the PURCHASER on how to proceed.
- 11.2 Any discrepancy observed by MMS INTEGRATOR between specification documents shall be informed to PURCHASER. MMS INTEGRATOR shall not proceed with any such aspect of the work until receiving an answer from the PURCHASER on how to proceed.
- 11.3 PURCHASER is responsible for ensuring that the product was received according to documentation provided by MMS SUPPLIER and specified by PETROBRAS. MMS SUPPLIER is responsible for correcting any documentation according to supplied product in case of discrepancies.
- 11.4 MMS INTEGRATOR is responsible for ensuring that the product was received according to documentation provided by VENDOR and specified by PETROBRAS. VENDOR is responsible for correcting any documentation according to supplied product in case of discrepancies.
- 11.5 PURCHASER is responsible for ensuring that the product was received according to documentation provided by MMS INTEGRATOR and specified by PETROBRAS. MMS INTEGRATOR is responsible for correcting any documentation according to supplied product in case of discrepancies.
- 11.6 MMS SUPPLIER shall provide all system design, implementation and configuration services required for the MMS proper operation, including full support for equipment, connectivity, configuration, advanced diagnostics interpretation support etc.