PETROBRAS	**TECHNICAL SPECIFICATION**	**Nº :** I-ET-3010.1M-1200-800-P4X-005	
	CLIENT: SUP		**SHEET:** 1 of 35
	JOB: REFERENCE BASIC DESIGN		1001056398 0010
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DP&T-SUP	**TITLE:** **FIELD INSTRUMENTATION**		NP-1
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1 INTRODUCTION

1.1 Object

1.1.1 This technical specification, along with I-ET-3010.00-1200-800-P4X-013 – GENERAL CRITERIA FOR INSTRUMENTATION DESIGN, defines the minimum requirements for the field instrumentation to be used in Offshore units.

1.1.2 For equipment and instruments related to Flow metering system, the following documents shall also be consulted: I-ET-3010.00-1200-813-P4X-001 - GENERAL CRITERIA FOR FLOW METERING SYSTEMS, I-ET-3010.1M-1200-800-P4X-003 - FLOW METERING SYSTEM – TOPSIDES, I-ET-3010.1M-1200-800-P4X-008 - FLOW METERING SYSTEM – HULL (HOLD).

1.1.3 The use of instrument types which are not covered herein shall be submitted to PETROBRAS approval.

1.2 Definitions

UNIT	FPSO (Floating, Production, Storage and Offloading), FSO (Floating, Storage and Offloading), SS (Semi-Submersible) or Fixed Offshore Unit.
PACKAGE	An assembly of equipment supplied interconnected, tested and operating, requiring only the available utilities from the UNIT for the PACKAGE operation.
PACKAGER	The responsible for project assembly, construction, fabrication, test and furnishing of the PACKAGE.
MANUFACTURER	The responsible for fabrication of equipment or components internal to the PACKAGE.
MODULE	The metallic structure suitable for lift and transport, where PACKAGES and equipment will be installed, being supplied completely mounted and precommissioned.
MODULE SUPPLIER	The responsible for project assembly, erection, construction, fabrication, test and furnishing of the MODULE.
BIDDER	The responsible for the lift, hook up, installation and integration of all MODULES on the UNIT Hull.

1.3 Abbreviations

ADV	Automatic Deluge Valve
AEPR	Automation & Electrical Panels Room
AFDS	Addressable Fire Detection System
ALARM	Alarm Management System

AMS	Asset Management System
BDV	Blowdown Valve
BS&W	Basic Sediments & Water
CCR	Central Control Room (located in the Hull Accommodation)
CCTV	Closed Circuit Television
CSS	Control and Safety System
CLOTS	Control Loops Tuning Optimization and Tunning System
CMS	Corrosion Monitoring System
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
FAT	Factory Acceptance Test
FGRS	Flare Gas Recovery System
FGS	Fire and Gas System
FMS	Flow Metering System
FO	Restriction Orifice
FRP	Fiber Reinforced Plastic
HART	Highway Addressable Remote Transducer
HMI	Human-Machine Interface
IP	Ingress Protection Ratings
IR	Infrared
LCF	Lista Contratual de Fornecedores (vendor list)
LEL	Lower Explosive Limit
MCT	Multi Cable Transit
OD	Outside Diameter
PCS	Process Control System
P&ID	Piping and Instrument Diagram
PSD	Process Shutdown System
PSV	Safety Relief Valve
RFI	Radio Frequency Interference
RTM	ANP/INMETRO Technical Regulation of Measurement of Oil and Gas
SAT	Site Acceptance Test
SIT	Site Integration Test
SDV	Shutdown Valve
SPDT	Single Pole, Double Throw
SOS	Supervision and Operation System
TOG	Total Oil and Grease
USEPA	United States Environmental Protection Agency
VMS	Flexible Riser Visual Monitoring System
WAG	Water Alternanting Gas
UV	Ultraviolet
UV-Vis	Ultraviolet-Visible
XV	ON-OFF Valve

2 REFERENCE DOCUMENTS, CODES AND STANDARDS

2.1 External References

2.1.1 International Codes, Recommended Practices and Standards

API - AMERICAN PETROLEUM INSTITUTE

API	MPMS	MANUAL OF PETROLEUM MEASUREMENT STANDARDS - ALL PARTS
API	RP 6FA	FIRE TEST FOR VALVES
API	RP 14C	RP FOR ANALYSIS, DESIGN, INSTALLATION AND TESTING OF BASIC SURFACE SAFETY SYSTEMS FOR OFFSHORE PRODUCTION PLATFORMS
API	RP 14G	RP FOR FIRE PREVENTION AND CONTROL ON OPEN TYPE OFFSHORE PRODUCTION PLATFORMS
API	RP 55	RECOMMENDED PRACTICES FOR OIL AND GAS PRODUCING AND GAS PROCESSING PLANT OPERATIONS INVOLVING HYDROGEN SULFIDE
API	RP 520-I	SIZING, SELECTION AND INSTALLATION OF PRESSURE-RELIEVING DEVICES IN REFINERIES - PART I - SIZING AND SELECTION
API	RP 520-II	SIZING, SELECTION, AND INSTALLATION OF PRESSURE - RELIEVING DEVICES IN REFINERIES, PART II - INSTALLATION
API	RP 551	PROCESS MEASUREMENT INSTRUMENTATION
API	RP 552	TRANSMISSION SYSTEMS
API	RP 554	PROCESS INSTRUMENTATION AND CONTROL - ALL PARTS
API	RP 555	PROCESS ANALYZERS
API	STD 526	FLANGED STEEL PRESSURE RELIEF VALVES
API	STD 527	SEAT TIGHTNESS OF PRESSURE RELIEF VALVES
API	STD 598	VALVE INSPECTION AND TESTING
API	STD 607	FIRE TEST FOR SOFT SEATED BALL VALVES

ASME - AMERICAN SOCIETY OF MECHANICAL ENGINEERS

ASME	SECTION VIII	DIVISION I
ASME	PTC	19.3 TW

ASTM – AMERICAN SOCIETY FOR TESTING AND MATERIALS

ASTM D 1142/95	STANDARD TEST METHOD FOR WATER VAPOR CONTENT OF GASEOUS FUELS BY MEASUREMENT OF DEW-POINT TEMPERATURE
ASTM F 1273	STANDARD SPECIFICATION FOR TANK VENT FLAME ARRESTERS

IEC - INTERNATIONAL ELECTROTECHNICAL COMMISSION

IEC	60068	ENVIRONMENTAL TESTING. GENERAL AND GUINDANCE
IEC	60079	ELECTRICAL APPARATUS FOR EXPLOSIVE GAS ATMOSPHERES - ALL PARTS

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: AUTOMATION, CONTROL AND INSTRUMENTATION
IEC	60331	TESTS FOR ELECTRIC CABLES UNDER FIRE CONDITIONS - CIRCUIT INTEGRITY – ALL PARTS
IEC	60529	DEGREES OF PROTECTION PROVIDED BY ENCLOSURES (IP CODE)
IEC	60533	ELECTRICAL AND ELECTRONIC INSTALLATIONS IN SHIPS - ELECTROMAGNETIC COMPATIBILITY
IEC	60945	MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS – GENERAL REQUIREMENTS – METHODS OF TESTING AND REQUIRED TEST RESULTS
IEC	61000	ELECTROMAGNETIC COMPATIBILITY (EMC) SERIES - ALL PARTS
IEC	61892-7	MOBILE AND FIXED OFFSHORE UNITS - ELECTRICAL INSTALLATIONS - PART 7: HAZARDOUS AREA
IEC	62337	COMMISSIONING OF ELECTRICAL, INSTRUMENTATION AND CONTROL SYSTEMS IN THE PROCESS INDUSTRY – SPECIFIC PHASES AND MILESTONES
IEC	62381	AUTOMATION SYSTEMS IN THE PROCESS INDUSTRY- FACTORY ACCEPTANCE TEST (FAT), SITE ACCEPTANCE TEST (SAT) AND SITE INTEGRATION TEST (SIT)
IEC	62382	ELECTRICAL AND INSTRUMENTATION LOOP CHECK

ISA - INTERNATIONAL SOCIETY OF AUTOMATION

ISA	RP 42.00.01	NOMENCLATURE FOR INSTRUMENT TUBE FITTINGS
ISA	TR 20.00.01	SPECIFICATION FORMS FOR PROCESS MEASUREMENT AND CONTROL INSTRUMENTS - PART 1: GENERAL CONSIDERATIONS UPDATED WITH 27 NEW SPECIFICATION FORMS
ISA	5.1-1992	INSTRUMENTATION SYMBOLS AND IDENTIFICATION
ISA	18.1	ANNUNCIATOR SEQUENCES AND SPECIFICATIONS
ISA	20	SPECIFICATION FORMS FOR PROCESS MEASUREMENT AND CONTROL INSTRUMENTS, PRIMARY ELEMENTS, AND CONTROL VALVES

ISA	51.1	PROCESS INSTRUMENTATION TERMINOLOGY
ISA	75.01.01	FLOW EQUATIONS FOR SIZING CONTROL VALVES
ISA	75.05.01	CONTROL VALVE TERMINOLOGY
ISA	75.17	CONTROL VALVE AERODYNAMIC NOISE PREDICTION
ISA	92.0.01	PERFORMANCE REQUIREMENTS FOR TOXIC GAS DETECTION INSTRUMENTS: HYDROGEN SULFIDE
ISA	92.0.02	INSTALLATION, OPERATION, AND MAINTENANCE OF TOXIC GAS-DETECTION INSTRUMENTS: HYDROGEN SULFIDE

ISO - INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO	5167-1	MEASUREMENT OF FLUID FLOW BY MEANS OF PRESSURE DIFFERENTIAL DEVICES INSERTED IN CIRCULAR CROSS-SECTION CONDUITS RUNNING FULL - PART 1: GENERAL PRINCIPLES AND REQUIREMENTS
ISO	5167-2	MEASUREMENT OF FLUID FLOW BY MEANS OF PRESSURE DIFFERENTIAL DEVICES INSERTED IN CIRCULAR CROSS-SECTION CONDUITS RUNNING FULL - PART 2: ORIFICE PLATES
ISO	10497	TESTING OF VALVES - FIRE TYPE-TESTING REQUIREMENTS
ISO	13702	PETROLEUM AND NATURAL GAS INDUSTRIES - OFFSHORE PRODUCTION INSTALLATIONS CONTROL AND MITIGATION OF FIRES AND EXPLOSIONS - REQUIREMENTS AND GUIDELINES
ISO	16852	FLAME ARRESTERS – PERFORMANCE REQUIREMENTS, TEST METHODS AND LIMITS FOR USE.
ISO	18453	NATURAL GAS - CORRELATION BETWEEN WATER CONTENT AND WATER DEW POINT
ISO	23251	PRESSURE-RELIEVING AND DEPRESSURING SYSTEMS

NACE - THE NATIONAL ASSOCIATION OF CORROSION ENGINEERS

NACE	MR0175 / ISO 15156 CIR 1 TO PT 3	PETROLEUM AND NATURAL GAS INDUSTRIES – MATERIALS FOR USE IN H2S – CONTAINING ENVIRONMENTS IN OIL AND GAS PRODUCTION – PART 3:CRACKING-RESISTANT CRAS(CORROSION-RESISTANT ALLOYS) AND OTHER ALLOYS TECHNICAL CIRCULAR 1 TO PART 3

NFPA - NATIONAL FIRE PROTECTION ASSOCIATION

NFPA	15	STANDARD FOR WATER SPRAY FIXED SYSTEMS FOR FIRE PROTECTION
NFPA	72	NATIONAL FIRE ALARM CODE

NFPA	496	STANDARD FOR PURGED AND PRESSURIZED ENCLOSURES FOR ELECTRICAL EQUIPMENT

OIML – ORGANISATION INTERNATIONALE DE MÉTROLOGIE LÉGALE

OIML	R117	MEASURING SYSTEMS FOR LIQUIDS OTHER THAN WATER

ANP - AGÊNCIA NACIONAL DO PETRÓLEO, GÁS NATURAL E BIOCOMBUSTÍVEIS

RESOLUÇÃO CONJUNTA ANP/INMETRO Nº1 (10/JUNHO/2013)	'RESOLUÇÃO CONJUNTA ANP-INMETRO Nº 1", ISSUED ON JUNE, 10th, 2013. NOTE: INCLUDES THE API, ISO, AGA, OIML ETC. STANDARDS MENTIONED IN THAT DOCUMENT.

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	13	CALDEIRAS E VASOS DE PRESSÃO
NR	26	SINALIZAÇÃO DE SEGURANÇA
NR	30	PLATAFORMAS E INSTALAÇÕES DE APOIO – ANEXO II

2.1.1 Classification Society

The detailed design shall be submitted to approval by Classification Society. The design and installation shall take into account their requirements and comments.

2.2 Internal References

2.2.1 PETROBRAS General Specifications

DR-ENGP-M-I-1.3-R.4 SAFETY ENGINEERING

I-ET-3010.1M-1200-200-P4X-001 – PIPING SPECIFICATION FOR TOPSIDE

I-ET-3010.1M-1200-200-P4X-002 – PIPING SPECIFICATION FOR HULL

I-ET-3000.00-1200-940-P4X-001 – TAGGING PROCEDURE FOR PRODUCTION UNITS DESIGN

I-ET-3010.1M-1200-800-P4X-001 – INSTRUMENTATION ADDITIONAL TECHNICAL REQUIREMENTS – TOPSIDES

I-ET-3010.1M-1200-800-P4X-006 – INSTRUMENTATION ADDITIONAL TECHNICAL REQUIREMENTS – HULL (HOLD)

I-ET-3010.1M-1200-800-P4X-003 - FLOW METERING SYSTEM – TOPSIDES

I-ET-3010.1M-1200-800-P4X-008 - FLOW METERING SYSTEM – HULL (HOLD)

I-DE-3010.1M-1200-944-P4X-001 – GENERAL NOTES

I-ET-3010.00-1200-800-P4X-013 – GENERAL CRITERIA FOR INSTRUMENTATION DESIGN

I-ET-3010.00-1200-956-P4X-006 – GENERAL PAINTING

I-ET-3010.00-5520-888-P4X-001 – CSS / SOS PANELS

I-ET-3010.00-5140-700-P4X-002 – SPECIFICATION FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS

I-FD-3010.1M-5400-947-P4X-001 – SAFETY DATA SHEET

NOTE: All P&IDs listed in I-LD-3010.1M-1200-940-P4X-002 – DOCUMENT LIST shall be considered as reference.

2.2.2 Order of Precedence

2.2.2.1 With regards to minimize doubts and conflicts among project documents, except where specific Codes and Regulations are more stringent, the order of precedence of technical documents shall be:

- This specification;
- Specifications I-ET-3010.00-1200-800-P4X-013 – GENERAL CRITERIA FOR INSTRUMENTATION DESIGN e I-ET-3010.00-1200-813-P4X-001 - GENERAL CRITERIA FOR FLOW METERING SYSTEMS;
- PETROBRAS General Specifications listed above (item 2.2.1);
- Other project documents listed on item above;
- Codes and Standards.

2.2.2.2 Any discrepancy between documents shall be informed to PETROBRAS. SUPPLIERS shall not proceed with any such aspect of the work until receiving PETROBRAS answer.

3 ENVIRONMENTAL AND OPERATION CONDITIONS

3.1 For operating and environmental conditions refer to I-ET-3010.1M-1200-800-P4X-001 – INSTRUMENTATION ADDITIONAL TECHNICAL REQUIREMENTS – TOPSIDES and I-ET-3010.1M-1200-800-P4X-006 – INSTRUMENTATION ADDITIONAL TECHNICAL REQUIREMENTS – HULL.

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

4 GENERAL REQUIREMENTS FOR THE INSTRUMENTATION SPECIFICATION

4.1 For field instruments and instrumentation accessories where painting is required I-ET-3010.00-1200-956-P4X-006 – GENERAL PAINTING shall be followed. The color of instruments and instrumentation accessories shall comply with the table below:

DEVICE	COLOR
Field Instruments	Follow the piping or equipment color
Instrument Supports	Follow the piping or equipment color
Instrument Air Piping	Internal area – White (following compartment color) External area – Ice Gray (following adjacent structure)
Actuators for instrumentation valve	Follow the valve color

4.2 Instruments of the same type and function shall be of the same manufacturer.

4.3 In general, field instruments shall be direct mounted. However, they shall be remote mounted in a tubular column or wall type support of 2 (two) inches, in the following cases:

- If high vibration is expected;
- Pressure instruments subjected to high temperature;
- Level instruments based on differential pressure;
- Flow instruments based on differential pressure;
- If instruments are not accessible for maintenance;
- When used for services where the process temperature exceeds +70°C or is below 0°C.

4.4 Inline instruments as flow instruments or valves subjected to high vibration shall have electronic components remotely mounted.

4.5 Instrument air-supply regulator filters shall be of coalescent type.

4.6 Solenoid valves shall not be used for diameter bigger than 1".

4.7 For air consumption calculation, in addition to item 6.1.3 of I-ET-3010.00-1200-800-P4X-013 – GENERAL CRITERIA FOR INSTRUMENTATION DESIGN, gastight dampers can be considered as intermittent consumers and, thus, do not need to be taken into account for air consumption calculation.

NOTE: It shall be considered dedicated air reservoirs for the remote panels, to keep

pressure for 30 minutes after ESD-3. The air consumption of these panels shall be taken into account in the design (HOLD).

4.8 The Instruments, valves, devices and materials shall be specified with appropriate materials for services with H_2S content so that the parts in contact with the fluid can resist to concentration in gas and oil according to Process Data. For the correct specification, shall be analyzed with special attention in order to define if they need to be resistant to H_2S. It shall take into account recommendations of the following standards, in the latest revisions:

- NACE STANDARD MR0175/ISO15156 CIR 1 TO PT 3– PETROLEUM AND NATURAL GAS INDUSTRIES – MATERIALS FOR USE IN H_2S – CONTAINING ENVIRONMENTS IN OIL AND GAS PRODUCTION - PART 3:CRACKING-RESISTANT CRAS(CORROSION-RESISTANT ALLOYS) AND OTHER ALLOYS TECHNICAL CIRCULAR 1 TO PART 3;
- API RP 55 – RECOMMENDED PRACTICES FOR OIL AND GAS PRODUCING AND GAS PROCESSING PLANT OPERATIONS INVOLVING HYDROGEN SULFIDE;
- API RP 551 – PROCESS MEASUREMENT INSTRUMENTATION.

4.9 Materials shall be selected on the basis of resistance to sulfide stress cracking and corrosion. Refer to Section 8, “Design and Construction Practices”: Appendix D for API RP 55, and NACE STANDARD MR0175/ISO15156 for recommendations for selection of equipment and materials.

4.10 Process connection shall not be used for supporting heavier instruments, including manifolds, diaphragm seals etc. In these cases, other means for supporting shall be in accordance with API RP 551 foreseen by Detail Design phase.

5 REQUIREMENTS FOR SPECIFICATION OF PRESSURE INSTRUMENTS

5.1 Manometers (Pressure Gauges)

5.1.1 Pressure gauges on steam service shall be provided with a siphon coil (pig tail type) connection. Pressure gauges on pulsating service measurements (such as discharge of reciprocating compressors, pumps etc.) shall be provided with a pulsation damper.

5.1.2 Block valve and vent valve shall be provided for impulse line installation or alternately, close-coupled AISI 316 stainless steel 2-valve manifold according API 551.

5.2 Pressure Transmitters

5.2.1 Pressure instruments in hot condensable gas, vapors and steam service shall be protected from process media by siphons coils or condensate seals.

5.2.2 Block valve and vent valve shall be provided for impulse line installation or alternately, close-coupled AISI 316 stainless steel 2-valve manifold according to API 551.

5.3 Differential Pressure Transmitters

5.3.1 Differential pressure transmitters shall be capable of withstanding full static pressure, on either port with, zero pressure on the other port, without damage or loss of calibration.

5.3.2 Differential pressure transmitters shall be provided with close-coupled AISI 316 stainless steel 5-valve manifold.

5.3.3 For connection of pressure instruments, see I-ET-3010.00-1200-800-P4X-013 – GENERAL CRITERIA FOR INSTRUMENTATION DESIGN.

5.4 Diaphragm Seals

5.4.1 The filling liquid chosen shall be compatible with the maximum process temperature.

5.4.2 Diaphragm seals shall be provided with a flushing ring between the process and the instrument connection to facilitate flushing with liquid from an external source, as per I-ET-3010.00-1200-800-P4X-013 – GENERAL CRITERIA FOR INSTRUMENTATION DESIGN. There shall have 2 (two) flushing connections ½" NPT(F) located on opposite sides of the ring and provided with isolation valves.

5.4.3 The type of capillary extension or sealing system legs (filling fluid, diameter etc.) shall minimize the influence of process and ambient temperature changes on the measurement. Response time of sealing systems shall be 5 s maximum.

5.4.4 Diaphragm seals shall be of the integral design. Where capillary extensions shall be used, the extension shall be AISI 316 stainless steel with AISI 316 stainless steel armoring and PVC covering. Capillary extensions shall be welded on both diaphragm seal and instrument sides. If required, provision shall be made to heat tracing the capillary extensions.

5.4.5 Care shall be taken in routing the capillary or sealing system legs to avoid effects of ambient temperature on the thermal expansion of the filling liquid. The capillary extension, if required, shall be provided with thermal insulation.

5.4.6 Diaphragm seals shall not be used on vacuum services.

5.4.7 Diaphragm seals shall be installed in a position avoiding deposit of dirty or debris on the seal surface.

5.5 Pressure Switches

5.5.1 Switch mechanisms, where applied, shall be dry snap acting micro type. Contacts

shall be SPDT (single pole, double throw) gold plated, 24 Vdc, 1 A rated. Mercury switches shall not be used.

5.5.2 The body and wetted parts materials shall be made of AISI 316 stainless steel.

6 REQUIREMENTS FOR SPECIFICATION OF TEMPERATURE INSTRUMENTS

6.1 General

6.1.1 Temperature transmitters requirements are described in document I-ET-3010.00-1200-800-P4X-013 – GENERAL CRITERIA FOR INSTRUMENTATION DESIGN.

6.1.2 The accuracy of temperature transmitters shall be ± 0.5 °C.

7 REQUIREMENTS FOR SPECIFICATION OF LEVEL INSTRUMENTS

7.1 General

7.1.1 The installation of level instruments shall not be susceptible to the accumulation of dirt in the surrounding of the meter/sensor.

7.1.2 Special contingency of blind-flanged internal level measurement process connections shall be provided for oil-water level interface measurement where required in the P&ID.

7.1.3 The use of stilling well is mandatory for top mounted internal level measurement. Precaution shall be taken into account for designing, fabrication and installation of the stilling well to avoid possible dirt built-up in and surrounding it.

7.1.4 For connection of level instruments, see I-ET-3010.00-1200-800-P4X-013 – GENERAL CRITERIA FOR INSTRUMENTATION DESIGN.

7.2 Level Gauge Indicators

7.2.1 Level gauges shall have adequate heating when operating with viscous product subject to solidification at environment temperature.

8 REQUIREMENTS FOR SPECIFICATION OF FLOW INSTRUMENTS

8.1 General

8.1.1 Technical requirements mentioned at I-ET-3010.00-1200-800-P4X-013 – GENERAL CRITERIA FOR INSTRUMENTATION DESIGN and I-ET-3010.00-1200-813-P4X-001 - GENERAL CRITERIA FOR FLOW METERING SYSTEMS shall also be taken into account.

8.2 Orifice Plate Measurements

8.2.1 Smart transmitters with 4 - 20 mA + HART output shall be used.

8.2.2 Multivariable sensors transmitters may be used in lieu of the 3 (three) smart transmitters.

8.2.3 Orifice plate calculations shall be performed according to ISO 5167 requirements.

8.2.4 The orifice plates shall be flange pressure measurement – flange taps.

8.2.5 Drain hole shall not be used on the orifice plates. The separation of the undesired fluid shall be done online or with a drain in the plate support device.

8.2.6 It shall assure that β factor shall be according to the requirements (see I-ET-3010.00-1200-813-P4X-001 - GENERAL CRITERIA FOR FLOW METERING SYSTEMS). If there is any divergence of these values, PETROBRAS shall be consulted.

8.2.7 Senior orifice fitting device shall be provided where indicated on P&IDs.

8.3 Meter Tubes (Straight Pipe Runs)

8.3.1 Meter tubes shall be mounted between flanges (spools), and tags shall be FX and FY, according to I-ET-3000.00-1200-940-P4X-001 – TAGGING PROCEDURE FOR PRODUCTION UNITS DESIGN.

8.3.2 Minimum straight upstream/downstream pipe runs length shall comply with, whichever is larger, manufacturer's recommendation, or:

- API MPMS 22.2 – for gas metering by V-cone meter;
- AGA-9 – for gas metering by ultrasonic flow meter;
- ISO 5167-1 and ISO 5167-2 – for gas metering by orifice plate;
- API MPMS 5.6 – for oil metering by Coriolis flow meter;
- API MPMS 5.8 – for oil metering by ultrasonic flow meter.

8.3.3 Shall be considered meter tubes mechanical characteristics such as line schedule, etc. (which shall comply with the requirements of appropriate pressure class, even after the process of machining and polishing to specify of internal roughness, etc.). These sections shall be provided next to the meters and attached with test certificates in compliance with ISO standard (internal roughness, etc.) in order to allow complete tracking.

8.3.4 A zanker flow conditioner shall be used in order to reduce requirements to the minimum straight length of the meter tube.

8.4 Positive Displacement Flow Meters

8.4.1 Oval Gears Positive Displacement flow meter can be used for liquids of high and low viscosity. The instrument selection shall take into account the manufacturer recommendation for maximum flow rate for continuous service and viscosity rate class. Your construction with special gears teeth profiles and special materials is suitable for viscous fluids containing hard solid impurities (sand, etc) up to 2 % and Ø1 mm.

8.4.2 Positive Displacement flow meters shall be configured for pulse signal output.

8.4.3 The Positive Displacement meter can be installed horizontally or vertically, but if mounted vertically should be with ascendant flow.

8.4.4 For use in low flow (chemical injection) shall be used positive displacement meter with gear and shall contain local LCD display, pulse or 4 - 20 mA + Hart output.

8.5 Mass (Coriolis) Flow Meters

8.5.1 Coriolis flow meters shall be configured for pulse signal output.

8.5.2 Coriolis meters may be installed either horizontally or vertically. The preferred installation is vertical with the flow up through the sensor and with the sensor at lowest point of the ascending pipe.

8.5.3 These meters shall not be used on liquid duties where cavitation or flashing may occur.

8.5.4 Mass flow meters also be used to provide density measurement from an additional output, but it shall be noted that this is not the primary function of the instrument and should be avoided. Density transmitters based on resonant principle shall be preferred. Density output shall be 4 - 20 mA + HART.

8.6 Electromagnetic Flow Meters

8.6.1 Electromagnetic flow meters may be used for water applications and for corrosive or low pressure drop services.

8.6.2 To avoid any risk of damage to meter lining by vacuum, electromagnetic flow meters shall not be installed on pump suction lines or downstream of shut off valves.

8.7 Ultrasonic Meters

8.7.1 Ultrasonic meters for liquid hydrocarbon applications shall take into account the maximum allowable viscosity and gas content in the liquid, as well as the fluid velocity.

8.7.2 Ultrasonic meters for oil metering applications shall not be used if the oil has high water contents (BS&W > 15 %).

8.7.3 Ultrasonic flow meters shall have pulse output.

8.8 V-Cone

8.8.1 The pressure taps shall be placed on the sides of the pipe in either the 3 (three) or the 9 (nine) o'clock position.

8.8.2 The minimum straight length upstream/downstream requirements shall be taken into account according to piping arrangements. These values shall be defined by flow meter MANUFACTURER.

9 CONTROL VALVES

9.1 General Requirements

9.1.1 Control Valve data sheets shall inform, for each valve, flow rate, pressure and temperature for all process conditions (normal, minimum and maximum), and all other fluid data required for valve calculations as: density, viscosity, molecular weight, specific heat ratio (Cp/Cv), compressibility factor, etc.

9.1.2 Control Valve manufacturers shall provide calculations sheets for each valve for all process conditions (normal, minimum and maximum), including actuator sizing, noise and flow speed at the valves.

9.1.3 The body type and construction for all valves to be installed at the FPSO shall comply with the requirements of I-ET-3010.1M-1200-200-P4X-001 – PIPING SPECIFICATION FOR TOPSIDE, I-ET-3010.1M-1200-200-P4X-002 – PIPING SPECIFICATION FOR HULL, and I-ET-3010.00-1200-800-P4X-013 – GENERAL CRITERIA FOR INSTRUMENTATION DESIGN.

9.2 Actuator

9.2.1 The actuator case housing shall be made of carbon or stainless steel.

9.2.2 The recommended valve actuator mounting position is vertical to the flow direction.

9.2.3 Actuator sizing shall take into account the largest pressure differential to which the valve is submitted.

9.2.4 The actuator shall be designed such that it will perform satisfactorily under the minimum air supply conditions for positioning during normal throttling control and maintaining the specified air failure position of the valve at the stated shut-off differential pressure. Electrical actuator may be considered for special conditions.

9.2.5 A mechanical pointer and scale type travel indicator, directly coupled to the actuator, shall be provided for local indication of valve travel. Permanent marks for full open and full closed positions shall be provided at the travel limits.

9.3 Positioners

9.3.1 Positioners shall be electro-pneumatic, smart type, with 4 - 20 mA + HART (2 wires, 24 VDC) electronic signal.

9.4 Accessories

9.4.1 Limit switches, if required, shall be of magnetic type (no moving parts).

9.5 Control Valves for Severe Service

9.5.1 Control valves for severe service shall be used according to the criteria described below:

- High differential pressure (pressure drop divided by inlet pressure > 0.5) in hydrocabon applications;
- Flashing and cavitation service;
- High level of noise and/or vibration;
- High rangeability (> 25:1).

9.5.2 Severe service valves shall have an inherent rangeability to handle both low and high flow rates. Typical rangeability is 25:1, although some applications require greater than 100:1.

10 CHOKE VALVES

10.1 Choke valves installed at main production lines, between production risers and production/test manifolds, at water injection lines and at gas injection lines shall be pneumatic actuated with position transmitter. The actuation shall be done from the Topsides SOS HMIs through hand operated controllers.

10.2 For actuation choke types, see I-ET-3010.00-1200-800-P4X-013 – GENERAL CRITERIA FOR INSTRUMENTATION DESIGN.

10.3 Other choke valves installed at the platform shall be field operated, without any indication at Topsides SOS HMIs.

10.4 For further details, see instrumentation diagram in the I-DE-3010.1M-1200-944-P4X-001 – GENERAL NOTES.

11 ON-OFF VALVES

11.1 General Requirements

11.1.1 Solenoid valve for on-off valve actuation shall be made of AISI 316 stainless steel and the power consumption shall be limited to 5 W per valve for the solenoids

connected to CSS I/O cards.

11.1.2 Limit switches shall be of magnetic type (no moving parts) and have visual valve position indication of the mechanical rotating type, with a transparent device protecting the movable part, open/close indication by means of different colors and inscriptions in black, able to be easily visualized the actual valve position from the lateral as well as from the top of the indication device. Also they shall permit set point adjustment without disassembling from the valve bodies.

11.1.3 All on-off valve actuators (SDV, BDV, ADV and XV) shall be made of steel.

11.1.4 In general, all valve actuators shall be pneumatic driven. Special cases shall be defined at project documents.

11.1.5 The body type and construction for all valves to be installed at the FPSO shall comply with the requirements of I-ET-3010.1M-1200-200-P4X-001 – PIPING SPECIFICATION FOR TOPSIDE, I-ET-3010.1M-1200-200-P4X-002 – PIPING SPECIFICATION FOR HULL, and I-ET-3010.00-1200-800-P4X-013 – GENERAL CRITERIA FOR INSTRUMENTATION DESIGN.

11.1.6 For all non-piggable ball blocked valves bigger than or equal to 10" rated 600# or higher, it shall also be considered the implementation alternative using a triple eccentric butterfly valve taking also into account that the pressure drop does not affect other process equipment.

11.1.7 Hydraulic circuits shall be used whenever the sizing results in actuators which are more than 2 m length.

11.2 Shutdown Valves (SDV)

11.2.1 SDV data sheets shall clearly inform the actuation time required. SDV manufacturer shall inform the actual actuation time for each valve, at operation conditions.

11.2.2 In general, actuation time for closing SDV ball or triple eccentric butterfly types is 1 (one) second per inch of the nominal size of the valve. Valve manufacturer shall inform the actual closing actuation time for proper valve application technical analysis.

11.2.3 The maximum stroke time allowed for any SDV actuation shall be 45 s.

11.3 Blowdown Valves (BDV)

11.3.1 Each BDV valve shall have 1 (one) air or hydraulic reservoir complying with NR-13 sized for 1 (one) valve operation in the minimum pressure of pneumatic specification or sized for 1 (one) valve operation in a complete cycle of opening/closing in the minimum pressure of hydraulic specification, and 2 (two) check valves in series to keep the BDV closed in case of failure of air supply or hydraulic supply.

11.3.2 The definition of capacity of hydraulic accumulators' banks shall be defined after sizing off all valves during the Detail Design phase.

11.3.3 Whenever necessary, a restriction orifice shall be provided, downstream from each BDV, to restrict the gas flow rate when the system is blown down. In this case, BDV data sheet shall clearly inform the differential pressure to be considered at the valve and for orifice dimensioning.

11.4 Automatic Deluge Valves (ADV)

11.4.1 All ADVs shall be supplied in individual skids, each skid comprised of the following items:

- 1 (one) ADV with actuator, with 2 (two) position limit switches for ADV status monitoring and 1 (one) quick exhaust device to minimize actuator venting time (this quick exhaust shall be furnished with the ADV actuator):
- 1 (one) by-pass valve;
- 1 (one) valve for drain and flushing connection.

NOTE 1: **Remote Manual Operation:** The opening of the deluge valves through the Topsides CSS/SOS HMIs shall be "energize to open" type so that the accidental loss of command does not inappropriately open the ADV, requering line monitoring. The opening command of the ADV shall be preceded by a "pop-up" type warning (on the Topsides SOS HMIs) alerting to the possibility of this command activating additional demand on the fire fighting pumps. The ADV shall be identified on the Topsides SOS HMIs screen by their tag number and also by the Fire Fighting Zone it attends;

NOTE 2: **Automatic Operation**: The opening of the deluge valves through the Topsides CSS due to activation of 1 (one) of the fusible plug or 1 (one) of the flame detectors. As defined in the previous item the opening command shall be of the "energize to open" type.

NOTE 3: Each Automatic Deluge Valve (ADV) for water system or foam system shall be provided with a dedicated ADV local panel, installed as close as possible to ADV skid. Each ADV local panel and its associated instrumentation accessories shall be hardwired connected to CSS Topsides Remote I/O Panel PN-5520117, installed at AEPR on Module M-17, by means of fire resistant cables. Further details, see item 16 below, I-DE-3010.1M-1200-944-P4X-001 – GENERAL NOTES and I-ET-3010.00-1200-800-P4X-013 – GENERAL CRITERIA FOR INSTRUMENTATION DESIGN.

11.4.2 After local or remote actuation, the ADV shall stay open until local closing by operator.

11.4.3 These valves shall be certified and approved by recognized institutions for offshore application.

11.4.4 The body type and construction for all valves shall be according to I-ET-3010.1M-

1200-200-P4X-001 – PIPING SPECIFICATION FOR TOPSIDE, I-ET-3010.1M-1200-200-P4X-002 – PIPING SPECIFICATION FOR HULL, I-ET-3010.00-1200-800-P4X-013 – GENERAL CRITERIA FOR INSTRUMENTATION DESIGN and P&ID requirements.

11.4.5 Additional requirements, as fire testing, for the deluge valves and their accessories shall be evaluated during detailed design phase, considering the classification society requirements and safety studies.

12 SAFETY RELIEF VALVES (PSV)

12.1 Balanced bellows valve design shall be considered for variable back pressures when the variation exceeds 10 % of the set pressure and by recommended practice, in services with toxic or corrosive fluids.

12.2 Pilot operated valves may be considered for high pressures only where operating pressures are close to the set pressure or narrow blow down is required. Design shall ensure that the main valve will continue to operate and relieve the required capacity even if the pilot valve fails. The use of Pilot-operated valves requires PETROBRAS formal approval.

12.3 It shall be possible to interchange the parts of a valve easily at site to achieve typically the following changes:

- From standard trim to balanced bellows type and vice-versa;
- Nozzle type to a different orifice for a given body size etc.

12.4 Standard valves shall be bubble-tight up to 95 % of set pressure.

13 ANALYZERS

13.1 General Requirements

13.1.1 Analyzers with sensing probes mounted into the process shall be provided with isolation and bypass valves to facilitate maintenance. The casing or enclosure shall be made of ASTM A351 GR CF8M stainless steel (AISI-316).

13.1.2 Where required, suitable upstream sample conditioning and sample transportation system shall be designed and installed to provide sample to analyzer specifications. The sample conditioning and transportation system shall be installed on a self-standing panel (AISI 316L stainless steel). Samples shall be returned to the process as far as possible instead of venting or draining.

13.1.3 Panels installed in open areas (outdoors) shall be designed for IP-56 protection degree according to IEC-60529 and shall be purged and pressurized according to NFPA 496 (“X” pressurization type) and shall comply with the area classification requirements.

13.1.4 The analyzer unit shall be smart microprocessor type. 4-20 mA analogue output signal shall be provided for sending the analized variable data to CSS (PCS system). Digital output signal (voltage-free contact) shall be used for remote indication of analyzer malfunction.

13.1.5 HART digital communication protocol and an alphanumeric display showing the set of measurement is not mandatory.

13.1.6 When applicable, the sampling system and all required accessories shall be supplied totally mounted and tested. All internal materials shall be, at least, AISI 316 stainless steel.

13.1.7 The power supply shall be 220 VAC (HOLD), except where indicated.

13.2 Water in Oil Analyzers (BS&W)

13.2.1 The selection of technology to be used shall take into account the water in oil range required as well fluid characteristics, according to Table 6 of I-ET-3010.00-1200-813-P4X-001 - GENERAL CRITERIA FOR FLOW METERING SYSTEMS.

13.2.2 The sources of variations that may change the performance of BS&W meters shall be observed as variation in water salinity, density, free gas and continuous oil or water regimes.

13.2.3 When specifying BS&W meter with ranges over 5%, the compensation of salinity on the oil/water mix shall be observed.

13.2.4 Water in oil analyzers shall not be used where free gas content is greater than 5%. In this case multiphase flow meters shall be provided.

13.2.5 The water in oil meters shall be mounted downstream a static mixer (with isokinetic taps) and be installed in a vertical position with ascending flow.

13.2.6 Water in oil analyzers shall have automatic built-in temperature compensation. The accuracy shall be better than 1% at full range.

13.2.7 Water in oil analyzers power supply shall be 24 Vdc, provided by Automation Remote I/O Panels.

13.3 Oil in Water Analyzers (TOG)

13.3.1 TOG shall be fluorescence or light scattering type technology and shall have self-cleaning capability.

13.3.2 TOG for discharge water applications shall comply with Classification Society requirements.

13.3.3 TOG can be installed in-line.

13.3.4 All sample wetted parts shall be corrosion resistant in accordance with fluid process conditions.

13.3.5 TOG shall measure 0 to 42 ppm of oil in water.

13.3.6 Manual sampler shall be provided for each TOG analysis point at the process line.

13.3.7 If required the sample conditioning shall be provided with all necessary accessories to provide pressure, temperature, flow rate and phase adjustments in order to make the sample compatible with the analyzer.

13.3.8 By-pass arrangement shall be only used in cases where there will be high variation on types of oils and grease at the process line and under PETROBRAS approval.

13.3.9 Automatic cleaning system is required and shall be of the acoustic method (ultrasonic). Other type of cleaning systems may be accepted under PETROBRAS approval.

13.3.10 Monitor/analyzer maintenance shall be possible of being carried out onboard.

13.4 Oxygen Analyzer

13.4.1 Oxygen analyzer shall be of advanced thermoparamagnetic type, or amperometric sensor type in gas measurement. For liquid measurement shall be applied only amperometric sensor type. Instrument accuracy shall be better than ± 1 % of full scale and repeatability of ± 0.2 % of span.

13.4.2 Analyzers sample system shall be provided with all necessary accessories for local flow indications, as: rotameter, needle valves, pressure gauges, etc.

13.4.3 Instruments shall be furnished with all necessary accessories for operation as: block valves, pressure regulating valves, sensors, vent, drain, etc.

13.4.4 Oxygen analyzer response time shall be lesser or equal than 20 seconds.

13.5 Salinity Analyzer

13.5.1 Salinity analyzer shall be microwave absorption cell type. Instrument accuracy shall be better than 2 % of the span.

13.5.2 Instruments shall be furnished with all necessary accessories for operation as: block valves, pressure regulating valves, sensors, vent, drain, etc.

13.6 Moisture Analyzer

13.6.1 Moisture analyzer shall be quartz crystal type. The probe shall incorporate moisture, temperature and pressure sensing elements. The electronic module shall transmit these signals to the analyzer transmitter unit.

13.6.2 The analyzer/transmitter shall check continuously the probe, the signal

transmission and itself and shall compensate the temperature and pressure influences in the moisture measurement.

13.6.3 Sample collecting point shall comply with API MPMS 14.1 standard. The gas sampling shall be discharged to the venting system.

13.6.4 Analyzer sample system shall be provided with all necessary accessories including heat tracing in order to avoid sample freezing.

13.6.5 Instrument uncertainty shall be less than 5 % of the span.

13.6.6 Analyzer shall be supplied with calibrating kit with certified N2 cylinder (super dry) with known dew point. The use of correction factor and its specification shall be according to ASTM 1142/95 standard.

13.6.7 Instruments shall be furnished with all necessary accessories for operation/installation as: block valves, pressure regulating valves, interconnecting cables, adapters, sensors fixing brackets and supports, etc.

13.7 Dew point Analyzer

13.7.1 Dew point analyzer shall be of high capacitive type with ultra thin aluminum oxide sensor material and ceramic based.

13.7.2 Analyzer sample system shall be provided with all necessary accessories including heat tracing in order to avoid sample freezing.

13.7.3 The analyzer shall check continuously the probe, the signal transmission and itself and shall compensate the temperature and pressure influences in the moisture measurement.

13.7.4 The analyzer shall have self diagnostic.

13.7.5 Analyzer shall be certified at vibration interferences according to IEC 60068-2-64 test Fh and IEC 60068-2-27 Test Ea.

13.7.6 Analyzer shall be operation measurement pressure up to 206 barg.

13.7.7 The analyzer shall be the lowest detectable of -100 °C and the highest calibrated level is of +20 °C.

13.7.8 All gas-wetted parts shall be in stainless steel (AISI 316L grade) with viton soft parts.

13.7.9 The gas sampling shall be discharged to the venting system.

13.7.10 Instrument accuracy shall be less than +/-2 % of the span.

13.7.11 Instruments shall be furnished with all necessary accessories for operation/installation as: block valves, pressure regulating valves, interconnecting cables, adapters, sensors fixing brackets and supports, etc.

13.7.12 The sample system shall have glycol absorption cartridge filter, used on natural gas systems only.

13.7.13 Shall be allowed readings of dew point °C / °F, lbmmscf, ppm(v) at gas, mgM-3 natural gas, DP@PR IDL gas and ppm(v), IDL gas.

13.7.14 To reduce the effects of diurnal (day-night) swings in temperature, which would induce transitional adsorption and de-sorption effects of the flowing sample and resultant erroneous measurements during periods of temperature change, the analyzer shall be provide with temperature control and then ensure continuous optimum analysis conditions of the main unit than will are internally temperature controlled at a stable level.

13.7.15 Sample system shall be provided with a system of gas purge and de-pressurized for maintenance.

13.7.16 Shall be permitted calculations for natural gas moisture content based on either ISO 18453 or IGT Research Bulletin nº 8.

13.8 CO_2 Analyzer

13.8.1 CO_2 analyzer shall be Tunable Diode Laser (TDL), Non-dispersive Infrared (NDIR) or use another detection method without moving parts, nor consumables.

13.8.2 CO2 analyzer shall be mounted directly onto measurement cells or DN50/ANSI 2" flanges.

13.8.3 Measurements shall be performed in real-time.

13.8.4 CO2 analyzer shall comply with the requirements for Group IIA, T3 classification area.

13.9 H_2S Analyzer

13.9.1 H_2S analyzer shall be ultraviolet-visible (UV-Vis) or Tunable Diode Laser (TDL) type. Instrument sensitivity shall be better than 1 % full scale. Response time shall be 90 % in less than 30 seconds.

13.9.2 Analyzers sample system shall be provided with all necessary accessories to provide pressure, temperature, flow rate and phase adjustments in order to make the sample compatible with the analyzer.

13.9.3 Instruments shall be furnished with all necessary accessories for operation, maintenance and cleaning the entire system. Flushing devices shall be furnished, if necessary.

13.10 Chlorine Analyzer

13.10.1 Chlorine analyzer shall be amperometric membrane using electrodes to provide a continuous online measurement of residual chlorine concentration.

13.10.2 Chlorine analyzer power supply shall be 24 Vdc.

14 REQUIREMENTS FOR SPECIFICATION OF SAFETY INSTRUMENTS

14.1 Gas Detectors

14.1.1 General Requirements

14.1.1.1 Gas detectors shall be type approval and shall be installed according to Safety Philosophy and Safety Studies requirements.

14.1.1.2 All Fire & Gas Detectors, except those pertaining to the AFDS shall be linked to Topsides CSS - FGS, where voting and diagnosis shall be carried out.

14.1.1.3 The instrument output shall be 0 - 20 mA .The 0 - 4 mA range shall be used for indicating malfunction. The 4 - 20 mA range shall indicate 0 to 100 % LEL of gas.

14.1.1.4 All gas detectors of the same type shall be of the same manufacturer.

14.1.1.5 Each gas detector shall be provided with resources to allow calibration without opening its enclosure and shall have protection against outside elements such as rain, dust, water spray etc. Proper accessories shall be provided, including the ones for gas detectors mounting/installation. Gas calibration kits shall be provided in a sufficient quantity for testing each gas detector during commissioning and pre-operation phases.

14.1.1.6 Stainless Steel AISI 316 shall be required for all kinds of detectors.

14.1.1.7 All detectors shall be marine approved and approved by Classification Society, excepting the open path gas detector which shall have the performance certificate by an International agency (FM, CSA, DENKO, or equivalent).

14.1.1.8 All material and hook-up associated to the installation of gas detectors (toxic gas detectors, CO2 gas detectors, open path combustible gas detectors and point combustible gas detectors) such as cables, ladders, supports, among others, shall be provide.

14.1.2 Combustible and CO2 Gas Detectors

14.1.2.1 Combustible gas detectors shall be Infrared (IR) type both for point optical type and open path applications.

14.1.2.2 CO2 gas detectors shall be Infrared (IR) type for point optical type applications.

14.1.2.3 Combustible gas detectors (point or open path type IR) shall be used to monitor flammable gas (CH4) leaks. These detectors shall be suitable for operation in “Group IIA, T3” hazardous areas, as a minimum.

14.1.2.4 CO2 gas detectors shall be used to monitor gas (CO2) leaks. These detectors shall be suitable for operation in “Group IIA, T3” hazardous areas, as a minimum, and in temperature below – 20°C.

14.1.2.5 Open Path detectors shall not be used at congested areas or in areas subject to high vibration.

14.1.2.6 The main characteristics of the IR point flammable gas detectors are:

- Detection principle: Infra red absorption by hydrocarbon gases;
- Range of detection: 0 to 100 % LEL;
- Accuracy: +/- 5% FULL SCALE (@ 25°C);
- Analogue signal 0-20 mA to include 0 – 100 %LEL signal and faults;
- Temperature range shall be –55ºC to +75ºC;
- Ingress protection IP66;
- Performance certificate and type approval certificate by an international agency body, for the sensor and transmitter shall be furnished;
- Equipped with automatic self testing features including test of electronic, sensor integrity (optic).

14.1.2.7 The main characteristics of the open path IR flammable gas detectors are:

- Detection principle: Infra Red absorption by hydrocarbon gases;
- Each detector includes an IR Source and a Receiver (detector with mirror is not acceptable);
- Range of detection: 0 to 5 % LEL.m (or ppm.meter);
- Path length: 5 to 120 meters;
- Analogue signal 0-20 mA to include 0 – 100 % LEL signal and faults;
- Temperature range shall be –40ºC to +60ºC;
- Ingress protection IP67;

- Performance certificate and type approval certificate by an international agency body, for the sensor and transmitter shall be furnished.

14.1.3 Toxic Gas Detectors

14.1.3.1 Electrochemical detectors shall be used to monitor the toxic gas (H2S) leaks. These detectors shall be suitable for operation in “Group IIB, T3” hazardous areas.

14.1.4 Hydrogen Gas Detectors

14.1.4.1 Catalytic detectors shall be used to monitor flammable gas leaks (H2). These detectors shall be suitable for operation in “Group IIC, T1” hazardous areas.

14.2 Flame Detectors

14.2.1 Multi-Spectrum type (IR3) detectors with microprocessor technologies shall be specified for optical flame detector at risers connection areas, manifold and wellhead areas.

14.2.2 In case at closed environments UV+IR detector can be accepted, for more information details see DR-ENGP-M-I-1.3-R.4 – SAFETY ENGINEERING.

14.2.3 Each flame detector shall be autonomous, i.e., it shall provide its output (4 - 20 mA) without the necessity of using specific monitors.

14.2.4 Easy access to clean up the lenses shall be provided. 2 (two) test devices shall be supplied in order to allow testing of fire detectors.

14.2.5 Flame detectors shall have immunity to false alarms (welding, lightning, x-rays, sparks/arcs, and sunlight).

14.2.6 Protection accessories against rain shall be provided to the flame detectors installed in open areas and exposed to rain incidence.

14.2.7 Protection accessories against sunlight and high flame flare shall be provided to the flame detectors installed in areas subjected to these conditions.

14.2.8 Proper installation accessories, such as mounting bracket/support and similar, shall be provided.

14.2.9 All material and hook-up associated to the installation of flame detectors such as cables, ladders, supports, among others shall be provide.

15 FLAME ARRESTERS

15.1 Design shall be in accordance with the following standards:

- ASTM F 1273 – STANDARD SPECIFICATION FOR TANK VENT FLAME

ARRESTER;

- ISO-16852 – FLAME ARRESTERS - PERFORMANCE REQUIREMENTS, TEST METHODS AND LIMITS FOR USE.

15.2 Dimensioning conditions and type shall be clearly indicated at the data sheets.

15.3 Material of construction for the entire arrester shall be AISI 316 stainless steel as a minimum.

15.4 The construction shall assure easy access to the arrester bank for inspecting its internals as well as its replacement.

16 FUSIBLE PLUG

16.1 This system shall be designed to enable the fire detection in earliest stages.

16.2 Active and passive resources for protection against fire shall comply with the requirements defined in DR-ENGP-M-I-1.3-R.4 – SAFETY ENGINEERING, including fusible plug detectors quantity and location requirements.

16.3 The system is comprised of several fusible plug networks according to the Fire Zones defined by Safety project documents.

16.4 Each fusible plug network is intended to keep its respective Automatic Deluge Valve (ADV) actuator pressurized, that is, in the closed position, in order to guarantee a dry section upstream in absence of fire. One fusible plug network will consist of one or more independent fusible plug loops. Each fusible plug loop shall contain no more than 65 fusible plugs, according to DR-ENGP-M-I-1.3-R.4 – SAFETY ENGINEERING.

16.5 The opening of the ADV and, consequently, the actuation of the deluge network shall be initiated just upon the melting temperature opening of any fusible plug in the network (indicating fire detected), thus leading to the depressurization of the respective fusible plug loop and the main fusible plug network header. The ADV shall be fully opened in up to 40 s (according to NFPA 15 – 10.4.2.1) after the fusible plug opening.

16.6 The following instrument/equipment shall make part of each fusible plug network:

- Air supply tubing;

  Each fusible plug loop shall have check valves installed in such a way that prevents other fusible plug loops depressurization and, consequently, minimizing the ADV opening time. For that, each fusible plug network node shall have 1 (one) check valve for each new branch, as illustrated in item 16.12. The check valves shall have a small pressure loss to not impact the limit of 200 m of the fusible plug loop;

- 1 (one) air reservoir to guarantee air supply for at least 2 (two) acting cycles of the ADV in case of air supply failure;

- 1 (one) pressure gauge to monitor air supply line, suitable for pressure detection from 0 - 750 kPa;
- 1 (one) pressure reducing valve (regulator) to provide 500 kPa (fusible plug network) air pressure to the ADV actuators as indicated in the operational conditions of the ADV data sheets;
- 1 (one) restriction orifice (FO) with 0.4 mm diameter to guarantee the recovery of air pressure in case of spurious leakages in the network;
- 1 (one) by-pass valve, spring push-button type. Needle valve shall not be used for this service;
- 1 (one) pressure transmitter with local indication to monitor the inlet pressure of the ADV actuators and interlocking in case of low pressure, with a virtual switch set at 450 kPa (signal to FGS Logic in order to open the ADV, to carry out actions according to I-FD-3010.1M-5400-947-P4X-001 – SAFETY DATA SHEET);
- 1 (one) pressure gauge to monitor the inlet pressure of the piloted valve, suitable for pressure detection from 0 - 600 kPa;
- 1 (one) piloted valve directly actuated by the fusible plug network with manual reset;
- 1 (one) manual three-way ball valve for the manual depressurization of the ADV actuator;
- 1 (one) ADV (See item 11.4);
- For further details, including the items that shall be installed in the dedicated ADV local panels, see instrumentation diagram in the I-DE-3010.1M-1200-944-P4X-001 – GENERAL NOTES.

Notes:

a) Remote Manual Operation

The opening of the deluge valves through the Topsides SOS HMIs shall be “energize to open” type so that the accidental loss of command does not inappropriately open the ADV. The opening command of the ADV shall be preceded by a “pop-up” type warning (on the Topsides SOS HMIs) alerting to the possibility of this command activating additional demand on the fire fighting pumps. The ADV shall be identified on the Topsides SOS IHM screen by their tag number and also by the Fire Fighting Zone it Attends;

b) Automatic Operation

The opening of the deluge valves the Topsides CSS due to activation of one of the fusible plug or one of the flame detectors. As defined in the previous item the opening command shall be of the “energize to open” type.

16.7 Fusible plugs, instruments, equipment, fitting and accessories specifications shall comply with the requirements described on I-ET-3010.00-1200-800-P4X-013 – GENERAL CRITERIA FOR INSTRUMENTATION DESIGN.

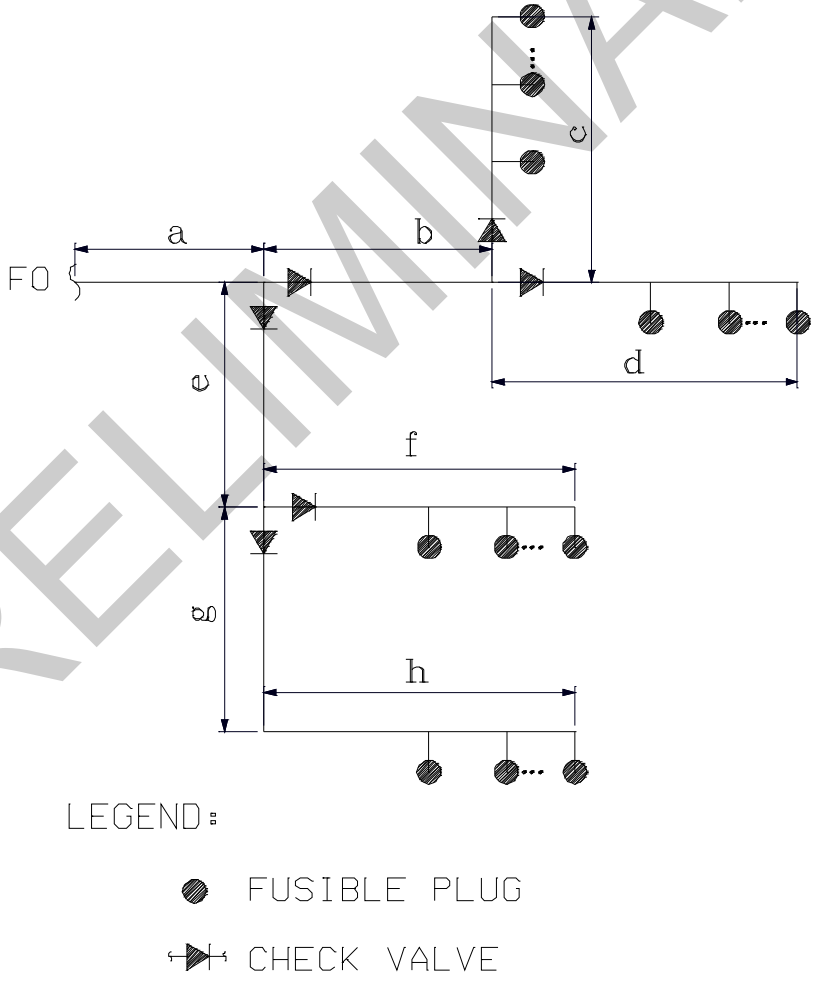
16.8 All piece of equipment used for fire-fighting shall be approved by a recognized institution, designed and tested according to recognized codes/standards. Certifying requirements for the fire-fighting equipment and materials shall comply with the Classification Society requirements.

16.9 Tubing to be used in the fusible plug networks shall be seamless with at 3/8" OD diameter and the connections fittings shall necessarily use the technology of double ferrules 3/8" OD.

16.10 Plug internal diameter, to be filled by the fusible alloy, shall be equal to the internal diameter of the network tubing.

16.11 Layout design of fusible plug network shall follow the guidelines below:

- The distance from FO to any fusible plug shall not exceed 200 m.



For example:

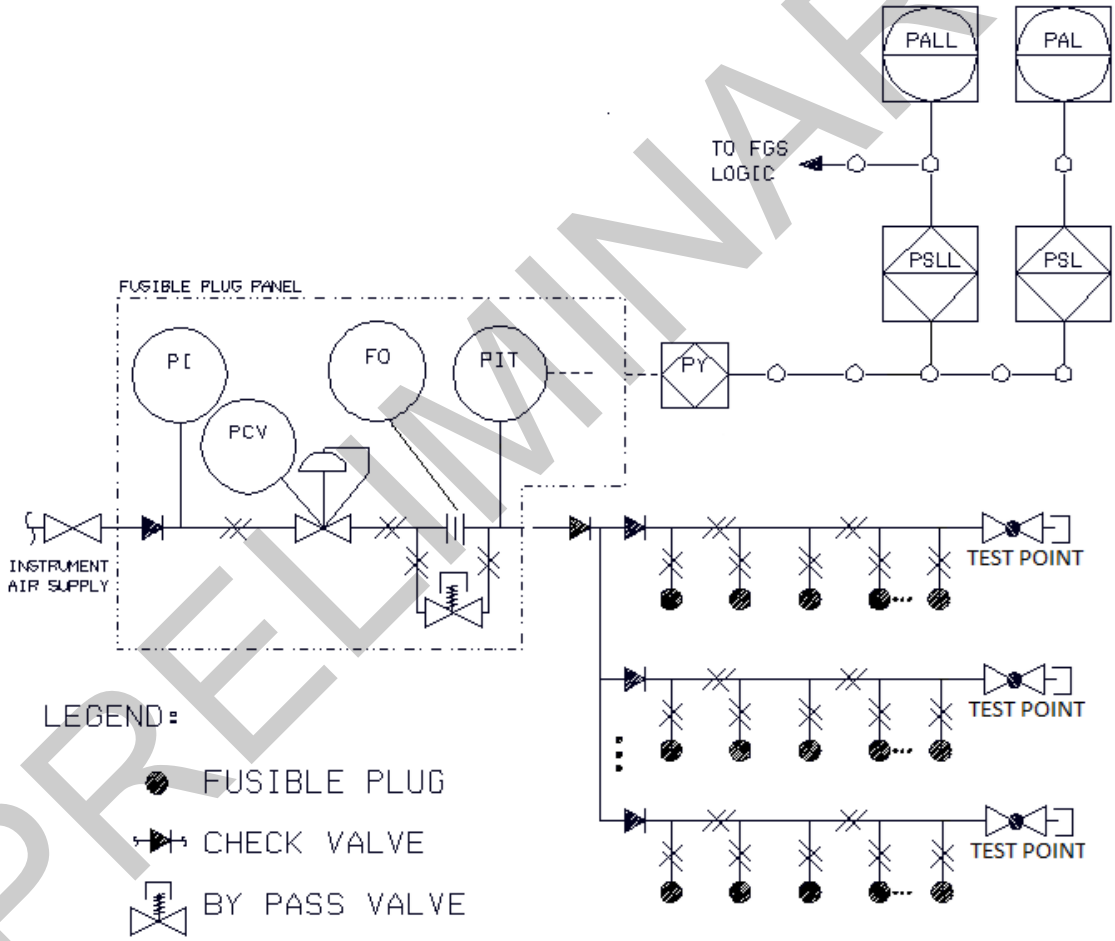
- Fusible plug loop (a + b + c) ≤ 200 m
- Fusible plug loop (a + e + f) ≤ 200 m

- Fusible plug loop (a + b + d) ≤ 200 m
- Fusible plug loop (a + e + g + h) ≤ 200 m

16.12 It shall be engraved on the fusible plug, information regarding to the useful life of each lot.

16.13 Routing of the fusible plug network tubing shall be designed in a manner to minimize damages or leakages due to load impact or people's step.

16.14 In zones where fusible plug network shall be used as the only responsible to fire detection without associated ADV, the following configuration shall be used:



16.14.1 The following instrument/equipment shall make part of each fusible plug network without associated ADV:

- Air supply tubing;
- Each fusible plug loop shall have check valves installed in such a way that prevents other fusible plug loops depressurization. Each fusible plug network node shall have 1 (one) check valve for each new branch, as illustrated in item 16.14;
- 1 (one) pressure gauge to monitor air supply line, suitable for pressure detection from 0 - 750 kPa;

- 1 (one) pressure reducing valve (regulator) to provide 500 kPa (fusible plug network);
- 1 (one) restriction orifice (FO) with 0.4 mm diameter to guarantee the recovery of air pressure in case of spurious leakages in the network;
- 1 (one) manual two-way ball valve with plug to test the fusible plug network in each fusible plug loop;
- 1 (one) pressure transmitter with local indication to monitor the inlet pressure and interlocking in case of low pressure, with a virtual switch set at 450 kPa (signal to FGS Logic in order to carry out safety actions according to I-FD-3010.1M-5400-947-P4X-001 – SAFETY DATA SHEET);

NOTE: These instruments shall be installed in a panel, as shown in item 16.16.

16.14.2 Layout design of fusible plug network for this application shall be in accordance with item 16.12;

17 INSTALLATION MATERIALS

17.1 Junction Boxes (JB)

17.1.1 JB tags shall be according to I-ET-3000.00-1200-940-P4X-001 – TAGGING PROCEDURE FOR PRODUCTION UNITS DESIGN.

17.1.2 All outdoor JBs enclosures shall be made of stainless steel AISI 316L, or of FRP material and shall have IP-56 minimum ingress protection degree, according to IEC 60529. In case of confined areas FRP junction box shall not be used.

17.1.3 FRP JBs shall have flame self-extinguishing and non-fired propagating properties. For more details see I-ET-3010.00-5140-700-P4X-002 – SPECIFICATION FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS.

17.1.4 JBs and local panels located in Topsides non hazardous open areas shall be certified to operate in Zone 1, Group IIA, T3 hazardous areas, when kept energized during ESD situation.

17.1.5 JBs shall be ample sized, with minimum of 20% spare (Terminals, cable entries).

NOTE: For low smoke and/or fire resistant cables, MCTs shall be used instead of cable glands in the panels inlet.

17.1.6 Supports, mounting brackets, bolts and nuts shall also be of stainless steel material (AISI 316L).

17.1.7 Cable gland installation shall include the use of union connections to make handling easier during maintenance.

17.1.8 Terminals strips, connectors and bolts used inside the JBs, located in Zone 1 and 2 shall be adequate for use when vibrations are present and avoiding sparks due to bad contact.

17.1.9 All terminals shall be SAK type with non-sparking terminations. Number of terminals per instrument junction box shall be standardized.

17.1.10 Signals to CSS related to PSD/HSD and FGS/HFGS sub-systems shall be segregated in different terminal strips and multicables (where applicable), when installed inside the same junction box.

17.1.11 Where required, the JBs shall have 1 (one) earth bar for earthing the armoring of cables. This bar shall be internally wired to the earth terminal of the box and it shall be provided with sufficient screws for terminating armour earthing wires. Each gland or gland plate shall be electrically bonded to its relevant equipment earth bar or terminal /junction box earthing stud. For discret instruments, shield drain wires from instruments shall be jumped inside the junction Box and shall only be earth on a dedicated earthing bar for shield drain wires on the panel, For Analogic instruments, cable shield drain wires shall be connected to its respective multicable pair/triad/quad individual shield drain wire and then connected to a dedicated earthing bar shield drain wires on the panel. The general shield drain wire on analog multicable shall be connected to dedicated earthing bar shield drain wires on the panel and shall be left unconnected at junction box according to IEC-60079-14.

17.1.12 Each outdoor junction box shall have an earth bolt at the outside for bonding to the skid structure. This bolt shall terminate at the inside to provide a grounding means inside the junction box to the safety ground bar.

17.1.13 For instruments to be installed within the module that shall be connected to its respective control rack installed at AEPR on Module M-17 e.g. CMS (Corrosion Monitoring System), FMS (Flow Metering System), MMS (Machinery Monitoring System), MODULE SUPPLIER shall foresee instruments cable signals and cable tray from the instrument into a junction box (also supplied by Module Supplier) at the battery limit of the Module in order to act as an interface between instruments and respective control rack at AEPR on Module M-17(HOLD).

17.1.14 Regarding to instrumentation cables in service related to actuation and status of Automatic Deluge Valves (ADVs), Blowdown Valves (BDVs) and selected Shutdown Valves (SDVs), interconnected to Safety System (FGS), the Detail Design Phase shall foresee a number of junction boxes (supplied by Module Supplier at the battery limit of the Module) to be interconnected to CSS-FGS at AEPR (Module M-17). The criteria for quantifying and locating these junctions boxes shall take into account to maximize availability of actuation of those final elements, e.g. at least one JB per Module level shall be foreseen. (HOLD)

NOTE: Due to the fact that those JBs are part of the Safety System (FGS), proper location and integrity protection shall be applied to them in order to be able to resist a fire condition.

17.2 Cable Glands

17.2.1 For instruments: As per I-ET-3010.00-1200-800-P4X-013 – GENERAL CRITERIA FOR INSTRUMENTATION DESIGN: Electric connections shall be ½”

NPT (F).

17.2.2 For Instrumentation Junction Boxes:

- Cylindrical Threaded joints for non metallic junction boxes.
- Cable glands for steel sheet enclosures shall have cylindrical thread with locknut.
- For all other cases, the threaded joints shall be taper type, NPT with standardized tolerances, according to ASME B 1.20.1.

17.2.3 Cable glands material shall follow the requirements of table below:

ENCLOSURE MATERIAL	CABLE GLAND MATERIAL
Stainless Steel	Stainless Steel AISI 316
Cast Iron	
Aluminium	Aluminium
FRP (Fiber Reinforced Plastic)	Nylon (1)

NOTE 1: Nylon cable glands shall be accepted only up to maximum size 1", with metallic plate for grounding, with internal locknut and if they are certified as Ex e or Ex n.

NOTE 2: For equipment installed in hazardous areas, the threads shall comply with the requirements of IEC-60079-0.

NOTE 3: Cable glands for equipment with any type of Ex classification shall comply with IEC-60079-14, specially item 10 - Cable entry systems and blanking elements and its subitems.

18 INSTRUMENT ASSEMBLY MATERIAL

18.1 Material Selection Requirements

18.1.1 All instruments and installation material shall be mounted and installed according to PETROBRAS standards and piping specifications I-ET-3010.1M-1200-200-P4X-001 – PIPING SPECIFICATION FOR TOPSIDE, I-ET-3010.1M-1200-200-P4X-002 – PIPING SPECIFICATION FOR HULL and typical hook-up drawings.

18.1.2 All material shall have high quality regarding dielectric rigidity, mechanical, thermal and chemical resistance, following in a strictly manner the standards used for its fabrication.

18.1.3 All material employed shall be non-hygroscopic, flame retardant and resistant to corrosion caused by a saline atmosphere environment with the presence of moisture and contact with hydrocarbons.

18.1.4 All screws, nuts and washers shall be made of bichromatized steel or AISI-316L stainless steel.

18.1.5 In order to avoid electrolytic corrosion, contacts between different metallic materials shall be prevented. Galvanic isolation shall be implemented where contact between different metallic materials is necessary.

18.1.6 Manufacturers shall keep uniformity of components for the same supply. The same model for plugs, junction boxes and all bulk material shall be used in all Unit modules.

18.1.7 For parts of the assembly not specifically detailed by PETROBRAS, the following requirements shall be taken into account:

- Galvanized bolts and nuts shall not be used.
- Ductile iron shall not be used without the prior formal approval of PETROBRAS.
- All proposed plastic components shall be as a minimum flame retardant UV resistant, and non-degradable.
- All spindles, bushings, bolting, screws, etc. shall be manufactured from a suitable grade of stainless steel or other corrosion proof material.
- All molded polyester parts shall be in an anti-static version for hazardous area locations.
- The use of asbestos in any form is prohibited.
- The use of aluminum and cast iron is prohibited.
- Whenever there is a need to use different materials in contact, one with another one, which may favor galvanic corrosion, protection procedures shall be foreseen, such as insulation, besides the use of anti-oxidant products.

18.1.8 It is not allowed to install cables, cable trays, conduits, tubing or piping at void spaces.

18.2 Heat Tracing

18.2.1 Heat tracing system shall be of electric type.

18.2.2 When high temperatures could emerge, at standstill or at normal operation, dangerous for operating personnel or deteriorating for products, thermostats to limit the temperature shall be included in the design.