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	CLIENT:	MARLIM LESTE E SUL	SHEET: 1 of 57
	PROGRAM:	PROJETO BÁSICO – REVIT I	
	AREA:	MARLIM LESTE E SUL	
	TITLE:	<b>FLOW METERING SYSTEM (FMS)</b>	ESUP
			INTERNAL

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EXECUTION	DVJH	CX2W	DVJH			
CHECK	CX2W	HRJ2	HRJ2			
APPROVAL	U361	U361	U44D			

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TITLE:

FLOW METERING SYSTEM (FMS)

ESUP

INTERNAL

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## 1 INTRODUCTION

### 1.1 Objective

1.1.1 The purpose of the Flow Metering System (FMS) is to measure oil, natural gas, condensate and water (produced, injected and disposal) produced by the UNIT. The system shall execute in-line measurements in a continuous manner for fiscal, allocation, custody transfer and operational purposes.

1.1.2 This Technical Specification, along with I-ET-3010.00-1200-813-P4X-001 – GENERAL CRITERIA FOR FLOW METERING SYSTEMS, describes the minimum requirements for supplying of for the UNIT's complete Flow Metering System (FMS).

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

### 1.2 Definitions

1.2.1 Refer to I-ET-3010.00-1200-940-P4X-002 – GENERAL TECHNICAL TERMS for the definitions of words emphasized in upper case that are not defined below.

**FISCAL METERING** Measurement of the gas and oil production volume where the government requires tax payments.

**ALLOCATION METERING** Measurement to determine the volume of production to be allocated at each well.

**CUSTODY TRANSFER METERING** Measurement for totalization of transferred fluids when changed their ownership, for legal or commercial purposes.

**OPERATIONAL METERING** Measurement for process control purposes, for production, transfer or storage, which are not classified as fiscal, allocation or custody transfer measurements.

**# SYMBOL** The symbol #, when used to represent grouped tags of instruments or equipment, indicates a break in the numbering sequence. For instance, the tags FIT-1210001A, FIT-1210001C, and FIT-1210001E can be grouped and represented as FIT-1210001A#C#E.

### 1.3 Abbreviations, acronyms, and initialisms

1.3.1 The following abbreviations are used in this document:

AC/DC	Alternating Current/Direct Current
AEPR	Automation & Electrical Panels Room
AX	Automatic Sampler
BS&W	Basic Sediments & Water
CCR-OA	Central Control Room – Operation Ambiance
CSS	Control and Safety System
DBB	Double block and bleed



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FAT	Factory Acceptance Test
FMS	Flow Metering System
GCA	Gas Chromatograph Analyzer
HMI	Human Machine Interface
LAN	Local Area Network
MFMS	Multiphase Flow Metering System
PCS	Process Control System
P&ID	Piping and Instrument Diagram
PI	Plant Information (software)
RTM	ANP/Inmetro Technical Regulation of Measurement of Oil and Gas
SAT	Site Acceptance Test
SOS	Supervision and Operation System
VCI	Volatile Corrosion Inhibitor
XML	Extensible Markup Language

## 2 REFERENCE DOCUMENTS, CODES AND STANDARDS

### 2.1 External references

#### 2.1.1 International codes, recommended practices, and standards

#### **AGA – AMERICAN GAS ASSOCIATION**

AGA REPORT Nº 8 THERMODYNAMIC PROPERTIES OF NATURAL GAS AND RELATED GASES - ALL PARTS

AGA REPORT Nº 9 MEASUREMENT OF GAS BY MULTIPATH ULTRASONIC METERS

#### **API – AMERICAN PETROLEUM INSTITUTE**

API MPMS MANUAL OF PETROLEUM MEASUREMENT STANDARDS - ALL PARTS

#### **IEC – INTERNATIONAL ELECTROTECHNICAL COMMISSION**

IEC 60079 EXPLOSIVE ATMOSPHERES – ALL PARTS

IEC 60529 DEGREES OF PROTECTION PROVIDED BY ENCLOSURES (IP CODE) – EDITION 2.2

IEC 61000 ELECTROMAGNETIC COMPATIBILITY (EMC) – ALL PARTS

IEC 61892 MOBILE AND FIXED OFFSHORE UNITS - ELECTRICAL INSTALLATIONS - 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 91 PETROLEUM AND RELATED PRODUCTS - TEMPERATURE AND PRESSURE VOLUME CORRECTION FACTORS (PETROLEUM MEASUREMENT TABLES) AND STANDARD REFERENCE CONDITIONS

ISO 4267-2 PETROLEUM AND LIQUID PETROLEUM PRODUCTS – CALCULATION OF OIL QUANTITIES – PART 2: DYNAMIC MEASUREMENTS

ISO 5167 MEASUREMENT OF FLUID FLOW BY MEANS OF PRESSURE DIFFERENTIAL DEVICES INSERTED IN CIRCULAR-CROSS SECTION CONDUITS RUNNING FULL - ALL PARTS

ISO 5168 MEASUREMENT OF FLUID FLOW – PROCEDURES

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<p>FOR THE EVALUATION OF UNCERTAINTIES</p> <p>ISO 6974 NATURAL GAS – DETERMINATION OF COMPOSITION AND ASSOCIATED UNCERTAINTY BY GAS CHROMATOGRAPHY – ALL PARTS</p> <p>ISO 10012 MEASUREMENT MANAGEMENT SYSTEMS - REQUIREMENTS FOR MEASUREMENT PROCESSES AND MEASURING EQUIPMENT</p> <p>ISO 17089-1 MEASUREMENT OF FLUID FLOW IN CLOSED CONDUITS - ULTRASONIC METERS FOR GAS - PART 1: METERS FOR CUSTODY TRANSFER AND ALLOCATION MEASUREMENT</p> <p>ISO 20456 MEASUREMENT OF FLUID FLOW IN CLOSED CONDUITS - GUIDANCE FOR THE USE OF ELECTROMAGNETIC FLOWMETERS FOR CONDUCTIVE LIQUIDS</p> <p>ISO GUM GUIDE TO THE EXPRESSION OF UNCERTAINTY IN MEASUREMENTS</p> <p><b>OIML – ORGANISATION INTERNATIONALE DE METROLOGIE LEGALE</b></p> <p>OIML R117 DYNAMIC MEASURING SYSTEMS FOR LIQUIDS OTHER THAN WATER – ALL PARTS</p> <p>OIML R137 GAS METERS – ALL PARTS</p> <p>2.1.2 Brazilian Codes and Standards</p> <p><b>ANP – AGÊNCIA NACIONAL DO PETRÓLEO, GÁS NATURAL E BIOCOMBUSTÍVEIS</b></p> <p>RESOLUÇÃO CONJUNTA ANP/INMETRO Nº 1 (10/JUNHO/2013) REGULAMENTO TÉCNICO DE MEDIÇÃO DE PETRÓLEO E GÁS NATURAL, A QUE SE REFERE À RESOLUÇÃO CONJUNTA ANP/INMETRO Nº 1 DE 10 DE JUNHO DE 2013</p> <p>OFÍCIO-CIRCULAR Nº1/2020/NFP/ANP (26/MAIO/2020) ESCLARECIMENTOS DO REGULAMENTO TÉCNICO DE MEDIÇÃO (RTM).</p> <p>RESOLUÇÃO ANP Nº 52 (26/DEZEMBRO/2013) REGULAMENTO TÉCNICO DE IMPLEMENTAÇÃO DOS RESULTADOS DE ANÁLISES FÍSICO-QUÍMICAS NAS MEDIÇÕES SUBSEQUENTES DE PETRÓLEO E GÁS NATURAL, A QUE SE REFERE À RESOLUÇÃO ANP Nº 52 DE 26 DE DEZEMBRO DE 2013</p> <p>RESOLUÇÃO ANP Nº 18 (27/MARÇO/2014) REGULAMENTO TÉCNICO DE NOTIFICAÇÃO DE FALHAS DE SISTEMAS DE MEDIÇÃO DE PETRÓLEO E GÁS NATURAL E FALHAS DE ENQUADRAMENTO DO PETRÓLEO, A QUE SE REFERE À RESOLUÇÃO ANP Nº 18, DE 27 DE MARÇO DE 2014</p>			

RESOLUÇÃO ANP Nº 65 (10/ DEZEMBRO /2014) REGULAMENTO TÉCNICO DE ENVIO DE DADOS DE PRODUÇÃO E MOVIMENTAÇÃO DE PETRÓLEO, GÁS NATURAL E ÁGUA A QUE SE REFERE À RESOLUÇÃO ANP Nº 65, DE 10 DE DEZEMBRO DE 2014

RESOLUÇÃO Nº 737 (27/ JULHO /2018) ALTERAÇÃO DA RESOLUÇÃO ANP Nº 65 DE 10 DE DEZEMBRO DE 2014

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

PORTARIA Nº 188 (27/ABRIL/2021) REGULAMENTO TÉCNICO METROLÓGICO CONSOLIDADO PARA CROMATÓGRAFOS A GÁS EM LINHA

PORTARIA Nº 291 (07/JULHO/2021) REGULAMENTO TÉCNICO METROLÓGICO DOS SISTEMAS DE MEDIÇÃO DINÂMICA EQUIPADOS COM MEDIDORES PARA QUANTIDADE DE LÍQUIDOS

PORTARIA Nº 298 (08/JULHO/2021) REGULAMENTO TÉCNICO METROLÓGICO CONSOLIDADO PARA OS COMPUTADORES DE VAZÃO E CONVERSORES DE VOLUME

PORTARIA Nº 617 (20/DEZEMBRO/2013) ALTERAÇÃO DA PORTARIA INMETRO Nº 298, DE 08 DE JULHO DE 2021

PORTARIA Nº 156 (30/MARÇO/2022) REGULAMENTO TÉCNICO METROLÓGICO CONSOLIDADO PARA MEDIDORES DE VAZÃO DE GÁS NATURAL

PORTARIA Nº 236 (14/JUNHO/2022) ALTERAÇÃO DA PORTARIA INMETRO Nº 156, DE 30 DE MARÇO DE 2022

PORTARIA Nº 115 (21/MARÇO/2022) REGULAMENTO CONSOLIDADO PARA EQUIPAMENTOS ELÉTRICOS PARA ATMOSFERAS EXPLOSIVAS

OFÍCIO CIRCULAR Nº 032/DIMEL (12/SETEMBRO/2017) VERIFICAÇÕES METROLÓGICAS DE MEDIDORES, SISTEMAS DE MEDIÇÃO E COMPUTADORES DE VAZÃO

2.1.3 All MTE – Ministério do Trabalho regulations (NRs) shall be followed.

2.1.4 Classification Society

2.1.4.1 Detail Design phase documentation of the project shall be submitted to approval by Classification Society.

2.1.4.2 The design, installation and operation shall strictly follow the Classification Society’s requirements and comments, along with the specific requirements identified in this document, also including all requirements of referenced documents.

**2.2 Internal references**

### 2.2.1 Typical Documents

I-ET-3000.00-1400-196-P4X-001	ERGONOMICS REQUIREMENTS FOR TOPSIDE
I-ET-3000.00-8222-941-PJN-001	LABORATORY - EQUIPMENT
I-ET-3010.00-1200-588-P4X-001	SAMPLE CONNECTIONS
I-ET-3010.00-1200-800-P4X-002	AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGE UNITS
I-ET-3010.00-1200-800-P4X-013	GENERAL CRITERIA FOR INSTRUMENTATION PROJECTS
I-ET-3010.00-1200-813-P4X-001	GENERAL CRITERIA FOR FLOW METERING SYSTEMS
I-ET-3010.00-1200-940-P4X-002	GENERAL TECHNICAL TERMS
I-ET-3010.00-1359-940-P4X-002	OFFLOADING SYSTEM
I-ET-3010.00-5520-888-P4X-001	AUTOMATION PANELS

### 2.2.2 Project Document List

I-DE-3010.2Q-1200-813-P4X-001	FLOW METERING LOCATIONS (FMS)
I-DE-3010.2Q-1200-813-P4X-002	FLOW METERING SYSTEM (FMS) ARCHITECTURE
I-DE-3010.2Q-1210-944-P4X-017	SATELLITE WATER INJECTION WELL A
I-DE-3010.2Q-1210-944-P4X-018	SATELLITE WATER INJECTION WELL B
I-DE-3010.2Q-1210-944-P4X-019	SUBSEA MANIFOLD WATER INJECTION MSIA-1
I-DE-3010.2Q-1210-944-P4X-020	SUBSEA MANIFOLD WATER INJECTION MSIA-2
I-DE-3010.2Q-1210-944-P4X-021	SUBSEA MANIFOLD WATER INJECTION MSIA-3
I-DE-3010.2Q-1210-944-P4X-022	SUBSEA MANIFOLD WATER INJECTION MSIA-4 (SPARE)
I-DE-3010.2Q-1210-944-P4X-023	SUBSEA MANIFOLD WATER INJECTION MSIA-5 (SPARE)
I-DE-3010.2Q-1210-944-P4X-026	PIG RECEIVER (IMPORTED OIL RECEIVING)
I-DE-3010.2Q-1212-944-P4X-001	CRUDE OIL METERING SYSTEM
I-DE-3010.2Q-1223-944-P4X-003	HP SEPARATOR A
I-DE-3010.2Q-1223-944-P4X-004	HP SEPARATOR B
I-DE-3010.2Q-1223-944-P4X-007	LP SEPARATOR A
I-DE-3010.2Q-1223-944-P4X-008	LP SEPARATOR B
I-DE-3010.2Q-1223-944-P4X-009	SETTLING SEPARATOR TANK A
I-DE-3010.2Q-1223-944-P4X-010	SETTLING SEPARATOR TANK B
I-DE-3010.2Q-1223-944-P4X-011	SETTLING SEPARATOR TANK C
I-DE-3010.2Q-1223-944-P4X-019	PRE-OIL DEHYDRATOR RECIRCULATION WATER PUMP A/D
I-DE-3010.2Q-1223-944-P4X-020	OIL DEHYDRATOR RECIRCULATION WATER



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	PUMP A/D
I-DE-3010.2Q-1223-944-P4X-023	OFF-SPEC OIL TANK
I-DE-3010.2Q-1223-944-P4X-026	TEST HEATER/TEST SEPARATOR
I-DE-3010.2Q-1223-944-P4X-027	TEST SEPARATOR OIL PUMP
I-DE-3010.2Q-1223-944-P4X-028	TEST SEPARATOR WATER PUMP
I-DE-3010.2Q-1231-944-P4X-012	LIFT GAS AND EXPORTATION HEADERS - PIG LAUNCHER/RECEIVER
I-DE-3010.2Q-1235-944-P4X-004	AMINE REGENERATION PACKAGE
I-DE-3010.2Q-1244-944-P4X-001	WELL PIG LAUNCHERS (LP-1244001A/B)
I-DE-3010.2Q-1244-944-P4X-002	WELL PIG LAUNCHERS (LP-1244001C/D)
I-DE-3010.2Q-1244-944-P4X-003	WELL PIG LAUNCHERS (LP-1244001E/F)
I-DE-3010.2Q-1244-944-P4X-004	WELL PIG LAUNCHERS (LP-1244001G/H)
I-DE-3010.2Q-1244-944-P4X-005	WELL PIG LAUNCHERS (LP-1244001J/K)
I-DE-3010.2Q-1244-944-P4X-006	WELL PIG LAUNCHERS (LP-1244001L/M)
I-DE-3010.2Q-1244-944-P4X-007	WELL PIG LAUNCHERS (LP-1244001N/P)
I-DE-3010.2Q-1244-944-P4X-008	WELL PIG LAUNCHERS (LP-1244001Q/R)
I-DE-3010.2Q-1244-944-P4X-009	WELL PIG LAUNCHERS (LP-1244001S/T)
I-DE-3010.2Q-1244-944-P4X-010	WELL PIG LAUNCHERS (LP-1244001U/V)
I-DE-3010.2Q-1244-944-P4X-011	WELL PIG LAUNCHERS (LP-1244001W/X)
I-DE-3010.2Q-1244-944-P4X-012	WELL PIG LAUNCHERS (LP-1244001Y)
I-DE-3010.2Q-1251-944-P4X-007	INJECTION WATER MAIN PUMP
I-DE-3010.2Q-1350-944-P4X-003	CARGO SYSTEM
I-DE-3010.2Q-1350-944-P4X-004	STRUCTURAL TANKS GAS RECOVERY SYSTEM
I-DE-3010.2Q-1413-942-P4X-001	M-03 - EXPORT GAS COMPRESSION - EQUIPMENT LAYOUT PLAN
I-DE-3010.2Q-1416-942-P4X-001	M-06 - GAS DEHYDRATION AND FUEL GAS - EQUIPMENT LAYOUT PLAN
I-DE-3010.2Q-1421-942-P4X-002	M-10B - PRODUCED WATER TREATMENT - EQUIPMENT LAYOUT PLAN
I-DE-3010.2Q-1427-942-P4X-002	M-16B - LAY-DOWN AREA AND SUBMARINE PUMPING UNIT - EQUIPMENT LAYOUT PLAN
I-DE-3010.2Q-5133-944-P4X-001	DIESEL INJECTION SYSTEM
I-DE-3010.2Q-5135-944-P4X-001	IMPORT GAS SLUG CATCHER AND FUEL GAS HEATING
I-DE-3010.2Q-5135-944-P4X-003	FUEL GAS DISTRIBUTION
I-DE-3010.2Q-5331-944-P4X-010	PRODUCED WATER BOOSTER PUMPS
I-DE-3010.2Q-5412-944-P4X-001	HIGH PRESSURE FLARE K.O.DRUM
I-DE-3010.2Q-5412-944-P4X-002	LOW PRESSURE FLARE K.O.DRUM
I-DE-3010.2Q-5412-944-P4X-003	HIGH/LOW PRESSURE FLARE



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I-DE-3010.2Q-5520-800-P4X-004	NETWORK INTERCONNECTION DIAGRAM
I-ET-3010.2Q-1200-800-P4X-001	INSTRUMENTATION ADDITIONAL TECHNICAL REQUIREMENTS
I-ET-3010.2Q-1200-800-P4X-004	MULTIPHASE FLOW METERING SYSTEM (MFMS)
I-ET-3010.2Q-1200-800-P4X-005	FIELD INSTRUMENTATION
I-ET-3010.2Q-1200-800-P4X-014	AUTOMATION INTERFACE OF <b>PACKAGED</b> UNITS
I-MD-3010.2Q-5520-800-P4X-003	AUTOMATION NETWORK DESCRIPTION

 <b>PETROBRAS</b>	<b>TECHNICAL SPECIFICATION</b>	<b>I-ET-3010.2Q-1200-800-P4X-003</b>	REV.: <b>B</b>
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			<b>INTERNAL</b>

**3 ENVIRONMENTAL AND OPERATION CONDITIONS**

3.1 For operating and environmental conditions, refer to I-ET-3010.2Q-1200-800-P4X-001 – INSTRUMENTATION ADDITIONAL TECHNICAL REQUIREMENTS.

3.2 Flow Metering System shall be fed according to I-ET-3010.00-1200-813-P4X-001 – GENERAL CRITERIA FOR FLOW METERING SYSTEMS.

3.3 FMS panel shall convert, condition, and distribute the different power supplies inside the panel, including voltage regulators where needed (e.g., for the cabinet’s internal distribution of 24 Vdc, 24 Vdc to automatic samplers (AX), 220 Vac @ 60 Hz to analyzers and heaters when needed and others).

3.4 For the compact provers a 690 Vac @ 60 Hz power supply shall be available.

## 4 GENERAL

### 4.1 General Requirements

4.1.1 This Technical Specification shall be read in conjunction with I-ET-3010.00-1200-813-P4X-001 – GENERAL CRITERIA FOR FLOW METERING SYSTEMS.

4.1.2 Documentation, Acceptance Tests, Training, Integration and Assembly Services shall be according to I-ET-3010.00-1200-813-P4X-001 – GENERAL CRITERIA FOR FLOW METERING SYSTEMS.

4.1.3 For further details about the whole FMS, see the followings documents:

- I-DE-3010.2Q-1200-813-P4X-001 – FLOW METERING LOCATIONS (FMS);
- I-DE-3010.2Q-1200-813-P4X-002 – FLOW METERING SYSTEM (FMS) ARCHITECTURE;
- I-ET-3010.2Q-1200-800-P4X-005 – FIELD INSTRUMENTATION.

4.1.4 The FMS automation shall also comply with its respective Automation Package requirements according to I-ET-3010.00-1200-800-P4X-002 – AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGE UNITS and I-ET-3010.2Q-1200-800-P4X-014 – AUTOMATION INTERFACE OF PACKAGED UNITS.

4.1.5 The requirements for specification of flow instruments shall be according to I-ET-3010.00-1200-813-P4X-001 – GENERAL CRITERIA FOR FLOW METERING SYSTEMS and I-ET-3010.2Q-1200-800-P4X-005 – FIELD INSTRUMENTATION.

4.1.6 SELLER is responsible for the documentation, inspection, and approval of the whole system by ANP, Inmetro and BUYER.

4.1.7 All flow meters, instruments and analyzers shall have valid calibration and dimensional inspection certificates by the time of ANP inspection for authorization of the metering system.

4.1.8 Ergonomics requirements for operation and maintenance listed in I-ET-3010.00-1200-800-P4X-013 – GENERAL CRITERIA FOR INSTRUMENTATION PROJECTS and I-ET-3000.00-1400-196-P4X-001 – ERGONOMICS REQUIREMENTS FOR TOPSIDE shall be followed. Complete access to all flow meters and components shall be provided.

4.1.9 Care shall be taken for the meter installation, as the signal attenuation due to cable length shall not affect the quality of the signal reception at the flow computer.

4.1.10 Process conditions do not always correlate to flowrates. For example, the minimum temperature or pressure may not occur at the minimum flow. For sizing and specification of flow meters, process conditions shall be assessed for each flow scenario.

4.1.11 Even though not detailed in this document, SELLER is responsible to supply as many orifice plates as necessary for each metering point that uses this technology, to cover the whole flow range required by process conditions and application.



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4.1.12 Manual sampling points shall comply with API MPMS 8 and API MPMS 14.1 recommendations for oil/water and gas, respectively. The sampling process shall be performed in a closed circuit with alignment of the purged gas to the flare system or oil/water to drain system. For further details on sampling points and typical sketches refer to I-ET-3010.00-1200-813-P4X-001 – GENERAL CRITERIA FOR FLOW METERING SYSTEMS and I-ET-3010.00-1200-588-P4X-001 – SAMPLE CONNECTIONS.

4.1.13 Sample cylinders, hoses, couplings, supports, and other items required to sample collection with pressurized cylinders shall be in SELLER scope of supply. For sample cylinder specifications, see I-ET-3000.00-8222-941-PJN-001 – LABORATORY - EQUIPMENT.

4.1.14 NR-13 shall be followed whenever necessary (e.g., filters, cylinders, etc.).

4.1.15 Unless otherwise specifically stated, condensate shall be treated as oil for compliance with ANP and Inmetro requirements.

4.1.16 Fiscal, allocation and custody transfer oil and condensate metering skids shall be installed at a level below the process line and their outlet line shall be at a level above meters so that they operate always filled, with no entrained gas.

4.1.17 Fiscal gas metering skids shall be installed at a level above the process line and their outlet line shall be at a level below meters to prevent condensate accumulation on the metering streams.

4.1.18 FMS shall meet the maximum uncertainty requirements of total oil and gas production. The maximum allowable uncertainty for total volume is 0.6% of produced oil and 3.0% of produced gas.

## 5 FISCAL METERING

### 5.1 Oil Flow Metering

#### 5.1.1 Oil to Cargo Tanks – Fiscal Metering Skid (Z-1212001)

5.1.1.1 Fiscal Metering Skid shall have means to keep production trains segregated and measure the flow of each production train individually.

5.1.1.2 Fiscal Metering Skid shall be composed of, at least:

- I. One fiscal positive displacement meter (FIT-1212008A) to measure 100% of production train A;
- II. One fiscal positive displacement meter (FIT-1212008B) to measure 100% of production train B;
- III. One fiscal positive displacement meter (FIT-1212008C) installed as a standby meter, which may be aligned either to measure production train A or production train B;
- IV. Filters installed upstream of each positive displacement meter, with mesh according to vendor recommendation;
- V. One compact prover (U-Z-1212001), which shall be installed in series to the flow meters and together on the skid structure;
- VI. Pressure and temperature transmitters for each stream and for the compact prover;
- VII. Sampling and analyzer system for each production train, installed downstream of the flow meters. Each production train outlet shall have the below dedicated set of instruments:
  - One mixing system (static or dynamic) installed upstream of BS&W analyzer and sampling systems. The mixer element shall guarantee homogeneity of the mixture for all expected flow range (concentration ratio C1/C2 above 0.9, as per ISO 3171). If static mixer is to be used, it shall be installed in a vertical position with ascending flow along with BS&W analyzer and manual and automatic sampling points;
  - One BS&W analyzer (AIT-1212004 for production train A and AIT-1212001 for production train B) installed downstream of the mixing system;
  - One automatic sampler (AX-1212004 for production train A and AX-1212001 for production train B) installed downstream of the mixing system;
  - One manual sampler (SC-Z-1212001A for production train A and SC-Z-1212001B for production train B) installed downstream of the mixing system, with connection and support for pressurized sample with cylinder and installed on a collecting box type "B", as per I-ET-3010.00-1200-588-P4X-001 – SAMPLE CONNECTIONS.
- VIII. Flow control valves with positioner installed downstream of the meters and compact prover;
- IX. Remote actuated DBB On-Off valves with position switches for meter alignments, installed upstream and downstream of each stream and for prover alignment;
- X. All required drain valves, vent, PSV and piping;
- XI. Junction boxes and control panels, as required;
- XII. Drain collector connected to the drain system of the UNIT;



XIII. Blind spectacles on each metering stream, upstream the filter and downstream the PIT/TIT, so as to allow each meter to become unavailable for legal requirement purposes;

XIV. Access facilities for the meters and instruments.

5.1.1.3 All instruments, field panels and equipment of Fiscal Metering Skid shall be furnished assembled on a single skid, to be lifted and mounted together on Topside of UNIT.

5.1.1.4 Cargo handling facilities (such as monorails) shall be supplied, for flow meters, filters and valves maneuver and maintenance. These facilities may either be supplied together on the skid or integrated on the module.

5.1.1.5 Flow, temperature and pressure transmitters of each stream shall be connected to their respective flow computer that receives and processes all signals to calculate and correct the flow of each metering loop (FQIT-1212008A/C).

5.1.1.6 Fiscal Metering Skid shall comply with accuracy class 0.3 according to OIML R117, with maximum permissible error 0.2% of the measured value for the flow meters and 0.3% for the metering point. Compact prover shall have maximum uncertainty of 0.04%, with 0.02% of maximum repeatability.

5.1.1.7 Each flow meter shall cover the nominal flow ranges specified in Inmetro model approval. The measurement system shall cover the rangeability since the departure of the UNIT, when low flow rates are expected.

5.1.1.8 It shall be confirmed during detail design the need of air eliminator device, as per API MPMS 5.2.

5.1.1.9 In case dynamic mixing (such as jet mixer, power mixer, fast loop) is required to guarantee the homogeneity of the mixture, spare of pump and flow gauge shall be supplied. Seal control of the inlet and outlet skid valves shall be provided to guarantee that the mixer is always operating.

5.1.1.10 BS&W analyzers shall meet the maximum permissible absolute error requirement of 0.05%.

5.1.1.11 BS&W analyzers shall be of retrievable probe type or installed in a bypass line with a diameter smaller than the diameter of the main process line, in order to allow the removal of them without interruption of the whole metering system operation.

5.1.1.12 BS&W analyzers and compact prover shall be connected to the same flow computer. BS&W information shall be shared for all meter streams on the flow computer. Automatic samplers shall be connected to FMS PLC.

5.1.1.13 Automatic samplers shall have a mixing pump connected to the sample containers for closed loop, in order to achieve a homogenous sample of the volume collected inside these containers, thus allowing the operator to take a smaller representative sample to the laboratory.



5.1.1.14 Installation of the homogenizing pump, as well as the cables, connectors and conduits shall be in accordance with IEC 60079 to meet the classified area and all certificates for operation in classified area shall be provided.

5.1.1.15 Electrical components of the compact prover shall be pre-wired to the control panel. The panel enclosure shall meet the requirements for use in hazardous areas (Zone 2, Group IIA, Temperature Class T3, according to IEC-60079) and it shall be proper for marine atmosphere (minimum protection IP-56).

5.1.1.16 All prover seals shall be filled PTFE. The flow tube, end flanges, connection flanges and internals shall be in AISI 316L. Alternatives shall be previously approved by BUYER.

5.1.1.17 Fiscal Metering Skid shall receive, from the FMS panel (PN-1223001), all power supplies of 220 Vac for adequate functioning of its instruments and other components (see item 3). In case power supplies of higher voltage are necessary, these shall be provided by the electrical system panels.

5.1.1.18 Power supply to be provided from FMS panel (PN-1223001) to the BS&W analyzers, automatic samplers and instrumentation shall be confirmed during Detail Design phase.

5.1.1.19 Fiscal Metering Skid shall receive a 690 Vac @ 60 Hz non-essential power supply from the electrical system panels in order to feed the compact prover.

5.1.1.20 Fiscal Metering Skid shall receive, from the flow computer, analogue 4-20 mA signals to be sent to each flow control valve (HV), in order to control process flow rate for calibration purposes and shall receive from the FMS PLC discrete signals to control each on-off valve (XV).

5.1.1.21 There shall be analogue dual pulse outputs from the flow meters, one analogue 4-20 mA output from each flow control valve positioner, PIT and TIT on the skid, and one discrete signal for the Unit Alarm Malfunction (UAM) from each BS&W analyzers to the fiscal crude oil flow computers.

5.1.1.22 There shall be one analogue 4-20 mA output from each PDIT, one discrete output from each automatic sampler and one discrete output from limit switches of each alignment valve to the FMS PLC.

5.1.1.23 Each automatic sampler shall send two discrete signals (LSH-1212004-1/2 and LSH-1212001-1/2) to the FMS PLC indicating that the respective sampling bottle is full. If a sample bottle is full, FMS PLC shall switch the automatic sampler to the other bottle. If both sample bottles are full, FMS PLC shall stop the automatic sampler and generate an alarm at FMS Workstation and SOS HMIs.

5.1.1.24 Each automatic sampler shall receive analogue 4-20 mA signal(s) from the FMS PLC and shall send and receive from the FMS PLC discrete pulse signal(s).

5.1.1.25 There shall be communication between the BS&W analyzers and the flow computer. The communication physical media and protocol between the analyzers and flow computers shall be confirmed during Detail Design phase.

5.1.1.26 For more signal interfaces details of Fiscal Metering Skid see I-DE-3010.2Q-1200-813-P4X-002 – FLOW METERING SYSTEM (FMS) ARCHITECTURE.

5.1.1.27 The piping from Fiscal Metering Skid shall enter and exit according to the restrictions imposed by the layout in I-DE-3010.2Q-1421-942-P4X-002 – M-10B – PRODUCED WATER TREATMENT – EQUIPMENT LAYOUT PLAN. The final layout shall be confirmed during Detail Design phase.

5.1.1.28 Fiscal Metering Skid shall be located downstream of the oil treatment and upstream of the cargo tanks. For more details see I-DE-3010.2Q-1212-944-P4X-001 – CRUDE OIL METERING SYSTEM.

### 5.1.2 Crude Oil Well Service Metering Skid (Z-5133002)

5.1.2.1 Crude Oil Well Service Metering Skid shall measure the crude oil volumes injected on the production wells or service lines through the Well Service Pump to discount, since this fluid will eventually go back to the process plant.

5.1.2.2 Crude Oil Well Service Metering Skid shall be composed of, at least:

- I. Three parallel fiscal mass flow meters, Coriolis type (FIT-5133002A/C), at a 3 x 50% configuration, with local indicator;
- II. Pressure and temperature transmitters for each stream;
- III. One mixing system (static or dynamic) installed on the common header downstream the meters and upstream of BS&W analyzer and sampling systems. The mixer element shall guarantee homogeneity of the mixture for all expected flow range (concentration ratio C1/C2 above 0.9, as per ISO 3171). If static mixer is to be used, it shall be installed in a vertical position with ascending flow along with BS&W analyzer and manual and automatic sampling points;
- IV. One BS&W analyzer (AIT-5133002) installed downstream of the mixing system;
- V. One automatic sampler (AX-5133002) installed downstream of the mixing system;
- VI. One manual sampler (SC-FIT-5133002) installed downstream of the mixing system, as per I-ET-3010.00-1200-588-P4X-001 – SAMPLE CONNECTIONS;
- VII. Flow control valves with positioner installed downstream of the meters;
- VIII. Remote actuated DBB On-Off valves with position switches for meter alignments, installed upstream and downstream of each stream;
- IX. All required drain valves, vent, PSV and piping;
- X. Blind spectacles on each metering stream, upstream the meter and downstream the PIT/TIT, so as to allow each meter to become unavailable, for legal requirement purposes;
- XI. Junction boxes and control panels, as required;
- XII. Drain collector connected to the drain system of the UNIT;
- XIII. Access facilities for the meters and instruments;

5.1.2.3 All instruments, field panels and equipment of Crude Oil Well Service Metering Skid shall be furnished assembled on a single skid, to be lifted and mounted together on Topside of UNIT.



5.1.2.4 Cargo handling facilities (such as monorails) shall be supplied for flow meters and valves maneuver and maintenance. These facilities may either be supplied together on the skid or integrated on the module.

5.1.2.5 Flow, temperature and pressure transmitters of each stream shall be connected to the flow computer that receives and processes all signals to calculate and correct the flow of each metering loop (FQIT-5133002A/C).

5.1.2.6 Flow meters shall be calibrated onboard, assembled on the calibration run of the Offloading Metering Skid (Z-1359501).

5.1.2.7 Crude Oil Well Service Metering Skid shall comply with accuracy class 0.3 according to OIML R117, with maximum permissible relative error 0.2% of the measured value for the flow meters and 0.3% for the metering point.

5.1.2.8 In case dynamic mixing (such as jet mixer, power mixer, fast loop) is required to guarantee the homogeneity of the mixture, spare of pump and flow gauge shall be supplied. Seal control of the inlet and outlet skid valves shall be provided to guarantee that the mixer is always operating.

5.1.2.9 BS&W analyzer shall meet the maximum permissible absolute error requirement of 0.05%.

5.1.2.10 BS&W analyzer shall be of retrievable probe type or installed in a bypass line with a diameter smaller than the diameter of the main process line, in order to allow the removal of them without interruption of the whole metering system operation.

5.1.2.11 BS&W information shall be shared for all meter streams on the flow computer. Automatic sampler shall be connected to FMS PLC.


5.1.2.12 Automatic sampler shall have a mixing pump connected to the sample containers for closed loop, in order to achieve a homogenous sample of the volume collected inside these containers, thus allowing the operator to take a smaller representative sample to the laboratory.

5.1.2.13 Installation of the homogenizing pump, as well as the cables, connectors and conduits shall be in accordance with IEC 60079 to meet the classified area and all certificates for operation in classified area shall be provided.

5.1.2.14 Crude Oil Well Service Metering Skid shall receive, from the FMS panel (PN-1223001), all power supplies of 220 Vac for adequate functioning of its instruments and other components (see item 3). In case power supplies of higher voltage are necessary, these shall be provided by the electrical system panels.

5.1.2.15 Power supply to be provided from FMS panel (PN-1223001) to the BS&W analyzer, automatic sampler and instrumentation shall be confirmed during Detail Design phase.

5.1.2.16 Crude Oil Well Service Metering Skid shall receive, from the flow computer, analogue 4-20 mA signals to be sent to each flow control valve (HV), and shall receive from the FMS PLC discrete signals to control each on-off valve (XV).

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5.1.2.17 There shall be analogue dual pulse outputs from the flow meters, one analogue 4-20 mA output from each flow control valve positioner, PIT and TIT on the skid, and one discrete signal for the Unit Alarm Malfunction (UAM) from the BS&W analyzer to the crude oil well service flow computers.

5.1.2.18 There shall be one discrete output from automatic sampler and one discrete output from limit switches of each alignment valve to the FMS PLC.

5.1.2.19 Automatic sampler shall send two discrete signals (LSH-5133002-1/2) to the FMS PLC indicating that the respective sampling bottle is full. If a sample bottle is full, FMS PLC shall switch the automatic sampler to the other bottle. If both sample bottles are full, FMS PLC shall stop the automatic sampler and generate an alarm at FMS Workstation and SOS HMIs.

5.1.2.20 Automatic sampler shall receive analogue 4-20 mA signal(s) from the FMS PLC and shall send and receive from the FMS PLC discrete pulse signal(s).

5.1.2.21 There shall be communication between the BS&W analyzers and the flow computer. The communication physical media and protocol between the analyzers and flow computers shall be confirmed during Detail Design phase.

5.1.2.22 FIT-5133002A/C metering points shall have an additional link for meter monitoring and diagnostics purposes. This communication shall be done through network and protocol shall be defined during Detail Design phase.

5.1.2.23 The piping from Crude Oil Well Service Metering Skid shall enter and exit according to the restrictions imposed by the layout in I-DE-3010.2Q-1427-942-P4X-002 – M-16B – LAY-DOWN AREA AND SUBMARINE PUMPING UNIT – EQUIPMENT LAYOUT PLAN. The final layout shall be confirmed during Detail Design phase.

5.1.2.24 For more details see I-DE-3010.2Q-5133-944-P4X-001 – DIESEL INJECTION SYSTEM.

## 5.2 Condensate Flow Metering

### 5.2.1 Condensate from Import Gas Metering Skid (Z-5135002)

5.2.1.1 Condensate from Import Gas Metering Skid shall be composed of, at least:

- I. Two parallel fiscal duty ultrasonic flow meters (FIT-5135002A/B), at a 2 x 100% configuration, with local indicator;
- II. One fiscal ultrasonic flow meter as master meter (FIT-5135002C), with local indicator, installed in series to the flow meters for calibration of duty meters (FIT-5135002A/B). One additional master meter shall be supplied as a non-installed spare meter;

Note: Other flow meter technologies may be acceptable if they are suitable for condensate metering under the process conditions as defined by the project. If non-ultrasonic meters are chosen to be used, SELLER shall submit a proposal to BUYER for approval.

- III. Pressure and temperature transmitters for each stream;



- IV. One fast loop sampling system (dynamic mixing) installed downstream of the flow meters to guarantee the homogeneity of the mixture C1/C2 above 0.9 for all expected flow range, as per ISO 3171;
- V. Two on-line densimeters (DIT-5135002A/B) at a 2x100% configuration installed in the fast loop line;
- VI. Two on-line BS&W analyzers (AIT-5135002A/B) at a 2x100% configuration installed in the fast loop line;
- VII. One automatic sampler (AX-5135002) installed downstream of the fast loop;
- VIII. One manual sampler (SC-FIT-5135002) installed downstream of the fast loop, as per I-ET-3010.00-1200-588-P4X-001 – SAMPLE CONNECTIONS;
- IX. Flow control valves with positioner installed for each stream;
- X. Remote actuated DBB On-Off valves with position switches for meter alignments installed upstream and downstream of each stream and for master meter alignment;
- XI. All required drain valves, vent, PSV and piping;
- XII. Junction boxes and control panels, as required;
- XIII. Drain collector connected to the drain system of the unit;
- XIV. Blind spectacles on each metering stream, upstream the meter and downstream the PIT/TIT, so as to allow each meter to become unavailable, for legal requirement purposes;
- XV. Access facilities for the meters and instruments.

5.2.1.2 All instruments, field panels and equipment of Condensate from Import Gas Metering Skid shall be furnished assembled on a single skid, to be lifted and mounted together on Topside of UNIT.

5.2.1.3 Cargo handling facilities (such as monorails) shall be supplied, for flow meters and valves maneuver and maintenance. These facilities may either be supplied together on the skid or integrated on the module.

5.2.1.4 Flow, temperature and pressure transmitters of each stream shall be connected to their respective flow computers, which process all signals to calculate and correct the volumes of each metering loop (FQIT-5135002A/C).

5.2.1.5 Condensate from Import Gas Metering Skid shall comply with accuracy class 0.3 according to OIML R117, with maximum permissible error 0.2% of the measured value for the duty meters, 0.1% for the master meter, and 0.3% for the metering point.

5.2.1.6 Spares shall be provided for pump and flow gauge of the fast loop. Seal control of the inlet and outlet skid valves shall be provided to guarantee that the fast loop is always operating.

5.2.1.7 BS&W analyzers shall meet the maximum permissible absolute error requirement of 0.05%.

5.2.1.8 BS&W analyzers and densimeters shall be connected to the flow computers and information shall be shared for all meter streams on the flow computer. Automatic sampler shall be connected to FMS PLC.

5.2.1.9 Condensate from Import Gas Metering Skid shall receive, from the FMS panel (PN 1223001), all power supplies of 220 Vac for adequate functioning of its instruments



and other components (see item 3). In case power supplies of higher voltage are necessary, these shall be provided by the electrical system panels.

5.2.1.10 Power supply to be provided from FMS panel (PN-1223001) to the BS&W analyzers, densimeters, automatic samplers and instrumentation shall be confirmed during Detail Design phase.

5.2.1.11 Condensate from Import Gas Metering Skid shall receive, from the flow computer, analogue 4-20 mA signals to be sent to each flow control valve (HV), in order to control process flow rate for calibration purposes, and shall receive, from the FMS PLC, discrete signals to control each on-off valve (XV).

5.2.1.12 There shall be analogue dual pulse outputs from the flow meters, one analogue 4-20 mA output from each flow control valve positioner, PIT and TIT on the skid, and one discrete signal for the Unit Alarm Malfunction (UAM) from each BS&W analyzer and densimeters to the flow computers.

5.2.1.13 There shall be one discrete output from automatic sampler and one discrete output from limit switches of each alignment valve to the FMS PLC.

5.2.1.14 The automatic sampler shall send two discrete signals (LSH-5135002A/B-1/2) to the FMS PLC indicating that the respective sampling bottle is full. If a sample bottle is full, FMS PLC shall switch the automatic sampler to the other bottle. If both sample bottles are full, FMS PLC shall stop the automatic sampler and generate an alarm at FMS Workstation and SOS HMIs.

5.2.1.15 The automatic sampler shall receive analogue 4-20 mA signal(s) from the FMS PLC and shall send and receive from the FMS PLC discrete pulse signal(s).

5.2.1.16 Automatic sampler shall have a mixing pump connected to the sample containers for closed loop, in order to achieve a homogenous sample of the volume collected inside these containers, thus allowing the operator to take a smaller representative sample to the laboratory.

5.2.1.17 Installation of the homogenizing pump, as well as the cables, connectors and conduits shall be in accordance with IEC 60079 to meet the classified area and all certificates for operation in classified area shall be provided.

5.2.1.18 There shall be communication between the BS&W analyzers, densimeters and the flow computer. The communication physical media and protocol between the analyzers and flow computers shall be confirmed during Detail Design phase.

5.2.1.19 FIT-5135002A/C metering points shall have an additional link for meter monitoring and diagnostics purposes. This communication shall be done through network and protocol shall be defined during Detail Design phase.

5.2.1.20 The piping from Condensate from Import Gas Metering Skid shall enter and exit according to the restrictions imposed by the layout in I-DE-3010.2Q-1416-942-P4X-001 – M-06 - GAS DEHYDRATION AND FUEL GAS - EQUIPMENT LAYOUT PLAN. The final layout shall be confirmed during Detail Design phase.

5.2.1.21 For more details see I-DE-3010.2Q-5135-944-P4X-001 – IMPORT GAS SLUG CATCHER AND FUEL GAS HEATING.

### 5.3 Gas Flow Metering

#### 5.3.1 HP Flare Gas Metering Point (FIT-5412011)

5.3.1.1 HP Flare Gas Metering Point consists of, at least:

- I. One dual-path ultrasonic transit time flow meter for flare applications, mounted in spool with retrievable sensors (FIT-5412011);
- II. Temperature and pressure transmitters;
- III. Upstream straight run of at least 20D (20 times the nominal diameter of the meter) and downstream straight length of at least 10D (10 times the nominal diameter of the meter);
- IV. Manual sample panel (SC-FIT-5412011), upstream the branch to the Flare Gas Recovery System;
- V. Access facilities for the meters and instruments.

5.3.1.2 Total uncertainty of the metering point shall be less than 5.0%.

5.3.1.3 Electronic unit of flare meter shall communicate with flow computer (FQIT-5412011) using field network (MODBUS RTU protocol).

5.3.1.4 Pressure and temperature transmitters shall be connected to the flow computer, which shall send the signals of transmitters to flare meter by MODBUS if required by flare meter MANUFACTURER.

5.3.1.5 Flow correction to reference conditions shall be done on the flow computer.

5.3.1.6 FIT-5412011 shall provide information through the MODBUS protocol for meter monitoring and diagnostics purposes.

5.3.1.7 Protective shades shall be provided to electronic of flow meter, in order to protect them from effects of large ambient temperature variations due to the flare radiation.

5.3.1.8 Flare meter spool shall have dimensional inspection certificate (including internal diameter) done by laboratory accredited by RBC or ILAC/IAAC.

5.3.1.9 Flare gas sampling point shall collect representative samples even with low pressure levels; therefore a vacuum pump shall be foreseen. Manual samplers are FMS scope of supply.

5.3.1.10 A pair of spare flow meter transducers shall be supplied loose.

5.3.1.11 For more details see I-DE-3010.2Q-5412-944-P4X-001 – HIGH PRESSURE FLARE K.O.DRUM and I-DE-3010.2Q-5412-944-P4X-003 – HIGH/LOW PRESSURE FLARE.

#### 5.3.2 LP Flare Gas Metering Point (FIT-5412010)

5.3.2.1 LP Flare Gas Metering Point consists of, at least:

- I. One dual-path ultrasonic transit time flow meter for flare applications, mounted in spool with retrievable sensors (FIT-5412010);
- II. Temperature and pressure transmitters;
- III. Upstream straight run of at least 20D (20 times the nominal diameter of the meter) and downstream straight length of at least 10D (10 times the nominal diameter of the meter);
- IV. Manual sample panel (SC-FIT-5412010), upstream the branch to the Flare Gas Recovery System;
- V. Access facilities for the meters and instruments.

5.3.2.2 Total uncertainty of the metering point shall be less than 5.0%.

5.3.2.3 Electronic unit of flare meter shall communicate with flow computer (FQIT-5412010) using field network (MODBUS RTU protocol).

5.3.2.4 Pressure and temperature transmitters shall be connected to the flow computer, which shall send the signals of transmitters to flare meter by MODBUS if required by flare meter MANUFACTURER.

5.3.2.5 Flow correction to reference conditions shall be done on the flow computer.

5.3.2.6 FIT-5412010 shall provide information through the MODBUS protocol for meter monitoring and diagnostics purposes.

5.3.2.7 Protective shades shall be provided to electronic of flow meters, in order to protect them from effects of large ambient temperature variations due to the flare radiation.

5.3.2.8 Flare meter spool shall have dimensional inspection certificate (including internal diameter) done by laboratory accredited by RBC or ILAC/IAAC.

5.3.2.9 Flare gas sampling point shall collect representative samples even with low pressure levels; therefore a vacuum pump shall be foreseen. Manual samplers are FMS scope of supply.

5.3.2.10 A pair of spare flow meter transducers shall be supplied loose.

5.3.2.11 For more details see I-DE-3010.2Q-5412-944-P4X-002 – LOW PRESSURE FLARE K.O.DRUM and I-DE-3010.2Q-5412-944-P4X-003 – HIGH/LOW PRESSURE FLARE.

### 5.3.3 Acid Vent Gas Metering Point (FIT-1235003)

5.3.3.1 Acid Vent Gas Metering Point consists of, at least:

- I. One dual-path ultrasonic transit time flow meter for flare applications, mounted in spool with retrievable sensors (FIT-1235003);
- II. Temperature and pressure transmitters;

- III. Upstream straight run of at least 20D (20 times the nominal diameter of the meter) and downstream straight length of at least 10D (10 times the nominal diameter of the meter);
- IV. Manual sample panel (SC-FIT-1235003);
- V. Access facilities for the meters and instruments.

5.3.3.2 Total uncertainty of the metering point shall be less than 5.0%.

5.3.3.3 Electronic unit of meter shall communicate with flow computer (FQIT-1235003) using field network (MODBUS RTU protocol).

5.3.3.4 Pressure and temperature transmitters shall be connected to the flow computer, which shall send the signals of transmitters to flare meter by MODBUS if required by flare meter MANUFACTURER.

5.3.3.5 Flow correction to reference conditions shall be done on the flow computer.

5.3.3.6 FIT-1235003 shall provide information through the MODBUS protocol for meter monitoring and diagnostics purposes.

5.3.3.7 Protective shades shall be provided to electronic of flow meters, in order to protect them from effects of large ambient temperature variations due to the flare radiation.

5.3.3.8 Meter spool shall have dimensional inspection certificate (including internal diameter) done by laboratory accredited by RBC or ILAC/IAAC.

5.3.3.9 Vent gas sampling point shall collect representative samples even with low pressure levels; therefore a vacuum pump shall be foreseen. Manual samplers are FMS scope of supply.

5.3.3.10 A pair of spare flow meter transducers shall be supplied loose.

5.3.3.11 For more details see I-DE-3010.2Q-1235-944-P4X-004 – AMINE REGENERATION PACKAGE.

#### **5.3.4 HP Fuel Gas Metering Point (FIT-5135033)**

5.3.4.1 HP Fuel Gas Metering Point shall be composed of, at least:

- I. Dual chamber orifice fitting (FE-5135033), provided with drains (with DBB valves);
- II. Orifice plates;
- III. Removable upstream (FX-5135033-1 and FX-5135033-3) and downstream (FY-5135033) straight pipe sections, according to ISO 5167-2 requirements and complementary requirements of I-ET-3010.00-1200-813-P4X-001 – GENERAL CRITERIA FOR FLOW METERING SYSTEMS;
- IV. Zanker flow conditioner (FX-5135033-2);
- V. Flow (FIT-5135033-1/2), temperature (TIT-5135033) and pressure (PIT-5135033) transmitters;
- VI. Related sample panel (SC-FIT-5135033) upstream the flow meters, on the common process line;

VII. Access facilities for the meters and instruments.

5.3.4.2 Total uncertainty of metering point for each orifice plate shall be less than 1.5%.

5.3.4.3 Flow, temperature, and pressure transmitters shall be connected to the flow computer (FQIT-5135033) that receives and processes all signals to calculate and correct the flow.

5.3.4.4 For more details see I-DE-3010.2Q-5135-944-P4X-003 – FUEL GAS DISTRIBUTION.

### 5.3.5 LP Fuel Gas Metering Point (FIT-5135013)

5.3.5.1 LP Fuel Gas Metering Point shall be composed of, at least:

- I. Dual chamber orifice fitting (FE-5135013), provided with drains (with DBB valves);
- II. Orifice plates;
- III. Removable upstream (FX-5135013-1 and FX-5135013-3) and downstream (FY-5135013) straight pipe sections, according to ISO 5167-2 requirements and complementary requirements of I-ET-3010.00-1200-813-P4X-001 – GENERAL CRITERIA FOR FLOW METERING SYSTEMS;
- IV. Zanker flow conditioner (FX-5135013-2);
- V. Flow (FIT-5135013-1/2), temperature (TIT-5135013) and pressure transmitters (PIT-5135013);
- VI. Related sample panel (SC-FIT-5135013) upstream the flow meters, on the common process line;
- VII. Access facilities for the meters and instruments.

5.3.5.2 Total uncertainty of each flow meter loop shall be less than 1.5%.

5.3.5.3 Flow, temperature, and pressure transmitters shall be connected to the flow computer (FQIT-5135013) that receives and processes all signals to calculate and correct the flow.

5.3.5.4 For more details see I-DE-3010.2Q-5135-944-P4X-003 – FUEL GAS DISTRIBUTION.

### 5.3.6 Gas Blanketing Recovery Metering Point (FIT-1350007)

5.3.6.1 Gas Blanketing Recovery Metering Point shall measure the natural gas at the outlet of the hydrocarbon blanketing system that returns to the process, at the outlet of the compression of the Structural Tanks Gas Recovery Unit (UC-Z-1350001).

5.3.6.2 Gas Blanketing Recovery Metering Point shall be composed of, at least:

- I. Dual chamber orifice fitting (FE-1350007), provided with drains (with DBB valves);
- II. Orifice plates;
- III. Removable upstream (FX-1350007-1 and FX-1350007-3) and downstream (FY-1350007) straight pipe sections, according to ISO 5167-2 requirements and

complementary requirements of I-ET-3010.00-1200-813-P4X-001 – GENERAL CRITERIA FOR FLOW METERING SYSTEMS;

- IV. Zanker flow conditioner (FX-1350007-2);
- V. Flow (FIT-1350007-1/2), temperature (TIT-1350007) and pressure transmitters (PIT-1350007);
- VI. Related sample panel (SC-FIT-1350007) upstream the flow meter;
- VII. Blind spectacle upstream the FX-1350007-1 straight pipe section, so as to allow metering point to become unavailable, for legal requirement purposes;
- VIII. Access facilities for the meters and instruments.

5.3.6.3 Total uncertainty of the metering point for each orifice plate shall be less than 1.5%.

5.3.6.4 Flow, temperature, and pressure transmitters shall be connected to the flow computer (FQIT-1350007) that receives and processes all signals to calculate and correct the flow.

5.3.6.5 For more details see I-DE-3010.2Q-1350-944-P4X-004 – STRUCTURAL TANKS GAS RECOVERY SYSTEM.

### 5.3.7 Gas Blanketing Inlet Metering Point (FIT-1350001)

5.3.7.1 Gas Blanketing Inlet Metering Point shall measure the natural gas consumed by the hydrocarbon blanketing system.

5.3.7.2 Gas Blanketing Inlet Metering Point shall be composed of, at least:

- I. Dual chamber orifice fitting (FE-1350001), provided with drains (with DBB valves);
- II. Orifice plates;
- III. Removable upstream (FX-1350001-1 and FX-1350001-3) and downstream (FY-1350001) straight pipe sections, according to ISO 5167-2 requirements and complementary requirements of I-ET-3010.00-1200-813-P4X-001 – GENERAL CRITERIA FOR FLOW METERING SYSTEMS;
- IV. Zanker flow conditioner (FX-1350001-2);
- V. Flow (FIT-1350001-1/2), temperature (TIT-1350001) and pressure transmitters (PIT-1350001);
- VI. Related sample panels (SC-FIT-1350001) upstream the flow meter;
- VII. Blind spectacle upstream the FX-1350001-1 straight pipe section, so as to allow metering point to become unavailable, for legal requirement purposes;
- VIII. Access facilities for the meters and instruments.

5.3.7.3 Total uncertainty of the metering point for each orifice plate shall be less than 1.5%.

5.3.7.4 Flow, temperature, and pressure transmitters shall be connected to the flow computer (FQIT-1350001) that receives and processes all signals to calculate and correct the flow.

5.3.7.5 For more details see I-DE-3010.2Q-1350-944-P4X-004 – STRUCTURAL TANKS GAS RECOVERY SYSTEM.

### 5.3.8 Gas Export/Import Metering Skid (Z-1231001)

5.3.8.1 Gas Export/Import Metering Skid shall measure bidirectional flow, in order to measure both the exported and imported gas on the pipeline.

5.3.8.2 Flow preference is in direction of the gas being exported. Therefore, when mentioned “downstream” or “outlet” of the skid, it shall be considered from the gas export perspective.

5.3.8.3 Gas Export/Import Metering Skid shall be composed of, at least:

- I. Two parallel ultrasonic duty flow meters (FIT-1231001A/B), at a 2 x 100% configuration, with local indicator;
- II. One ultrasonic master meter (FIT-1231001C) with local indicator, installed in series to the flow meters for calibration of duty flow meters (FIT-1231001A/B);
- III. One additional master meter shall be supplied as a non-installed spare;
- IV. Two temperature transmitters (downstream and upstream of the meter) and one pressure transmitter for each stream;
- V. Removable straight runs (FX-1231001A/C-1, FX-1231001A/C-3, FX-1231001A/C-4, and FX-1231001A/C-6) and flow conditioners (FX-1231001A/C-2 and FX-1231001A/C-5) for each stream, in accordance with meter respective Inmetro type approval or ISO 17089, whichever it is more restrict;
- VI. One manual sample panel (SC-FIT-1231001), installed on the common header;
- VII. One chromatograph analyzer (AIT-1231001), installed on the common header;
- VIII. Flow control valves with positioner for each stream;
- IX. Remote actuated DBB On-Off valves with position switches for meter alignments installed upstream and downstream of each stream and for master meter alignment;
- X. All required valves, drains, PSV and piping;
- XI. Junction boxes and control panels, as required;
- XII. Blind spectacles on each metering stream, upstream and downstream the meter stream, so as to allow each meter to become unavailable, for legal requirement purposes;
- XIII. Access facilities for the meters and instruments.

5.3.8.4 All instruments, field panels and equipment of Gas Export/Import Metering Skid shall be furnished assembled on a single skid, to be lifted and mounted together on Topside of UNIT.

5.3.8.5 Cargo handling facilities (such as monorails) shall be supplied, for flow meters and valves maneuver and maintenance. These facilities may either be supplied together on the skid or integrated on the module.

5.3.8.6 Flow, temperature and pressure transmitters of each stream shall be connected to their respective flow computers, which process all signals to calculate and correct the volumes of each metering loop (FQIT-1231001A/C).

5.3.8.7 Gas Export/Import Metering Skid shall comply with accuracy class 0.5 according to OIML R137, with maximum uncertainty of 0.7% for the duty meters and 0.5% for the master meter. The total uncertainty of the metering point shall be less than 1.0%.



5.3.8.8 Chromatograph analyzer shall read hydrocarbon composition (at least C9+), CO<sub>2</sub>, H<sub>2</sub>S and N<sub>2</sub> and have a maximum uncertainty of 0.3% on the compressibility factor.

5.3.8.9 The FMS shall implement a logic to validate the online chromatograph results prior to update it on flow computer. On successive chromatograph invalidation, an alarm shall be indicated on both FMS and SOS HMIs.

5.3.8.10 Gas Export/Import Metering Skid shall receive, from the FMS panel (PN-1223001), all power supplies of 220 Vac for adequate functioning of its instruments and other components (see item 3). In case power supplies of higher voltage are necessary, these shall be provided by the electrical system panels.

5.3.8.11 Gas Export/Import Metering Skid shall receive, from the flow computer, analogue 4-20 mA signals to be sent to each flow control valve (HV), in order to control process flow rate for calibration purposes, and shall receive, from the FMS PLC, discrete signals to control each on-off valve (XV).

5.3.8.12 There shall be analogue dual pulse outputs from the flow meters, one analogue 4-20 mA output from each flow control valve positioner, PIT and TIT on the skid, and one discrete signal for the Unit Alarm Malfunction (UAM) from the chromatograph analyzer to the flow computer.

5.3.8.13 There shall be one discrete output from limit switches of each alignment valve to the FMS PLC.

5.3.8.14 Straight pipe runs as well as flow conditioners shall have dimensional inspection certificate done by laboratory accredited by RBC or ILAC/IAAC.

5.3.8.15 FIT-1231001A/C metering points shall have an additional link for meter monitoring and diagnostics purposes. This communication shall be done through network and protocol shall be defined during Detail Design Phase.

5.3.8.16 SELLER shall guarantee that ultrasonic transducers will not be damaged by gas percolation when operating at high pressure.

5.3.8.17 As the skid is bidirectional, SELLER shall guarantee that the acoustic noise generated by the control valve when it is modulating upstream of the meter does not interfere with the quality of the flow measurement.

5.3.8.18 On flow computers, there shall be implemented segregate variables and totalizers for export and import volumes.

5.3.8.19 The piping from Gas Export/Import Metering Skid shall enter and exit according to the restrictions imposed by the layout in I-DE-3010.2Q-1413-942-P4X-001 – M-03 – EXPORT GAS COMPRESSION – EQUIPMENT LAYOUT PLAN. Arrangement shall avoid condensate accumulation on the meters. The final layout shall be confirmed during Detail Design phase.

5.3.8.20 For more details see I-DE-3010.2Q-1231-944-P4X-012 – LIFT GAS AND EXPORTATION HEADERS – PIG LAUNCHER/RECEIVER.



### 5.3.9 Flare Pilot Metering Point (FIT-5412009)

5.3.9.1 Flare Pilot Metering Point consists of, at least:

- I. One fiscal mass flow meter (category D), Coriolis type (FE-5412009), with local indicator;
- II. One spare flow meter, supplied loose;
- III. Temperature (TIT-5412009) and pressure (PIT-5412009) transmitters;
- IV. Related sample panels (SC-FIT-5412009) upstream the flow meter;
- V. Block valves;
- VI. Access facilities for the meters and instruments.

5.3.9.2 Flare Pilot Metering Point shall comply with accuracy class 0.5 according to OIML R137, with maximum uncertainty of 0.7% for the duty meters and 0.5% for the master meter. The total uncertainty of the metering point shall be less than 1.0%.

5.3.9.3 There shall be analogue dual pulse output from the flow meter and temperature and pressure transmitters shall be connected to the flow computer (FQIT-5412009) that receives and processes all signals to calculate and correct the flow.

5.3.9.4 FIT-5412009 meter shall have an additional link for meter monitoring and diagnostics purposes. This communication shall be done through network and protocol shall be defined during Detail Design phase.

5.3.9.5 For more details see I-DE-3010.2Q-5412-944-P4X-003 – HIGH/LOW PRESSURE FLARE.

## 6 ALLOCATION METERING

### 6.1 Multiphase Flow Metering System

6.1.1.1 The allocation of the wells shall be done by topside and subsea multiphase meters for satellite and manifolded wells, respectively. The Test Separator's outlet flow meters have the function of verifying the performance of the topside multiphase meters. In contingency case, the well allocation may be carried out by these flow meters that are installed downstream of the Test Separator (SG-1223003).

6.1.1.2 For more details of Multiphase Flow Metering System see I-ET-3010.2Q-1200-800-P4X-004 – MULTIPHASE FLOW METERING SYSTEM (MFMS)

### 6.2 Oil Flow Metering

#### 6.2.1 Oil from Test Separator Metering Point (FIT-1223023A/C)

6.2.1.1 Oil from Test Separator Metering Point shall be composed of, at least:

- I. Three parallel duty mass flow meters, Coriolis type, at a 2 x 50% for high flow range (FIT-1223023A/B) and 1 x 100% for low flow range (FIT-1223023C) configuration, with local indicator;
- II. Pressure and temperature transmitters for each stream;
- III. One mixing system (static or dynamic) installed on the common header and upstream of BS&W analyzer and sampling systems. The mixer element shall guarantee homogeneity of the mixture for all expected flow range (concentration ratio C1/C2 above 0.9, as per ISO 3171). If static mixer is to be used, it shall be installed in a vertical position with ascending flow along with BS&W analyzer and manual and automatic sampling points;
- IV. One in-line BS&W analyzer (AIT-1223023) microwave technology, installed downstream of the mixing system;
- V. One automatic sampler (AX-1223023) installed downstream of the mixing system;
- VI. One manual sampler (SC-FIT-1223023) installed downstream of the mixing system, using probes of 5 internal bundle type. Sampler shall foresee pressurized connection for cylinder for PVT samples and installed on a collecting box type "B", as per I-ET-3010.00-1200-588-P4X-001 – SAMPLE CONNECTIONS;
- VII. Double block and bleed valves for meter alignments;
- VIII. Access facilities for the meters and instruments.

6.2.1.2 The metering system shall be installed below the SG-1223003 with enough height to deviate the oil from saturation, thus preventing the formation of gases and vapor through the flow meters when the pumps B-1223003A/B are not operating.

6.2.1.3 Flow meters shall be calibrated onboard, assembled on the calibration run of the Offloading Metering Skid (Z-1359501).

6.2.1.4 Cargo handling facilities (such as monorails) shall be supplied to remove flow meters to calibrate them on the Offloading Metering Skid (Z-1359501).



6.2.1.5 FIT-1223023A/C metering points shall comply with accuracy class 1.0 according to OIML R117, with maximum permissible error 0.6% of the measured value for the flow meter and 1.0% for the metering point.

6.2.1.6 Flow, temperature, pressure transmitters and BS&W analyzer shall be connected to the flow computer (FQIT-1223023A/C) that receives and processes all signals to calculate and correct the flow. Automatic sampler shall be connected to FMS PLC. The communication physical media and protocol between the analyzer and flow computer shall be confirmed during Detail Design phase.

6.2.1.7 BS&W analyzer and manual and automatic samplers are part of the FMS scope of supply.

6.2.1.8 In case dynamic mixing (such as jet mixer, power mixer, fast loop) is required to guarantee the homogeneity of the mixture, spare of pump and flow gauge shall be supplied. Seal control of the inlet and outlet skid valves shall be provided to guarantee that the mixer is always operating.

6.2.1.9 The automatic sampler shall have a mixing pump connected to the sample containers for closed loop, in order to achieve a homogenous sample of the volume collected inside these containers, thus allowing the operator to take a smaller representative sample to the laboratory.

6.2.1.10 The installation of the homogenizing pump, as well as the cables, connectors and conduits shall be in accordance with IEC 60079 to meet the classified area and all certificates for operation in classified area shall be provided.

6.2.1.11 Power supply to be provided from FMS panel (PN-1223001) to the BS&W analyzer, automatic sampler and instrumentation shall be confirmed during Detail Design phase.


6.2.1.12 There shall be analogue dual pulse outputs from the flow meters, one analogue 4-20 mA output from each PIT and TIT, and one discrete signal for the Unit Alarm Malfunction (UAM) from the BS&W analyzer to the flow computer.

6.2.1.13 Automatic sampler shall send two discrete signals (LSH-1223023-1/2) to the FMS PLC indicating that the respective sampling bottle is full. If a sample bottle is full, FMS PLC shall switch the automatic sampler to the other bottle. If both sample bottles are full, FMS PLC shall stop the automatic sampler and generate an alarm at FMS Workstation and SOS HMIs.

6.2.1.14 Automatic sampler (AX-1223023) shall receive analogue 4-20 mA signal(s) from the FMS PLC and shall send and receive from the FMS PLC discrete pulse signal(s).

6.2.1.15 FIT-1223023A/C metering points shall have an additional link for meter monitoring and diagnostics purposes. This communication shall be done through network and protocol shall be defined during Detail Design phase.

6.2.1.16 For more details see I-DE-3010.2Q-1223-944-P4X-027 – TEST SEPARATOR OIL PUMP.

 <b>PETROBRAS</b>	<b>TECHNICAL SPECIFICATION</b>	<b>I-ET-3010.2Q-1200-800-P4X-003</b>	REV.: <b>B</b>
	MARLIM LESTE E SUL		SHEET: 33 of 57
	TITLE:	FLOW METERING SYSTEM (FMS)	
		ESUP	
			INTERNAL

### 6.3 Gas Flow Metering

#### 6.3.1 Gas from Test Separator Metering Point (FIT-1223074)

6.3.1.1 Gas from Test Separator Metering Point consists of, at least:

- I. Dual chamber orifice fitting (FE-1223074), provided with drains (with DBB valves);
- II. Orifice plates;
- III. Removable upstream (FX-1223074-1 and FX-1223074-3) and downstream (FY-1223074) straight pipe sections, according to ISO 5167-2 requirements and complementary requirements of I-ET-3010.00-1200-813-P4X-001 – GENERAL CRITERIA FOR FLOW METERING SYSTEMS;
- IV. Zanker flow conditioner (FX-1223074-2);
- V. Flow (FIT-1223074-1/2), temperature (TIT-1223074) and pressure (PIT-1223074) transmitters;
- VI. Related sample panel (SC-FIT-1223074) upstream the flow meter;
- VII. Access facilities for the meters and instruments.

6.3.1.2 Total uncertainty of the metering point for each orifice plate shall be less than 2.0%.

6.3.1.3 Flow, temperature, and pressure transmitters shall be connected to the flow computer (FQIT-1223074) that receives and processes all signals to calculate and correct the flow.

6.3.1.4 Care shall be taken to prevent pressure drop in the flow meter in order to avoid the condensate accumulation, such as thermal insulation for the pipes, positioning the meter as close as possible to the test separator (SG-1223003) and having an upward slope on piping.

6.3.1.5 Dual chamber orifice fitting drain shall be connected to closed drain through a DBB valve and blind spectacle.

6.3.1.6 For more details see I-DE-3010.2Q-1223-944-P4X-026 – TEST HEATER/TEST SEPARATOR.

#### 6.3.2 Individual Gas Lift per Well Metering Point – Satellite Production Well (FIT-1244001A/G)

6.3.2.1 Each Individual Gas Lift per Well Metering Point consists of, at least:

- I. Dual chamber orifice fitting (FE-1244001A/G), provided with drains (with DBB valves);
- II. Orifice plates;
- III. Removable upstream (FX-1244001A/G-1 and FX-1244001A/G-3) and downstream (FY-1244001A/G) straight pipe sections, according to ISO 5167-2 requirements and complementary requirements of I-ET-3010.00-1200-813-P4X-001 – GENERAL CRITERIA FOR FLOW METERING SYSTEMS;
- IV. Zanker flow conditioner (FX-1244001A/G-2);
- V. Flow transmitters with range extension, temperature and pressure transmitters;

- VI. Blind spectacle upstream the FX-1244001A/G-1 straight pipe section, so as to allow each meter to become unavailable, for legal requirement purposes;
- VII. Access facilities for the meters and instruments.

6.3.2.2 Total uncertainty of the loop shall be less than 2.0%.

6.3.2.3 Flow, temperature, and pressure transmitters shall be connected to the flow computer (FQIT-1244001A/G) that receives and processes all signals to calculate and correct the flow.

6.3.2.4 For sampling of individual gas lift, total gas lift sampling panel shall be used. To achieve this, there shall be no gas stream entering or chemical injection line between the total gas lift sampling point and the individual gas lift flow meters.

6.3.2.5 For more details, see I-DE-3010.2Q-1244-944-P4X-001 – WELL PIG LAUNCHERS (LP-1244001A/B), I-DE-3010.2Q-1244-944-P4X-002 – WELL PIG LAUNCHERS (LP-1244001C/D), I-DE-3010.2Q-1244-944-P4X-003 – WELL PIG LAUNCHERS (LP-1244001E/F), and I-DE-3010.2Q-1244-944-P4X-004 – WELL PIG LAUNCHERS (LP-1244001G/H).

### **6.3.3 Gas Lift Individual per Manifold Metering Point – Manifolded Well (FIT-1244001H#K#L#N#Q#S#T#V#X)**

6.3.3.1 Each Gas Lift Individual per Manifold Metering Point consists of, at least:

- I. Dual chamber orifice fitting (FE-1244001H#K#L#N#Q#S#T#V#X), provided with drains (with DBB valves);
- II. Orifice plates;
- III. Removable upstream (FX-1244001H#K#L#N#Q#S#T#V#X-1 and FX-1244001H#K#L#N#Q#S#T#V#X-3) and downstream (FY-1244001H#K#L#N#Q#S#T#V#X) straight pipe sections, according to ISO 5167-2 requirements and complementary requirements of I-ET-3010.00-1200-813-P4X-001 – GENERAL CRITERIA FOR FLOW METERING SYSTEMS;
- IV. Zanker flow conditioner (FX-1244001H#K#L#N#Q#S#T#V#X-2);
- V. Flow transmitters with range extension, temperature and pressure transmitters;
- VI. Blind spectacles upstream the FX-1244001H/K/L/N/Q/S/T/V/X-1 straight pipe sections, so as to allow each meter to become unavailable, for legal requirement purposes;
- VII. Access facilities for the meters and instruments.

6.3.3.2 Total uncertainty of the metering point for each orifice plate shall be less than 2.0%.

6.3.3.3 Flow, temperature and pressure transmitters shall be connected to the flow computer (FQIT-1244001H#K#L#N#Q#S#T#V#X) that receives and processes all signals to calculate and correct the flow.

6.3.3.4 For sampling of individual gas lift, total gas lift sampling panel shall be used. To achieve this, there shall be no gas stream entering or chemical injection line between the total gas lift sampling point and the individual gas lift flow meters.

6.3.3.5 For more details see I-DE-3010.2Q-1244-944-P4X-004 – WELL PIG LAUNCHERS (LP-1244001G/H), I-DE-3010.2Q-1244-944-P4X-005 – WELL PIG LAUNCHERS (LP-1244001J/K), I-DE-3010.2Q-1244-944-P4X-006 – WELL PIG LAUNCHERS (LP-1244001L/M), I-DE-3010.2Q-1244-944-P4X-007 – WELL PIG LAUNCHERS (LP-1244001N/P), I-DE-3010.2Q-1244-944-P4X-008 – WELL PIG LAUNCHERS (LP-1244001Q/R), I-DE-3010.2Q-1244-944-P4X-009 – WELL PIG LAUNCHERS (LP-1244001S/T), I-DE-3010.2Q-1244-944-P4X-010 – WELL PIG LAUNCHERS (LP-1244001U/V), and I-DE-3010.2Q-1244-944-P4X-011 – WELL PIG LAUNCHERS (LP-1244001W/X).

### **6.3.4 Gas Lift Individual per Well Metering Point – Manifold Test Line (FIT-1244001J#M#P#R#U#W#Y)**

6.3.4.1 Each Gas Lift Individual per Well Metering Point consists of, at least:

- I. Dual chamber orifice fittings (FE-1244001J#M#P#R#U#W#Y), provided with drains (with DBB valves);
- II. Orifice plates;
- III. Removable upstream (FX-1244001J#M#P#R#U#W#Y-1 and FX-1244001J#M#P#R#U#W#Y-3) and downstream (FY-1244001J#M#P#R#U#W#Y) straight pipe sections, according to ISO 5167-2 requirements and complementary requirements of I-ET-3010.00-1200-813-P4X-001 – GENERAL CRITERIA FOR FLOW METERING SYSTEMS;
- IV. Zanker flow conditioner (FX-1244001J#M#P#R#U#W#Y-2);
- V. Flow transmitters with range extension, temperature and pressure transmitters;
- VI. Blind spectacle upstream the FX-1244001J#M#P#R#U#W#Y-1 straight pipe section, so as to allow each meter to become unavailable, for legal requirement purposes;
- VII. Access facilities for the meters and instruments.

6.3.4.2 Total uncertainty of the loop shall be less than 2.0%.

6.3.4.3 Flow, temperature and pressure transmitters shall be connected to the flow computer (FQIT-1244001J#M#P#R#U#W#Y) that receives and processes all signals to calculate and correct the flow.

6.3.4.4 For individual gas lift sampling, the total gas lift sampling panel shall be used. To achieve this, there shall be no gas stream entering or chemical injection line between the total gas lift sampling point and the individual gas lift flow meters.

6.3.4.5 For more details see I-DE-3010.2Q-1244-944-P4X-005 – WELL PIG LAUNCHERS (LP-1244001J/K), I-DE-3010.2Q-1244-944-P4X-006 – WELL PIG LAUNCHERS (LP-1244001L/M), I-DE-3010.2Q-1244-944-P4X-007 – WELL PIG LAUNCHERS (LP-1244001N/P), I-DE-3010.2Q-1244-944-P4X-008 – WELL PIG LAUNCHERS (LP-1244001Q/R), I-DE-3010.2Q-1244-944-P4X-010 – WELL PIG LAUNCHERS (LP-1244001U/V), I-DE-3010.2Q-1244-944-P4X-011 – WELL PIG LAUNCHERS (LP-1244001W/X), and I-DE-3010.2Q-1244-944-P4X-012 – WELL PIG LAUNCHERS (LP-1244001Y).

## 7 CUSTODY TRANSFER METERING

### 7.1 Oil Flow Metering

#### 7.1.1 Offloading Transfer Metering Skid (Z-1359501)

7.1.1.1 Offloading Transfer Metering Skid shall measure the crude oil volumes transferred during the offloading process.

7.1.1.2 Offloading Transfer Metering Skid shall be specified, acquired, installed and commissioned by SELLER. It serves the Hull offloading system, but it is installed on Topsides.

7.1.1.3 Offloading Transfer Metering Skid shall be composed of, at least:

- I. Five parallel Custody Transfer positive displacement meters (FIT-1359501A/E) at a 5 x 25% configuration;
- II. Filters installed upstream of each positive displacement meter, with mesh according to vendor recommendation;
- III. One calibration run in series with the positive displacement meters, for calibration of oil meters (see item 7.1.1.14), with a virtual tag (FIT-1359502) to be linked to flow computer. Blind flanges with seal shall be installed when no meter is mounted. This stream shall have alignment only to the compact prover and no direct alignment to the outlet header of the skid;
- IV. One compact prover (U-Z-1359501), which shall be installed in series to the flow meters and together on the skid structure;
- V. Pressure and temperature transmitters for each stream (including the calibration one) and for the compact prover;
- VI. One dynamic mixing system installed on the common header and upstream of BS&W analyzer and sampling systems. The mixer system shall guarantee homogeneity of the mixture for all expected flow range (concentration ratio C1/C2 above 0.9, as per ISO 3171);
- VII. One BS&W analyzer (AIT-1359501) installed downstream of the mixing system;
- VIII. One automatic sampler (AX-1359501) installed downstream of the mixing system;
- IX. One manual sampler (SC-Z-1359501) installed downstream of the mixing system, as per I-ET-3010.00-1200-588-P4X-001 – SAMPLE CONNECTIONS;
- X. Flow control valves with positioner installed downstream of the meters and compact prover;
- XI. Remote actuated DBB On-Off valves with position switches for meter alignments, installed upstream and downstream of each stream and for prover alignment;
- XII. All required drain valves, vent, PSV and piping;
- XIII. Junction boxes and control panels, as required;
- XIV. Drain collector connected to the drain system of the UNIT;
- XV. Blind spectacles on each metering stream, upstream the filter and downstream the PIT/TIT, so as to allow each meter to become unavailable, for legal requirement purposes;
- XVI. Access facilities for the meters and instruments.



7.1.1.4 All instruments, field panels and equipment of Offloading Transfer Metering Skid shall be furnished assembled on a single skid, to be lifted and mounted together on Topside of UNIT.

7.1.1.5 Cargo handling facilities (such as monorails) shall be supplied, for flow meters, filters and valves maneuver and maintenance. These facilities may either be supplied together on the skid or integrated on the module.

7.1.1.6 Design flow rate of the Offloading Transfer Metering Skid shall cover the total maximum flow rate of the offloading pumps, with addition of a 10% margin. See I-ET-3010.00-1359-940-P4X-002 – OFFLOADING SYSTEM for further details.

7.1.1.7 Flow, temperature, and pressure transmitters of each stream shall be connected to their respective flow computer that receives and processes all signals to calculate and correct the flow of each metering loop (FQIT-1359501A/E).

7.1.1.8 Offloading Transfer Metering Skid shall comply with accuracy class 0.3 according to OIML R117, with maximum permissible error 0.2% of the measured value for the flow meters and 0.3% for the metering point. Compact prover shall have maximum uncertainty of 0.04%, with 0.02% of maximum repeatability.

7.1.1.9 It shall be confirmed during detail design the need of air eliminator device, as per API MPMS 5.2.

7.1.1.10 Each flow meter shall cover the nominal flow ranges specified in Inmetro model approval.

7.1.1.11 Dynamic mixing system (such as jet mixer, power mixer, fast loop) shall be supplied in order to minimize pressure drop on the system. It shall be supplied spares for pump and flow gauge, if applicable.

7.1.1.12 BS&W analyzers shall meet the maximum permissible absolute error requirement of 0.05%.

7.1.1.13 BS&W analyzers shall be of retrievable probe type or installed in a bypass line with a diameter smaller than the diameter of the main process line, in order to allow the removal of them without interruption of the whole metering system operation.

7.1.1.14 Calibration run shall be designed to allow the calibration of the Crude Oil Well Service Pump meters (FIT-5133002A/C), the test separator oil flow meters (FIT-1223023A/C) and the operational oil flow meters (FIT-1223054A/B-1/2, FIT-1223932A/B-1/2, FIT-1223536A/C, FIT-1223050) using the compact prover (U-Z-1359501). A virtual tag FIT-1359502 shall be implemented on flow computer for calculations purposes. Pressure and temperature transmitters (PIT-1359502 and TIT-1359502) shall be installed locally for these calculations and flow correction, on the same pipe diameter of the meter flange. Additional pipe spools may be required to allow the listed meters to be installed on the calibration stream.

7.1.1.15 BS&W analyzer and compact prover shall be connected to the same flow computer. BS&W information shall be shared for all meter streams on the flow computer. Automatic sampler shall be connected to FMS PLC.



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7.1.1.16 Automatic sampler shall have a mixing pump connected to the sample containers for closed loop, in order to achieve a homogenous sample of the volume collected inside these containers, thus allowing the operator to take a smaller representative sample to the laboratory.

7.1.1.17 Installation of the homogenizing pump, as well as the cables, connectors and conduits shall be in accordance with IEC 60079 to meet the classified area and all certificates for operation in classified area shall be provided.

7.1.1.18 Electrical components of the compact prover shall be pre-wired to the control panel. The panel enclosure shall meet the requirements for use in hazardous areas (Zone 2, Group IIA, Temperature Class T3, according to IEC-60079) and it shall be proper for marine atmosphere (minimum protection IP-56).

7.1.1.19 All prover seals shall be filled PTFE. The flow tube, end flanges, connection flanges and internals shall be in AISI 316L. Alternatives shall be previously approved by BUYER.

7.1.1.20 Offloading Transfer Metering Skid shall receive, from the FMS panel (PN-1223001), all power supplies up to 220 Vac for adequate functioning of its instruments and other components (see item 3). In case power supplies of higher voltage are necessary, these shall be provided by the electrical system panels.

7.1.1.21 Power supply to be provided from FMS panel (PN-1223001) to the BS&W analyzer, automatic sampler and instrumentation shall be confirmed during Detail Design phase.

7.1.1.22 Offloading Transfer Metering Skid shall receive a 690 Vac @ 60 Hz power supply from the electrical system panels in order to feed the compact prover.

7.1.1.23 Offloading Transfer Metering Skid shall receive, from the flow computer, analogue 4-20 mA signals to be sent to each flow control valve (HV), in order to control process flow rate for calibration purposes and shall receive from FMS PLC discrete signals to control each on-off valve (XV).

7.1.1.24 There shall be analogue dual pulse outputs from the flow meters, one analogue 4-20 mA output from each flow control valve positioner, PIT and TIT on the skid, and one discrete signal for the Unit Alarm Malfunction (UAM) from BS&W analyzer to the offloading custody transfer flow computers.

7.1.1.25 There shall be one analogue 4-20 mA output from each PDIT, one discrete output from the automatic sampler and one discrete output from limit switches of each alignment valve to the FMS PLC.

7.1.1.26 Automatic sampler shall send two discrete signals (LSH-1359501-1/2) to the FMS PLC indicating that the respective sampling bottle is full. If a sample bottle is full, FMS PLC shall switch the automatic sampler to the other bottle. If both sample bottles are full, FMS PLC shall stop the automatic sampler and generate an alarm at FMS Workstation and SOS HMIs.



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7.1.1.27 Automatic sampler shall receive analogue 4-20 mA signal(s) from the FMS PLC and shall send and receive from the FMS PLC discrete pulse signal(s).

7.1.1.28 There shall be communication between the BS&W analyzer and the flow computer. The communication physical media and protocol between analyzer and flow computers shall be confirmed during Detail Design phase.

7.1.1.29 For more signal interfaces details of Offloading Transfer Metering Skid see I-DE-3010.2Q-1200-813-P4X-002 – FLOW METERING SYSTEM (FMS) ARCHITECTURE.

7.1.1.30 The piping from Offloading Transfer Metering Skid shall enter and exit according to the restrictions imposed by the layout in I-DE-3010.2Q-1427-942-P4X-002– M-16B - LAY-DOWN AREA AND SUBMARINE PUMPING UNIT - EQUIPMENT LAYOUT PLAN. The final layout shall be confirmed during Detail Design phase.

7.1.1.31 For more details see I-DE-3010.2Q-1350-944-P4X-003 – CARGO SYSTEM.

## 8 OPERATIONAL METERING

### 8.1 Oil Flow Metering

#### 8.1.1 Oil from HP Separators Metering Point (FIT-1223054A/B-1/2)

8.1.1.1 Each production train shall have one Oil from HP Separators Metering point that measure oil volume at the outlet of HP Separators (SG-1223001A/B).

8.1.1.2 Each Oil from HP Separators Metering point consists of, at least:

- I. Two parallel mass flow meters, Coriolis type (FIT-1223054A-1/2 for production train A and FIT-1223054B-1/2 for production train B) at a 2 x 100% configuration, with local indicator;
- II. Pressure and temperature transmitters for each stream;
- III. One manual sampler (SC-FIT-1223054A for production train A and SC-FIT-1223054B for production train B) installed on the common header downstream of the flow meters;
- IV. Bypass and block valves;
- V. Access facilities for the meters and instruments.

8.1.1.3 Flow, temperature and pressure transmitters shall be connected to respective flow computer (FQIT-1223054A/B-1/2) that receives and processes all signals to calculate and correct the flow.

8.1.1.4 The metering system shall be installed below the SG-1223001A/B with enough height to deviate the oil from saturation, thus preventing the formation of gases and vapor through the flow meters.

8.1.1.5 The metering system shall comply with accuracy class 1.0 according to OIML R117, with maximum permissible relative error 0.6% of the measured value for the flow meters and 1.0% for the system.

8.1.1.6 FIT-1223054A-1/2 and FIT-1223054B-1/2 metering points shall have an additional link for meter monitoring and diagnostics purposes. This communication shall be done through network and protocol shall be defined during Detail Design phase.

8.1.1.7 Flow meters shall be calibrated onboard, assembled on the calibration run of the Offloading Metering Skid (Z-1359501).

8.1.1.8 For more details see I-DE-3010.2Q-1223-944-P4X-003 – HP SEPARATOR A and I-DE-3010.2Q-1223-944-P4X-004 – HP SEPARATOR B.

#### 8.1.2 Oil from LP Separators Metering Point (FIT-1223932A/B-1/2)

8.1.2.1 Each production train shall have one Oil from LP Separators Metering point that measure oil volume at the outlet of LP Separators (SG-1223002A/B).

8.1.2.2 Each Oil from LP Separators Metering point consists of, at least:

- I. Two parallel mass flow meters, Coriolis type (FIT-1223932A-1/2 for production train A and FIT-1223932B-1/2 for production train B) at a 2 x 100% configuration, with local indicator;
- II. Pressure and temperature transmitters for each stream;
- III. One manual sampler (SC-FIT-1223932A for production train A and SC-FIT-1223932B for production train B) installed on the common header downstream of the flow meters;
- IV. Bypass with block valves;
- V. Access facilities for the meters and instruments.

8.1.2.3 Flow, temperature and pressure transmitters shall be connected to its respective flow computer (FQIT-1223932A/B-1/2) that receives and processes all signals to calculate and correct the flow.

8.1.2.4 The metering system shall be installed below the SG-1223002A/B with enough height to deviate the oil from saturation, thus preventing the formation of gases and vapor through the flow meters.

8.1.2.5 The metering system shall comply with accuracy class 1.0 according to OIML R117, with maximum permissible relative error 0.6% of the measured value for the flow meters and 1.0% for the metering point.

8.1.2.6 FIT-1223932A-1/2 and FIT-1223932B-1/2 metering points shall have an additional link for meter monitoring and diagnostics purposes. This communication shall be done through network and protocol shall be defined during Detail Design phase.

8.1.2.7 Flow meters shall be calibrated onboard, assembled on the calibration run of the Offloading Metering Skid (Z-1359501).

8.1.2.8 For more details see I-DE-3010.2Q-1223-944-P4X-007 – LP SEPARATOR A and I-DE-3010.2Q-1223-944-P4X-008 – LP SEPARATOR B.

### 8.1.3 Oil from Settling Separator Tank Metering Point (FIT-1223536A/C)

8.1.3.1 Each Oil from Settling Separator Tank Metering Point at the outlet of Settling Separators Tank (TQ-1223501A/C) consists of, at least:

- I. One positive displacement meter (FIT-1223536A for Settling Tank A, FIT-1223536B for Settling Tank B and FIT-1223536C for Settling Tank C);
- II. One filter upstream of the meter, with mesh according to vendor recommendation;
- III. Pressure and temperature transmitters for each stream;
- IV. One manual sampler (SC-FIT-1223536A/C) installed downstream of its respective flow meter;
- V. Bypass with block valve;
- VI. Access facilities for the meters and instruments.

8.1.3.2 Flow, temperature and pressure transmitters shall be connected to its respective flow computer (FQIT-1223536A/C) that receives and processes all signals to calculate and correct the flow.

8.1.3.3 The metering system shall comply with accuracy class 1.0 according to OIML R117, with maximum permissible relative error 0.6% of the measured value for the flow meters and 1.0% for the system.

8.1.3.4 Flow meters shall be calibrated onboard, assembled on the calibration run of the Offloading Metering Skid (Z-1359501).

8.1.3.5 For more details see I-DE-3010.2Q-1223-944-P4X-009 – SETTLING SEPARATOR TANK A, I-DE-3010.2Q-1223-944-P4X-010 – SETTLING SEPARATOR TANK B and I-DE-3010.2Q-1223-944-P4X-011 – SETTLING SEPARATOR TANK C.

#### 8.1.4 Imported Oil to Off-Spec Tank Metering Point (FIT-1223050)

8.1.4.1 Imported Oil to Off-Spec Tank Metering Point consists of, at least:

- I. One positive displacement flow meter (FIT-1223050);
- II. One filter upstream of the meter, with mesh according to vendor recommendation;
- III. Pressure and temperature transmitter;
- IV. One static mixer installed upstream of the meter;
- V. One BS&W analyzer (AIT-1210013) installed downstream of the mixing system;
- VI. One manual sampler (SC-FIT-1223050) installed upstream of the flow meter;
- VII. Bypass with block valves;
- VIII. Access facilities for the meters and instruments.

8.1.4.2 Flow, temperature and pressure transmitters shall be connected to respective flow computer (FQIT-1223050) that receives and processes all signals to calculate and correct the flow.

8.1.4.3 There shall be analogue dual pulse outputs from the flow meter, and one analogue 4-20 mA output from PIT and TIT.


8.1.4.4 Oil Imported Metering Point shall comply with accuracy class 0.3 according to OIML R117, with maximum permissible relative error 0.2% of the measured value for the flow meters and 0.3% for the system.

8.1.4.5 BS&W analyzer (AIT-1210013) requirements:

- I. Shall meet the maximum permissible absolute error requirement of 0.05%.
- II. Shall be of retrievable probe type.
- III. Power supply to be provided from FMS panel (PN-1223001) shall be confirmed during Detail Design phase.
- IV. There shall be one discrete signal for the Unit Alarm Malfunction (UAM) from the BS&W analyzer to the flow computer (FQIT-1223050).
- V. The communication physical media and protocol between the analyzer and flow computer shall be confirmed during Detail Design phase.

8.1.4.6 Flow meter shall be calibrated onboard, assembled on the calibration run of the Offloading Metering Skid (Z-1359501).

8.1.4.7 For more details see I-DE-3010.2Q-1223-944-P4X-023 – OFF-SPEC OIL TANK and I-DE-3010.2Q-1210-944-P4X-026 – PIG RECEIVER (IMPORTED OIL RECEIVING).

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### 8.1.5 Diesel Well Service Metering Point (FIT-5133003)

8.1.5.1 Diesel Well Service Metering consists of, at least:

- I. One mass flow meter, Coriolis type (FIT-5133003) at a 1 x 100% configuration, with local indicator;
- II. Pressure and temperature transmitters;
- III. One manual sampler (SC-FIT-5133003) installed downstream of the flow meters;
- IV. Access facilities for the meters and instruments;

8.1.5.2 There shall be analogue dual pulse outputs from the flow meters, and one analogue 4-20 mA output from each PIT and TIT to the diesel well service flow computer.

8.1.5.3 Diesel Well Service Metering point shall comply with accuracy class 0.3 according to OIML R117, with maximum permissible relative error 0.2% of the measured value for the flow meters and 0.3% for the system.

8.1.5.4 FIT-5133003 metering point shall have an additional link for meter monitoring and diagnostics purposes. This communication shall be done through network and protocol shall be defined during Detail Design phase.

8.1.5.5 For more details see I-DE-3010.2Q-5133-944-P4X-001 – DIESEL INJECTION SYSTEM.

## 8.2 Gas Flow Metering


### 8.2.1 Gas from HP Separators Metering Point (FIT-1223053A/B)

8.2.1.1 Each production train shall have one Gas from HP Separators Metering point that measure gas volume at the outlet of HP Separators (SG-1223001A/B).

8.2.1.2 Each Gas from HP Separators Metering point consists of, at least:

- I. Dual chamber orifice fitting (FE-1223053A for production train A and FE-1223053B for production train B), provided with drains (with DBB valves);
- II. Orifice plates;
- III. Removable upstream (FX-1223053A-1 and FX-1223053A-3; FX-1223053B-1 and FX-1223053B-3) and downstream (FY-1223053A and FY-1223053B) straight pipe sections, according to ISO 5167-2 requirements and complementary requirements of I-ET-3010.00-1200-813-P4X-001 – GENERAL CRITERIA FOR FLOW METERING SYSTEMS;
- IV. Zanker flow conditioner (FX-1223053A-2 and FX-1223053B-2);
- V. Flow (FIT-1223053A/B), temperature (TIT-1223053A/B) and pressure (PIT-1223053A/B) transmitters;
- VI. Related sample panel (SC-FIT-1223053A/B) upstream its respective flow meter;
- VII. Access facilities for the meters and instruments.

8.2.1.3 Total uncertainty of the metering point for each orifice plate shall be less than 3.0%.

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8.2.1.4 Flow, temperature and pressure transmitters shall be connected to respective flow computer (FQIT-1223053A/B) that receives and processes all signals to calculate and correct the flow.

8.2.1.5 For more details see I-DE-3010.2Q-1223-944-P4X-003 – HP SEPARATOR A and I-DE-3010.2Q-1223-944-P4X-004 – HP SEPARATOR B.

### 8.2.2 Gas from LP Separators Metering Point (FIT-1223004A/B)

8.2.2.1 Each production train shall have one Gas from LP Separators Metering point that measure gas volume at the outlet of LP Separators (SG-1223002A/B).

8.2.2.2 Each Gas from LP Separators Metering point consists of, at least:

- I. Dual chamber orifice fitting (FE-1223004A for production train A and FE-1223004B for production train B), provided with drains (with DBB valves);
- II. Orifice plates;
- III. Removable upstream (FX-1223004A-1 and FX-1223004A-3; FX-1223004B-1 and FX-1223004B-3) and downstream (FY-1223004A and FY-1223004B) straight pipe sections, according to ISO 5167-2 requirements and complementary requirements of I-ET-3010.00-1200-813-P4X-001 – GENERAL CRITERIA FOR FLOW METERING SYSTEMS;
- IV. Zanker flow conditioner (FX-1223004A-2 and FX-1223004B-2);
- V. Flow (FIT-1223004A/B), temperature (TIT-1223004A/B) and pressure transmitters (PIT-1223053A/B);
- VI. Related sample panel (SC-FIT-1223004A/B) upstream its respective flow meter;
- VII. Access facilities for the meters and instruments.

8.2.2.3 Total uncertainty of the metering point for each orifice plate shall be less than 3.0%.

8.2.2.4 Flow, temperature and pressure transmitters shall be connected to respective flow computer (FQIT-1223004A/B) that receives and processes all signals to calculate and correct the flow.

8.2.2.5 For more details see I-DE-3010.2Q-1223-944-P4X-007 – LP SEPARATOR A and I-DE-3010.2Q-1223-944-P4X-008 – LP SEPARATOR B.

### 8.2.3 Gas from Settling Separator Tank Metering Point (FIT-1223537)

8.2.3.1 Gas from Settling Separator Tank Metering Point measures the commingled output from Settling Tanks A, B and C (TQ-1223501A/C). This metering point consists of, at least:

- I. One ultrasonic transit time flow meter for flare applications, mounted in spool with retrievable sensors (FIT-1223537);
- II. Temperature and pressure transmitters;
- III. Upstream and downstream straight run length of at least 10D upstream and 5D downstream, or according to vendor recommendation;
- IV. Manual sample panel (SC-FIT-1223537);
- V. Access facilities for the meters and instruments.

8.2.3.2 Total uncertainty of the loop shall be less than 5.0%.

8.2.3.3 Electronic unit of flare meter shall communicate with flow computer (FQIT-1223537) using field network (MODBUS protocol).

8.2.3.4 Flow correction to reference conditions shall be done on the flow computer.

8.2.3.5 Pressure and temperature transmitters shall be connected to the flow computer, which shall send the signals of transmitters to flow meter by MODBUS if required by MANUFACTURER.

8.2.3.6 Sampling point shall collect representative samples even with low pressure levels; therefore a vacuum pump shall be foreseen. Manual samplers are FMS scope of supply.

8.2.3.7 For more details see I I-DE-3010.2Q-1223-944-P4X-009 – SETTLING SEPARATOR TANK A.

#### **8.2.4 Total Gas Lift Metering Point (FIT-1231031)**

8.2.4.1 Total Gas Lift Metering Point consists of, at least:

- I. Dual chamber orifice fitting (FE-1231031), provided with drains (with DBB valves);
- II. Orifice plates;
- III. Removable upstream (FX-1231031-1 and FX-1231031-3) and downstream (FY-1231031) straight pipe sections, according to ISO 5167-2 requirements and complementary requirements of I-ET-3010.00-1200-813-P4X-001 – GENERAL CRITERIA FOR FLOW METERING SYSTEMS;
- IV. Zanker flow conditioner (FX-1231031-2);
- V. Flow (FIT-1231031-1/2), temperature (TIT-1231031) and pressure (PIT-1231031) transmitters;
- VI. Related sample panel (SC-FIT-1231031) upstream of the flow meter;
- VII. Access facilities for the meters and instruments.

8.2.4.2 Total uncertainty of the metering point for each orifice plate shall be less than 3.0%.

8.2.4.3 Flow, temperature and pressure transmitters shall be connected to the flow computer (FQIT-1231031) that receives and processes all signals to calculate and correct the flow.

8.2.4.4 For more details see I-DE-3010.2Q-1231-944-P4X-012 – LIFT GAS AND EXPORTATION HEADERS – PIG LAUNCHER/RECEIVER.

#### **8.2.5 Flare Assist Gas Metering Point (FIT-5412012)**

8.2.5.1 Flare Assist Gas Metering Point consists of, at least:

- I. Dual chamber orifice fitting (FE-5412012), provided with drains (with DBB valves);
- II. Orifice plates;
- III. Removable upstream (FX-5412012-1 and FX-5412012-3) and downstream (FY-5412012) straight pipe sections, according to ISO 5167-2 requirements and

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- IV. Zanker flow conditioner (FX-5412012-2);
- V. Flow (FIT-5412012-1/2), temperature (TIT-5412012) and pressure transmitters (PIT-5412012);
- VI. Access facilities for the meters and instruments.

8.2.5.2 Total uncertainty of the metering point for each orifice plate shall be less than 3.0%.

8.2.5.3 Flow, temperature and pressure transmitters shall be connected to the flow computer (FQIT-5412012) that receives and processes all signals to calculate and correct the flow.

8.2.5.4 For sampling of Flare Assist Gas Metering Point, LP Fuel Gas sampling panel shall be used. To achieve this, there shall be no gas stream entering or chemical injection line between the LP Fuel Gas sampling point and the Flare Assist Gas flow meter.

8.2.5.5 For more details see I-DE-3010.2Q-5412-944-P4X-003 – HIGH/LOW PRESSURE FLARE.

### 8.2.6 Purge Gas to Flare Metering Point (FIT-5412052)

8.2.6.1 The flow metering point consists of:

- I. Dual chamber orifice fitting (FE-5412052), provided with drain (with DBB valve);
- II. Orifice plates;
- III. Removable upstream (FX-5412052-1 and FX-5412052-3) and downstream (FY-5412052) straight pipe sections, according to ISO 5167-2 requirements and complementary requirements of I-ET-3010.00-1200-813-P4X-001 – GENERAL CRITERIA FOR FLOW METERING SYSTEMS;
- IV. Zanker flow conditioner (FX-5412052-2);
- V. Flow (FIT-5412052), temperature (TIT-5412052) and pressure (PIT-5412052) transmitters;
- VI. Access facilities for the meters and instruments.

8.2.6.2 Total uncertainty of the metering point for each orifice plate shall be less than 3.0%.

8.2.6.3 Flow, temperature and pressure transmitters shall be connected to the flow computer (FQIT-5412052) that receives and processes all signals to calculate and correct the flow.

8.2.6.4 In case dimensioning of metering point requires a flow meter with diameter smaller than 2", alternative technologies shall be submitted for BUYER approval.

8.2.6.5 For sampling of Purge Gas to Flare Metering Point, LP Fuel Gas sampling panel shall be used. To achieve this, there shall be no gas stream entering or chemical injection line between the LP Fuel Gas sampling point and the Purge Gas to Flare flow meter.

8.2.6.6 For more details see I-DE-3010.2Q-5412-944-P4X-003 – HIGH/LOW PRESSURE FLARE.

### 8.3 Water Flow Metering

#### 8.3.1 Produced Water from Test Separator Metering Point (FIT-1223021)

8.3.1.1 Produced Water from Test Separator Metering Point shall measure the water volume at outlet of the Test Separator (SG-1223003) and shall be composed of, at least:

- I. One magnetic flow meter (FIT-1223021), spool type;
- II. Temperature and pressure transmitters;
- III. Upstream straight pipe run of at least 5D (5 times the nominal diameter of the meter) and downstream straight pipe run of at least 2D (2 times the nominal diameter of the meter), according to ISO 20456 or vendor recommendation;
- IV. Related sampling panel (SC-FIT-1223021) upstream of the flow meter;
- V. Bypass and block valves;
- VI. Access facilities for the meters and instruments.

8.3.1.2 Produced Water from Test Separator Metering Point shall comply with accuracy class 1.0 according to Portaria Inmetro 291/2021, with maximum permissible relative error 0.6% of the measured value for the flow meter and 1.0% for the whole system.

8.3.1.3 Flow, temperature and pressure transmitters shall be connected to the flow computer (FQIT-1223021) that receives and processes all signals to calculate and correct the flow.

8.3.1.4 For more details see I-DE-3010.2Q-1223-944-P4X-028 – TEST SEPARATOR WATER PUMP.


#### 8.3.2 Discharged Produced Water Metering Point (FIT-5331001A/B)

8.3.2.1 The Discharged Produced Water Metering Point consists of, at least:

- I. Two parallel magnetic flow meters (FIT-5331001A/B), spool type, at a 2 x 100% arrangement;
- II. Pressure and temperature transmitters for each stream;
- III. Upstream straight pipe run of at least 5D (5 times the nominal diameter of the meter) and downstream straight pipe run of at least 2D (2 times the nominal diameter of the meter), according to ISO 20456 or vendor recommendation, for each stream;
- IV. Related sample panel (SC-FIT-5331001) close to the flow meters;
- V. Access facilities for the meters and instruments.

8.3.2.2 Discharged Produced Water Metering Point shall comply with accuracy class 1.0 according to Portaria Inmetro 291/2021, with maximum permissible relative error 0.6% of the measured value for the flow meter and 1.0% for the whole system.

8.3.2.3 Flow, temperature and pressure transmitters shall be connected to the flow computer (FQIT-5331001A/B) that receives and processes all signals to calculate and correct the flow.

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8.3.2.4 The manual sampling connection shall have a vertical upward section with pitot tube to meet current IBAMA requirements. For further details see I-ET-3010.00-1200-588-P4X-001 – SAMPLE CONNECTIONS.

8.3.2.5 For more details see I-DE-3010.2Q-5331-944-P4X-010 – PRODUCED WATER BOOSTER PUMPS.

### 8.3.3 Produced Water to Injection Metering Point (FIT-5331028)

8.3.3.1 Produced Water to Injection Metering Point shall measure the water at the outlet of the Produced Water Booster Pumps.

8.3.3.2 Produced Water to Injection Metering Point consists of, at least:

- I. One magnetic flow meter (FIT-5331028), spool type;
- II. Pressure and temperature transmitters;
- III. Upstream straight pipe run of at least 5D (5 times the nominal diameter of the meter) and downstream straight pipe run of at least 2D (2 times the nominal diameter of the meter), according to ISO 20456 or vendor recommendation, for each stream;
- IV. Related sample panel (SC-FIT-5331028) close to the flow meter;
- V. Bypass and block valves;
- VI. Access facilities for the meters and instruments.

8.3.3.3 Produced Water to Injection Metering Point shall comply with accuracy class 1.0 according to Portaria Inmetro 291/2021, with maximum permissible relative error 0.6% of the measured value for the flow meter and 1.0% for the whole system.

8.3.3.4 Flow, temperature and pressure transmitters shall be connected to the flow computer (FQIT-5331028) that receives and processes all signals to calculate and correct the flow.

8.3.3.5 For more details see I-DE-3010.2Q-5331-944-P4X-010 – PRODUCED WATER BOOSTER PUMPS.

### 8.3.4 Water from Settling Separator Tank Metering Point (FIT-1223503A/C)

8.3.4.1 Each flow metering point at the water outlet of the Settling Separator Tanks (TQ-1223501A/C) consists of, at least:

- I. One magnetic flow meter for each tank (FIT-1223503A/C), spool type;
- II. Pressure and temperature transmitters;
- III. Upstream straight pipe run of at least 5D (5 times the nominal diameter of the meter) and downstream straight pipe run of at least 2D (2 times the nominal diameter of the meter), according to ISO 20456 or vendor recommendation;
- IV. Related sample panel (SC-FIT-1223503A/C) upstream its respective flow meter;
- V. Bypass and block valves;
- VI. Access facilities for the meters and instruments.

8.3.4.2 Flow, temperature and pressure transmitters shall be connected to respective flow computer (FQIT-1223503A/C) that receives and processes all signals to calculate and correct the flow.

8.3.4.3 Water from Settling Separator Tank Metering Points shall comply with accuracy class 1.0 according to Portaria Inmetro 291/2021, with maximum permissible relative error 0.6% of the measured value for the flow meter and 1.0% for the whole system.

8.3.4.4 For more details see I-DE-3010.2Q-1223-944-P4X-009 – SETTLING SEPARATOR TANK A, I-DE-3010.2Q-1223-944-P4X-010 – SETTLING SEPARATOR TANK B and I-DE-3010.2Q-1223-944-P4X-011 – SETTLING SEPARATOR TANK C.

### **8.3.5 Water from Pre-Oil Dehydrators Metering Point (FIT-1223062 and FIT-1223132)**

8.3.5.1 Each production train shall have one Water from Pre-Oil Dehydrators Metering Point that measure the water outlet of the Pre-Oil Dehydrators (TO-1223001A/B).

8.3.5.2 Each Water from Pre-Oil Dehydrators Metering Point consists of, at least:

- I. One magnetic flow meter (FIT-1223062 for train A and FIT-1223132 for train B), spool type;
- II. Pressure and temperature transmitters for each stream;
- III. Upstream straight pipe run of at least 5D (5 times the nominal diameter of the meter) and downstream straight pipe run of at least 2D (2 times the nominal diameter of the meter), according to ISO 20456 or vendor recommendation;
- IV. Related sample panel (SC-FIT-1223062 and SC-FIT-1223132) upstream its respective flow meter;
- V. Bypass and block valves;
- VI. Access facilities for the meters and instruments.

8.3.5.3 Flow, temperature and pressure transmitters shall be connected to respective flow computer (FQIT-1223062 and FQIT-1223132) that receives and processes all signals to calculate and correct the flow.

8.3.5.4 Water from Pre-Oil Dehydrators Metering Point shall comply with accuracy class 1.0 according to Portaria Inmetro 291/2021, with maximum permissible relative error 0.6% of the measured value for the flow meter and 1.0% for the whole system.

8.3.5.5 For more details see I-DE-3010.2Q-1223-944-P4X-019 – PRE-OIL DEHYDRATOR RECIRCULATION WATER PUMP A/D.

### **8.3.6 Water from Oil Dehydrators Metering Point (FIT-1223147/148)**

8.3.6.1 Each production train shall have one Water from Oil Dehydrators Metering Point that measure the water outlet of the Oil Dehydrators (TO-1223002A/B).

8.3.6.2 Each Water from Oil Dehydrators Metering Point consists of, at least:

- I. One magnetic flow meter (FIT-1223147 for train A and FIT-1223148 for train B), spool type;
- II. Pressure and temperature transmitters for each stream;

- III. Upstream straight pipe run of at least 5D (5 times the nominal diameter of the meter) and downstream straight pipe run of at least 2D (2 times the nominal diameter of the meter), according to ISO 20456 or vendor recommendation;
- IV. Related sample panel (SC-FIT-1223147 and SC-FIT-1223148) upstream its respective flow meter;
- V. Bypass and block valves;
- VI. Access facilities for the meters and instruments.

8.3.6.3 Flow, temperature and pressure transmitters shall be connected to respective flow computer (FQIT-1223147 and FQIT-1223148) that receives and processes all signals to calculate and correct the flow.

8.3.6.4 Water from Oil Dehydrators Metering Point shall comply with accuracy class 1.0 according to Portaria Inmetro 291/2021, with maximum permissible relative error 0.6% of the measured value for the flow meter and 1.0% for the whole system.

8.3.6.5 For more details see I-DE-3010.2Q-1223-944-P4X-020 – OIL DEHYDRATOR RECIRCULATION WATER PUMP A/D.

### **8.3.7 Total Injected Water Metering Point (FIT-1251017A/C)**

8.3.7.1 The total injection is composed by three injection headers. Each header has one Total Injected Water Metering Point that consists of, at least:

- I. One magnetic flow meter (FIT-1251017A/C), spool type;
- II. Pressure and temperature transmitters;
- III. Upstream straight pipe run of at least 5D (5 times the nominal diameter of the meter) and downstream straight pipe run of at least 2D (2 times the nominal diameter of the meter), according to ISO 20456 or vendor recommendation;
- IV. Related sample panel (SC-FIT-1251017A/C) upstream its respective flow meter;
- V. Access facilities for the meters and instruments.

8.3.7.2 Flow, temperature and pressure transmitters shall be connected to the flow computer (FQIT-1251017A/C) that receives and processes all signals to calculate and correct the flow.

8.3.7.3 Total Injected Water Metering Points shall comply with accuracy class 1.0 according to Portaria Inmetro 291/2021, with maximum permissible relative error 0.6% of the measured value for the flow meter and 1.0% for the whole system.

8.3.7.4 For more details see I-DE-3010.2Q-1251-944-P4X-007 – INJECTION WATER MAIN PUMP.

### **8.3.8 Water Injection per Well Metering Point – Satellite Well (FIT-1210058A/B)**

8.3.8.1 Each flow metering point consists of, at least:

- I. One magnetic flow meter (FIT-1210058A/B), spool type;
- II. Pressure and temperature transmitters for each stream;
- III. Upstream straight pipe run of at least 5D (5 times the nominal diameter of the meter) and downstream straight pipe run of at least 2D (2 times the nominal diameter of the meter) for each stream, according to ISO 20456 or vendor recommendation;

- IV. Related sample panel (SC-FIT-1210058A/B) close to its respective flow meter;
- V. Access facilities for the meters and instruments.

8.3.8.2 Flow, temperature and pressure transmitters shall be connected to the flow computer (FQIT-1210058A/B) that receives and processes all signals to calculate and correct the flow.

8.3.8.3 FIT-1210058A/B metering points shall comply with accuracy class 1.0 according to Portaria Inmetro 291/2021, with maximum permissible relative error 0.6% of the measured value for the flow meter and 1.0% for the whole system.

8.3.8.4 For more details see I-DE-3010.2Q-1210-944-P4X-017 – SATELLITE WATER INJECTION WELL A and I-DE-3010.2Q-1210-944-P4X-018 – SATELLITE WATER INJECTION WELL B.

### **8.3.9 Water Injection per Manifold Metering Point – Manifoldd Wells (FIT-1210058C/G)**

8.3.9.1 Each flow metering point consists of, at least:

- I. One magnetic flow meter (FIT-1210058C/G), spool type;
- II. Pressure and temperature transmitters for each stream;
- III. Upstream straight pipe run of at least 5D (5 times the nominal diameter of the meter) and downstream straight pipe run of at least 2D (2 times the nominal diameter of the meter) for each stream, according to ISO 20456 or vendor recommendation;
- IV. Related sample panel (SC-FIT-1210058C/G) close to its respective flow meter;
- V. Access facilities for the meters and instruments.

8.3.9.2 Flow, temperature and pressure transmitters shall be connected to the flow computer (FQIT-1210058C/G) that receives and processes all signals to calculate and correct the flow.

8.3.9.3 FIT-1210058C/G metering points shall comply with accuracy class 1.0 according to Portaria Inmetro 291/2021, with maximum permissible relative error 0.6% of the measured value for the flow meter and 1.0% for the whole system.

8.3.9.4 For more details see I-DE-3010.2Q-1210-944-P4X-019 – SUBSEA MANIFOLD WATER INJECTION MSIA-1, I-DE-3010.2Q-1210-944-P4X-020 – SUBSEA MANIFOLD WATER INJECTION MSIA-2, I-DE-3010.2Q-1210-944-P4X-021 – SUBSEA MANIFOLD WATER INJECTION MSIA-3, I-DE-3010.2Q-1210-944-P4X-022 – SUBSEA MANIFOLD WATER INJECTION MSIA-4 (SPARE), I-DE-3010.2Q-1210-944-P4X-023 – SUBSEA MANIFOLD WATER INJECTION MSIA-5 (SPARE)

## 9 AUTOMATION SYSTEM OF THE FMS

### 9.1 Flow Metering System Workstation

9.1.1 The FMS Workstation comprises of FMS Server Virtual Image (running in Topsides SOS Process Cluster PN-5523009), its clients FMS Local HMI (installed at PN-1223001) and FMS Remote HMI (PN-1223002, located at CCR-OA).

9.1.2 The FMS Workstation shall be according to I-ET-3010.00-1200-813-P4X-001 - GENERAL CRITERIA FOR FLOW METERING SYSTEMS.

### 9.2 Flow Metering System Panel (PN-1223001)

9.2.1 Flow Metering System (FMS) Panel (PN-1223001) shall be installed indoors, in an air-conditioned area, at the AUTOMATION & ELECTRICAL PANELS ROOM (AEPR).

9.2.2 FMS Panel shall accommodate the following components, at least:

- I. FMS LAN Ethernet Switches;
- II. FMS Local HMI (thin client to access FMS Server Virtual);
- III. All FMS flow computers;
- IV. Spare flow computers;
- V. FMS PLC;
- VI. Power supply conditioning circuits and components;
- VII. Optical Converters and Optical Distributor (DIO);
- VIII. Any other component necessary for adequate functioning, maintenance, and ergonomics of the panel.

9.2.3 For each discrete signal exchanged between FMS panel and CSS, an interposing relay shall be included. The interposing relay shall be installed in the FMS panel. For more details see I-ET-3010.00-1200-800-P4X-002 – AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGE UNITS.

9.2.4 FMS panel shall have a 20% spare of the total amount of I/O channels counted for all types of I/O cards. Additionally, it shall be foreseen empty slots related to 10% of the I/O count, for future use.


9.2.5 All empty I/O slots shall be provided with blank plates.

9.2.6 All channels, including spare or additional channels, shall be wired to terminals, ready for field interconnection.

9.2.7 All terminal blocks shall be provided with 20% of wired extra terminal connectors and 10% of extra terminal connectors, for future use.

9.2.8 Application program shall be capable to process at least the total amount of I/O channels counted, including installed and uninstalled spare.

9.2.9 For more panel characteristics, see I-ET-3010.00-5520-888-P4X-001 – AUTOMATION PANELS.

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### 9.3 Flow Computers

9.3.1 There shall be independent flow computers for:

- I. Crude oil to cargo tanks fiscal metering;
- II. Crude oil well service fiscal metering;
- III. Condensate from import gas metering;
- IV. Crude oil allocation metering;
- V. Offloading custody transfer metering;
- VI. Crude oil and water operational metering;
- VII. Gas fiscal export/import metering;
- VIII. Gas fiscal additional metering;
- IX. Gas allocation metering;
- X. Gas operational metering.

9.3.2 An additional flow computer (spare) shall be provided for liquids metering and another additional flow computer (spare) for natural gas metering.

9.3.3 The spare flow computers shall be supplied with I/O cards installed to communicate with at least 4 flow loops. These spares shall be installed and wired inside the FMS Panel.

9.3.4 Flow computers shall be installed inside the FMS Panel (PN-1223001) and shall be linked to the FMS Server Virtual Image running in Topsides SOS Process Cluster (PN-5523009). The FMS Server Virtual Image shall communicate to the FMS Local HMI, installed at the FMS Panel and to the FMS Remote HMI (PN-1223002). Additionally, the FMS Server Virtual Image shall also communicate, through Topside Package Units RTDS A/B, to the Topsides SOS HMIs (PN-5523002A/E) and to the Topsides Main HMI (PN-5523003) installed at CCR-OA. For further details, see:

- I-DE-3010.2Q-1200-813-P4X-002 – FLOW METERING SYSTEM (FMS) ARCHITECTURE;
- I-DE-3010.2Q-5520-800-P4X-002 – AUTOMATION AND CONTROL ARCHITECTURE.

9.3.5 In specific situations, flow computers shall have analog outputs to send the instantaneous flow rate to CSS – PCS, in order to control process variables. These communications are represented in the Piping and Instrument Diagrams (P&IDs), as required. For further details see the P&IDs (item 2.2.2).

9.3.6 All flow computers shall have Gigabit Ethernet and USB 3.0 communication interface in order to allow notebook or hand-held connection for ANP audit purposes.

9.3.7 Each FQIT in the P&IDs is related to a metering point loop.

9.3.8 Each flow computer shall communicate to a minimum of 4 flow loops, plus one calibration loop. For dimensioning criteria, it was assumed that each flow computer communicates to a maximum of 4 flow loops plus calibration loop. Deviations shall be previously approved by PETROBRAS.

9.3.9 Oil and gas ultrasonic and coriolis meters shall have an additional communication link with the flow computers in order to provide diagnostics information. Communication



protocol shall be confirmed during Detail Design phase. Diagnostics of the meters shall be available on the FMS Workstation.

#### 9.4 Communication Architecture and Network Requirements

9.4.1 A redundant network (FMS LAN) shall be supplied for the Flow Metering System.

9.4.2 All switches on the FMS LAN shall be of the managed type and shall be able to communicate using Gigabit Ethernet links (1 Gbps).

9.4.3 The FMS Server Virtual Image and the FMS Remote HMI shall be both physically connected to the Package Units LAN by Gigabit Ethernet links. FMS Local HMI and all flow computers shall be all physically connected to the FMS LAN by Gigabit Ethernet links.

9.4.4 Flow computers shall communicate with the FMS Server Virtual Image. Data shall depart from the flow computers, and go first through FMS LAN, and then through Package Units LAN, in order to arrive at the FMS Server Virtual Image.

9.4.5 FMS Server Virtual Image shall communicate with Topside Package RTDS Virtual Images A/B, Topsides SOS HMIs, Topsides Main HMI, and the Corporate Network by Gigabit Ethernet links through the Package Unit LAN and SOS Supervisory LAN.

9.4.6 The FMS PLC connection to the FMS LAN shall be redundant. The FMS PLC shall communicate with the flow computers and FMS Server Virtual Image by OPC-UA.

9.4.7 There shall be a redundant connection between the FMS LAN and the FMS Server Virtual Image.

9.4.8 The FMS Server Virtual Image communicates with the FMS Local HMI and with the FMS Remote HMI, both HMIs of thin client type. Communication shall be through Remote Desktop (RDP).

9.4.9 The interface with Topsides SOS HMIs PN-5523002A/E and Topsides Main HMI PN-5523003 shall be made through SOS Supervisory LAN (for details see I-DE-3010.2Q-5520-800-P4X-002 - AUTOMATION AND CONTROL ARCHITECTURE). The FMS LAN Switches shall be connected to the Package Units LAN. This communication shall be implemented as a Gigabit Ethernet link.

9.4.10 FMS shall make available the information from allocation flow meters to the MFMS. For the interface with MFMS Panel (PN-1223005) see I-ET-3010.2Q-1200-800-P4X-004 – MULTIPHASE FLOW METERING SYSTEM (MFMS) and I-DE-3010.2Q-1200-813-P4X-002 – FLOW METERING SYSTEM (FMS) ARCHITECTURE.

9.4.11 FMS LAN shall be connected to two switches on the Package Units LAN ring. For additional information see I-DE-3010.2Q-5520-800-P4X-004 – NETWORK INTERCONNECTION DIAGRAM.

9.4.12 FMS data shall be available on PI. Connection of PI to SOS Supervisory LAN and data transmission to onshore applications shall be according to I-DE-3010.2Q-5520-800-P4X-004 - NETWORK INTERCONNECTION DIAGRAM.



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9.4.13 FMS data shall also be transmitted to Corporate Network by Package Units LAN for posterior XML file generation and ANP transmission. Therefore, FMS shall make available at FMS Server Virtual Image and SOS Package Units RTDS all necessary data for XML file generation. This also includes a OPC Server at the FMS Server Virtual Image to provide the database.

9.4.14 FMS data shall be available on the Corporate Network through specific policies in Automation Firewall. Direct connection of the FMS LAN to the Automation Firewall shall not be accepted. Communication with the Corporate Network shall be done by the Package Units LAN: FMS Server Virtual Image and FMS Remote HMI shall be accessible from onshore.

9.4.15 For further details, see I-DE-3010.2Q-1200-813-P4X-002 – FLOW METERING SYSTEM (FMS) ARCHITECTURE.

9.4.16 The FMS Server Virtual Image clock shall be used as reference to synchronize all the flow computers. For more details see I-ET-3010.00-1200-813-P4X-001 – GENERAL CRITERIA FOR FLOW METERING SYSTEMS. The synchronization of clocks between the FMS Server Virtual Image and the supervisory system shall use SNTP packets circulating in the automation rings. For more details see I-MD-3010.2Q-5520-800-P4X-003 – AUTOMATION NETWORK DESCRIPTION.

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**10 WARRANTY**

- 10.1 SELLER shall give warranty for all components of this supply's scope, even for equipment or device furnished by others, of at least 24 (twenty-four) months from delivery or for 12 (twelve) months of operation.
- 10.2 This warranty shall cover fabrication or installation problems, as well as any service included in the scope of supply.
- 10.3 SELLER shall warranty the supply of spare parts, at least, for up to 10 (ten) years after the acceptance test date, and technical assistance at installation site performed by qualified and certified maintenance staff, when requested.
- 10.4 During warranty period, any defective part shall be changed for a new one, within 1 (one) week, after the problem is reported.



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## 11 PACKING REQUIREMENTS

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

11.2 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.

11.3 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 shall not be used together for protecting the same compartment.