PETROBRAS	**TECHNICAL SPECIFICATION**	No. I-ET-3010.2D-1200-800-P4X-003	
	CLIENT: AGUP		SHEET 1 of 54
	JOB: HIGH CAPACITY FPSO – GAS EXPORTATION ALL ELECTRIC		
	AREA: ATAPU 2 AND SÉPIA 2		
SRGE	TITLE: **FLOW METERING SYSTEM (FMS)**		INTERNAL
			ESUP

INDEX OF REVISIONS

REV.	DESCRIPTION AND/OR REVISED SHEETS
0	ORIGINAL ISSUE
A	REVISED WHERE INDICATED

	REV. 0	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE	JUN/24/22	DEC/15/22							
DESIGN	ESUP	ESUP							
EXECUTION	C27N	CX2W							
CHECK	HRJ2	HRJ2							
APPROVAL	U5D6	U5D6							

SUMMARY

1 INTRODUCTION

1.1 Object

1.1.1 The purpose of the Flow Metering System (FMS) is to measure oil, natural gas, water (produced, injected and disposal) and carbon dioxide rich gas 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 the complete FMS Automation System for the UNIT's 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 in upper-case that are not defined below.

FISCAL MEASUREMENT	Measurement of the gas and oil production volume where the government requires taxation payments.
ALLOCATION MEASUREMENT	Measurement used to determine the volume of production to be allocated at each field in a group of fields or at each well within the same field.
CUSTODY TRANSFER MEASUREMENT	Measurement for totalization of transferred fluids when their ownership changes.
OPERATIONAL MEASUREMENT	Measurement used for production control purposes.

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
GCA	Gas Chromatograph Analyzer
CSS	Control and Safety System
FAT	Factory Acceptance Test
FMS	Flow Metering System
HMI	Human Machine Interface
LAN	Local Area Network
PCS	Process Control System

P&ID	Piping and Instrumentation 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	Nº 7	MEASUREMENT OF NATURAL GAS BY TURBINE METERS
AGA	Nº 8	THERMODYNAMIC PROPERTIES OF NATURAL GAS AND RELATED GASES - ALL PARTS
AGA	Nº 11	MEASUREMENT OF NATURAL GAS BY CORIOLIS METER

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)
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 FOR THE EVALUATION OF UNCERTAINTIES
ISO	10012	MEASUREMENT MANAGEMENT SYSTEMS - REQUIREMENTS FOR MEASUREMENT PROCESSES AND MEASURING EQUIPMENT
ISO	17089-1	MEASUREMENT OF FLUID FLOW IN CLOSED CONDUITS - ULTRASONIC METERS FOR GAS - PART 1: METERS FOR CUSTODY TRANSFER AND ALLOCATION MEASUREMENT
ISO	20456	MEASUREMENT OF FLUID FLOW IN CLOSED CONDUITS - GUIDANCE FOR THE USE OF ELECTROMAGNETIC FLOWMETERS FOR CONDUCTIVE LIQUIDS
ISO	GUM	GUIDE TO THE EXPRESSION OF UNCERTAINTY IN MEASUREMENTS

OIML – ORGANISATION INTERNATIONALE DE METROLOGIE LEGALE

OIML	R117	DYNAMIC MEASURING SYSTEMS FOR LIQUIDS OTHER THAN WATER – ALL PARTS
OIML	R137	GAS METERS – ALL PARTS

2.1.2 Brazilian codes and standards

ANP – AGÊNCIA NACIONAL DO PETRÓLEO, GÁS NATURAL E BIOCOMBUSTÍVEIS

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)
OFÍCIO-CIRCULAR Nº1/2020/NFP/ANP	ESCLARECIMENTOS DO REGULAMENTO TÉCNICO DE MEDIÇÃO (RTM).

(26/MAIO/2020)

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
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
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/DEZEMBRO/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 COMMEDIDORES 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 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 Project's documentation, in all phases (Basic Engineering Design and Detail Engineering Design Phases), will 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 referenced documents' requirements.

2.2 Internal References

2.2.1 Typical Documents

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

2.2.2 Project Document List

I-DE-3010.2D-5520-800-P4X-002	AUTOMATION AND CONTROL ARCHITECTURE
I-DE-3010.2D-1200-813-P4X-001	FLOW METERING LOCATIONS (FMS)
I-DE-3010.2D-1200-813-P4X-002	FLOW METERING SYSTEM (FMS) ARCHITECTURE
I-DE-3010.2D-1210-944-P4X-010	WAG INJECTION AND SATELLITE PRODUCTION WELL "K"
I-DE-3010.2D-1210-944-P4X-011	WAG INJECTION AND SATELLITE PRODUCTION WELL "L"
I-DE-3010.2D-1210-944-P4X-012	WAG INJECTION AND SATELLITE PRODUCTION WELL "M"
I-DE-3010.2D-1210-944-P4X-013	WAG INJECTION AND SATELLITE PRODUCTION WELL "N"
I-DE-3010.2D-1210-944-P4X-014	WAG INJECTION AND SATELLITE PRODUCTION WELL "P"
I-DE-3010.2D-1210-944-P4X-015	WAG INJECTION WELL "Q"
I-DE-3010.2D-1210-944-P4X-016	WAG INJECTION WELL "R"
I-DE-3010.2D-1210-944-P4X-017	WAG INJECTION WELL "S"
I-DE-3010.2D-1210-944-P4X-018	WAG INJECTION WELL "T"
I-DE-3010.2D-1210-944-P4X-019	WAG INJECTION WELL "U"

I-DE-3010.2D-1210-944-P4X-020	WAG INJECTION WELL "V"
I-DE-3010.2D-1210-944-P4X-021	WAG INJECTION WELL "W"
I-DE-3010.2D-1212-944-P4X-001	CRUDE OIL METERING SYSTEM
I-DE-3010.2D-1223-944-P4X-003	FREE WATER SEPARATOR “A”
I-DE-3010.2D-1223-944-P4X-004	FREE WATER SEPARATOR “B”
I-DE-3010.2D-1223-944-P4X-009	PRE OIL DEHYDRATOR “A”
I-DE-3010.2D-1223-944-P4X-010	PRE OIL DEHYDRATOR “B”
I-DE-3010.2D-1223-944-P4X-011	OIL DEHYDRATOR “A”
I-DE-3010.2D-1223-944-P4X-012	OIL DEHYDRATOR “B”
I-DE-3010.2D-1223-944-P4X-013	PRE-OIL DEHYDRATOR RECIRCULATION WATER PUMP A/D
I-DE-3010.2D-1223-944-P4X-014	OIL DEHYDRATOR RECIRCULATION WATER PUMP A/D
I-DE-3010.2D-1223-944-P4X-017	TEST HEATER / TEST SEPARATOR
I-DE-3010.2D-1223-944-P4X-019	TEST SEPARATOR PUMPS
I-DE-3010.2D-1231-944-P4X-014	LIFT GAS AND EXPORTATION HEADERS – PIG LAUNCHER/ RECEIVER
I-DE-3010.2D-1244-944-P4X-001	WELL PIG LAUNCHERS (LP-1244001A/B)
I-DE-3010.2D-1244-944-P4X-002	WELL PIG LAUNCHERS (LP-1244001C/D)
I-DE-3010.2D-1244-944-P4X-003	WELL PIG LAUNCHERS (LP-1244001E/F)
I-DE-3010.2D-1244-944-P4X-004	WELL PIG LAUNCHERS (LP-1244001G/H)
I-DE-3010.2D-1244-944-P4X-005	WELL PIG LAUNCHER (LP-1244001J)
I-DE-3010.2D-1244-944-P4X-006	WELL PIG LAUNCHERS (LP-1244002A/B)
I-DE-3010.2D-1244-944-P4X-007	WELL PIG LAUNCHERS (LP-1244002C/D)
I-DE-3010.2D-1244-944-P4X-008	WELL PIG LAUNCHER (LP-1244002E)
I-DE-3010.2D-1251-944-P4X-007	INJECTION WATER MAIN PUMP
I-DE-3010.2D-1252-944-P4X-001	INJECTION GAS COMPRESSION UNIT – TRAIN A.
I-DE-3010.2D-1252-944-P4X-003	INJECTION GAS HEADER
I-DE-3010.2D-1350-944-P4X-001	STRUCTURAL TANKS GAS RECOVERY SYSTEM
I-DE-3010.2E-1350-944-P4X-003	CARGO SYSTEM
I-DE-3010.2D-1414-942-P4X-001	M-04 – CO2 REMOVAL - EQUIPMENT LAYOUT PLAN
I-DE-3010.2D-1417-942-P4X-001	M-07A – INJECTION AND EXPORT COMPRESSION - EQUIPMENT LAYOUT PLAN
I-DE-3010.2D-1417-942-P4X-002	M-07B – INJECTION AND EXPORT COMPRESSION - EQUIPMENT LAYOUT PLAN
I-DE-3010.2D-1412-942-P4X-001	M-02 – CO2 COMPRESSION - EQUIPMENT LAYOUT PLAN
I-DE-3010.2D-1421-942-P4X-002	M-10B - PRODUCED WATER TREATMENT AND TEST SEPARATOR - EQUIPMENT LAYOUT PLAN
I-DE-3010.2D-5133-944-P4X-001	DIESEL INJECTION SYSTEM
I-DE-3010.2D-5133-944-P4X-002	DIESEL TOPSIDES DISTRIBUTION SYSTEM
I-DE-3010.2D-5135-944-P4X-003	FUEL GAS DISTRIBUTION

I-DE-3010.2D-5331-944-P4X-003	GAS FLOTATION UNIT "A"
I-DE-3010.2D-5331-944-P4X-007	PRODUCED WATER BOOSTER PUMP AND FILTER
I-DE-3010.2D-5412-944-P4X-003	HIGH / LOW PRESSURE FLARE
I-DE-3010.2D-5520-800-P4X-004	NETWORK INTERCONNECTION DIAGRAM
I-ET-3010.2D-1200-800-P4X-001	INSTRUMENTATION ADDITIONAL TECHNICAL REQUIREMENTS
I-ET-3010.2D-1200-800-P4X-005	FIELD INSTRUMENTATION
I-ET-3010.2D-1350-196-P4X-001	ERGONOMICS REQUIREMENTS FOR TOPSIDES
I-ET-3010.2E-1359-940-P4X-001	OFFLOADING SYSTEM
I-ET-3010.2D-1200-800-P4X-014	AUTOMATION INTERFACE OF PACKAGE UNITS
I-MD-3010.2D-5520-800-P4X-003	AUTOMATION NETWORK DESCRIPTION

3 ENVIRONMENTAL AND OPERATIONAL CONDITIONS

3.1 For operating and environmental conditions, refer to I-ET-3010.2D-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-ET-3010.2D-1200-800-P4X-005 – FIELD INSTRUMENTATION;
- I-DE-3010.2D-1200-813-P4X-001 – FLOW METERING LOCATIONS (FMS);
- I-DE-3010.2D-1200-813-P4X-002 – FLOW METERING SYSTEM (FMS) ARCHITECTURE.

4.1.4 The Flow Metering System 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-3010.2D-1200-800-P4X-014 - AUTOMATION INTERFACE OF PACKAGE 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-3010.2D-1200-800-P4X-005 – FIELD INSTRUMENTATION.

4.1.6 SUPPLIER 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-3010.2D-1350-196-P4X-001 – ERGONOMICS REQUIREMENTS FOR TOPSIDES shall be followed. Complete access to all flow meters and components shall be provided.

4.1.9 Flow meters used in the FMS system shall have output type according to item 12 ANNEX – METERING LOOPS.

4.1.10 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.

4.1.11 Process conditions do not relate to flowrates. For example, the minimum temperature or the minimum pressure condition do not occur necessarily at the minimum flow. For sizing and specification of flow meters, process conditions shall be considered for each flow condition.

4.1.12 Even though not detailed in this document, SUPPLIER 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.

4.1.13 The manual sampling points shall comply with API MPMS 14.1 recommendations and be provided with sampling panels with brackets for cylinders/bottles and means for purging the cylinders/bottles before collecting the sample. The sampling process shall be performed in a closed circuit with alignment of the purge 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.

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

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

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

4.1.17 Flow Measurement System shall meet the maximum uncertainty requirements of total oil and gas production. The maximum allowable uncertainty is 0.6% for total volume of produced oil, and 3% for produced gas.

5 FISCAL METERING

5.1 Oil Flow Measurement

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

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

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

- One fiscal turbine meter (FIT-1212008A) to measure 100% of production train A;
- One fiscal turbine meter (FIT-1212008B) to measure 100% of production train B;
- One fiscal turbine meter (FIT-1212008C) installed as a standby meter, which may be aligned either to measure production train A or production train B;
- One fiscal coriolis meter (FIT-1212011) with smaller diameter, which may be aligned either to measure production train A or production train B, for low flow rate cases, such as due to production restriction. Meter shall be capable of measuring at least 60 m^3/h;
- Each meter shall have local indication;
- Filters upstream of each turbine meter, with mesh according to vendor recommendation;
- One compact prover (U-Z-1212001), which shall be mounted together on the skid structure;
- Downstream of the flow meters, each production train shall have a dedicated:
    - Static mixer;
    - A BS&W analyzer (AIT-1212004 for production train A and AIT-1212001 for production train B) installed downstream of the static mixer;
    - An automatic sampler (AX-1212004 for production train A and AX-1212001 for production train B) installed downstream of the static mixer;

- A manual sampler (SC-Z-1212001A for production train A and SC-Z-1212001B for production train B) installed downstream of the static mixer, 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.

- Pressure and temperature transmitters for each stream and for the compact prover;
- Flow control valves downstream of the meters and compact prover;
- Remote controlled double block and bleed valves with positioner for meter alignments, upstream and downstream each stream;
- All required valves, PSV and piping;
- Junction boxes and control panels, as required;
- Drain collector connected to the drain system of the unit;
- Removable upstream (FX-1212008A/B/C) straight pipe run of at least 10D (10 times the nominal diameter of the meter) with flow conditioner (FX-1212007A/B/C) and downstream (FY-1212008A/B/C) straight pipe run of at least 5D (5 times the nominal diameter of the meter) for each stream, according to API MPMS 5.3 or meter respective Inmetro type approval (PAM), whichever is more restrict;
- Blind spectacles on each metering stream, so as to allow each meter to become unavailable, for legal requirement purposes;
- Access facilities for the meters and instruments.

5.1.1.3 Flow, temperature and pressure transmitters of each stream shall be connected to their respective flow computer (FQIT-1212008A/B/C or FQIT-1212011) that receives and processes all signals to calculate and correct the flow.

5.1.1.4 The flow meters 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 skid. Compact prover shall have 0.04% maximum uncertainty, with 0,02% of maximum repeatability.

5.1.1.5 Upstream (FX-1212008A/B/C) and downstream (FY-1212008A/B/C) straight pipe runs, as well as flow conditioners (FX-1212007A/B/C), shall have dimensional inspection certificate done by laboratory accredited by RBC or ILAC/IAAC.

5.1.1.6 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.

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

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

5.1.1.9 BS&W analyzers (AIT-1212001 and AIT-1212004) and compact prover shall be connected to the flow computer (FQIT-1212004). BS&W information shall

be shared for all meter streams on the flow computer. Automatic samplers (AX-1212001 and AX-1212004) shall be connected to FMS PLC.

5.1.1.10 The Fiscal Metering Skid (Z-1212001) shall be located downstream of the oil treatment and upstream of the cargo tanks. For more details see I-DE-3010.2D-1212-944-P4X-001 – CRUDE OIL METERING SYSTEM.

5.1.1.11 The instruments, field panels and equipment of Z-1212001 shall be furnished assembled on a single skid, to be lifted and mounted together on Topside of UNIT.

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

5.1.1.13 A filter sized in accordance with ANSI/ ISA-RP31.1 recommendations or a more stringent filtration when specified or recommended by the MANUFACTURER shall be installed upstream of each turbine meter.

5.1.1.14 The 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.

5.1.1.15 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.

5.1.1.16 For the compact prover, electrical components 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).

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

5.1.1.18 The Fiscal Metering Skid (Z-1212001) shall receive, from the FMS panel (PN-1223001), all necessary 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.

5.1.1.19 The power supply to be provided from FMS panel (PN-1223001) to the BS&W analyzers shall be confirmed during detailing design phase.

5.1.1.20 Among other necessary power supplies, the Fiscal Metering Skid (Z-1212001) shall receive a 24 Vdc supply from the FMS panel (PN-1223001) for the automatic samplers and instrumentation.

5.1.1.21 Among other necessary power supplies, the Fiscal Metering Skid (Z-1212001) shall receive a 690 Vac @ 60 Hz non-essential power supply from the electrical system panels in order to feed the compact prover (U-Z-1212001).

5.1.1.22 The Fiscal Metering Skid shall receive, from the flow computer, analogue 4-20 mA signals to be sent to each HVs in order to control process flow rate for calibration purposes and shall receive, from the FMS PLC, discrete signals to control each XV and the automatic sampler.

5.1.1.23 There shall be one analogue 4-20 mA output from each HV positioner, PIT and TIT on the skid, analogue dual pulse outputs from the flowmeters and a discrete signal for the Malfunction Unit Alarm (UAM) of the BS&W analyzers to the fiscal crude oil flow computer. There shall be one analogue 4-20 mA output from each PDIT, a discrete output from the automatic samplers and a discrete output from the limit switches to the FMS PLC.

5.1.1.24 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 sample 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.

5.1.1.25 Each automatic sampler (AX-1212001 and AX-1212004) 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).

5.1.1.26 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 Engineering Design Phase.

5.1.1.27 FIT-1212011 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 Engineering Design Phase.

5.1.1.28 There shall be analogue 4-20 mA output from flow computers FQIT-1212008A/B/C and FQIT-1212011 to the CSS for sodium hydroxide injection controlling.

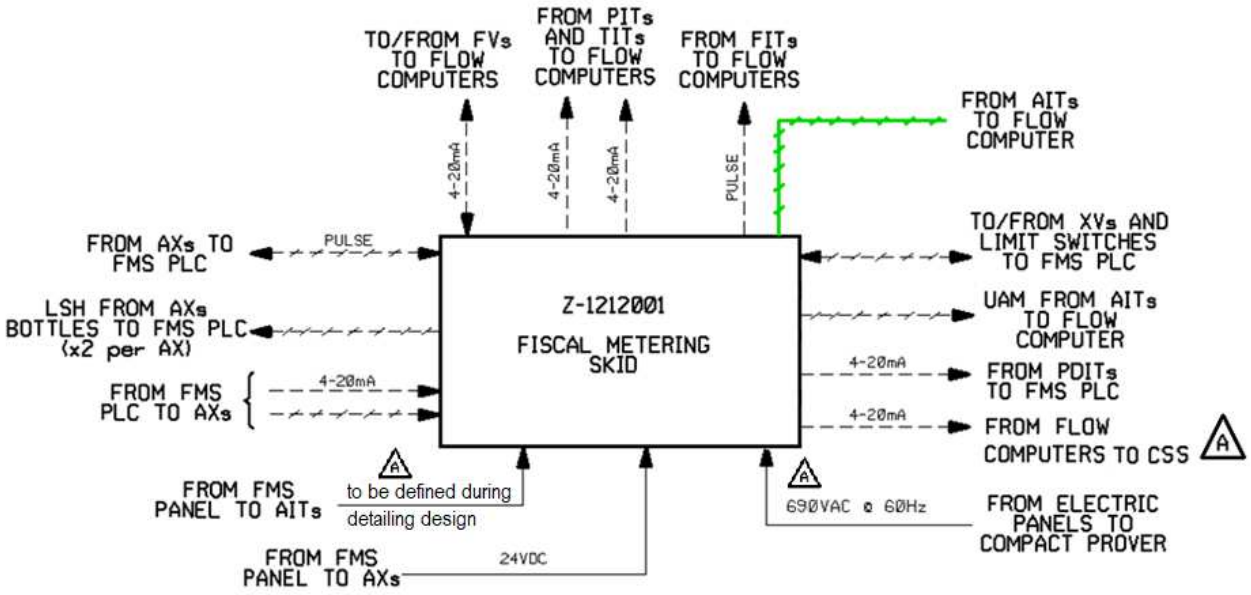

Figure 1 – Fiscal Metering Skid (Z-1212001) signal interfaces.

5.1.1.29 The piping from crude oil metering skid shall enter and exit according to the restrictions imposed by the layout in I-DE-3010.2D-1421-942-P4X-003 - M-10C - OIL PROCESSING - EQUIPMENT LAYOUT PLAN. The final layout shall be confirmed during Detail Engineering Design Phase.

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

5.1.2.1 The objective of this metering system is to discount the crude oil volumes injected on the production wells or service lines through the Well Service Pump, since this fluid will eventually go back to the process plant.

5.1.2.2 The XV-5133020 limit switches shall be interconnected to the FMS. If this XV is not fully closed (i.e., if the corresponding ZSL is not active), the volume totalization from FIT-5133002A/B shall not be incremented, so that it is not considered for volume discounts purposes when diesel is aligned to Test Separator.

5.1.2.3 The Crude Oil Well Service Metering Skid shall be composed of:

- 2 (two) parallel mass flow meters, Coriolis type (FIT-5133002A/B), at a 2 x 100% configuration, with local indicator;
- Pressure and temperature transmitters for each stream;
- A static mixer, downstream of the flow meter;
- A BS&W analyzer (AIT-5133002) installed downstream of the static mixer;
- An automatic sampler (AX-5133002) installed downstream of the static mixer;
- A manual sampler (SC-FIT-5133002) installed downstream of the static mixer, as per I-ET-3010.00-1200-588-P4X-001 - SAMPLE CONNECTIONS;

- Remote controlled double block and bleed valves with positioner for meter alignments, upstream and downstream each stream;
- All required valves, PSV and piping;
- Blind spectacles on each metering stream, so as to allow each meter to become unavailable, for legal requirement purposes;
- Junction boxes and control panels, as required;
- Drain collector connected to the drain system of the unit;
- Access facilities for the meters and instruments;

5.1.2.4 Z-1359501 shall have provisions to calibrate FIT-5133002A/B onboard.

5.1.2.5 It shall be foreseen cargo handling facilities (such as monorails or others) to remove flow meters to calibrate them on Z-1359501 skid.

5.1.2.6 Flow, temperature and pressure transmitters shall be connected to the flow computer (FQIT-5133002) that receives and processes all signals to calculate and correct the flow.

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 meter and 0.3% for the whole system.

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

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

5.1.2.10 Manual (SC-FIT-5133002) and automatic (AX-5133002) samplers are part of the FMS scope of supply.

5.1.2.11 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.

5.1.2.12 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.

5.1.2.13 The automatic sampler (AX-5133002) shall receive a 24 Vdc power supply (see item 3) from the FMS panel (PN-1223001).

5.1.2.14 The automatic sampler (AX-5133002) 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.

5.1.2.15 The automatic sampler (AX-5133002) 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).

5.1.2.16 FIT-5133002A/B 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 Engineering Design Phase.

5.1.2.17 The instruments, field panels and equipment of Z-513302 shall be furnished assembled on a single skid, to be lifted and mounted together on Topside of UNIT.

5.1.2.18 For more details see I-DE-3010.2D-5133-944-P4X-001 – DIESEL INJECTION SYSTEM and I-DE-3010.2D-5133-944-P4X-002 – DIESEL TOPSIDES DISTRIBUTION SYSTEM.

5.2 Gas Flow Measurement

5.2.1 HP Flare Gas

5.2.1.1 The HP Flare Gas metering point consists of:

- A dual-path ultrasonic transit time flow meter for flare applications, mounted in spool with retrievable sensors (FIT-5412011);
- Temperature and pressure transmitters;
- 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);
- Manual sample panel (SC-FIT-5412011), upstream the branch to the Flare Gas Recovery System;
- Access facilities for the meters and instruments.

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

5.2.1.3 The electronic unit of flare meter shall communicate with flow computer (FQIT-5412011) using field network (MODBUS RTU protocol). Flow correction to reference conditions shall be done on the flow computer. Pressure and temperature signals shall be sent to flow computer that will send these signals to flare meter by MODBUS.

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

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

5.2.1.6 The flare gas sampling panel shall be capable of collecting representative samples even with low pressure levels, therefore a vacuum pump shall be foreseen. Manual samplers are FMS scope of supply.

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

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

5.2.2 LP Flare Gas

5.2.2.1 The LP Flare Gas metering point consists of:

- A dual-path ultrasonic transit time flow meter for flare applications, mounted in spool with retrievable sensors (FIT-5412010);
- Temperature and pressure transmitters;
- 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);
- Manual sample panel (SC-FIT-5412010), upstream the branch to the Flare Gas Recovery System;
- Access facilities for the meters and instruments.

5.2.2.2 The total uncertainty of the loop shall be less than 5.0%.

5.2.2.3 The electronic unit of flare meter shall communicate with flow computer (FQIT-5412011) using field network (MODBUS RTU protocol). Flow correction to reference conditions shall be done on the flow computer. Pressure and temperature signals shall be sent to flow computer that will send these signals to flare meter by MODBUS.

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

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

5.2.2.6 The flare gas sampling points shall be capable of collecting representative samples even with low pressure levels, therefore a vacuum pump shall be foreseen. Manual samplers are FMS scope of supply.

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

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

5.2.3 HP Fuel Gas Metering Skid (Z-5135001)

5.2.3.1 The HP Fuel Gas Metering Skid shall be composed of, at least:

- 2 (two) parallel ultrasonic duty flow meters (FIT-5135015A/B), at a 2 x 100% configuration, with local indicator;
- One ultrasonic master meter (FIT-5135015C) with local indicator, installed in series to the flow meters, for calibration of duty flow meters (FIT-

5135015A/B). One additional master meter shall be supplied as a non-installed spare meter;

- Pressure and temperature transmitters for each stream;
- A chromatograph analyzer (AIT-5135015) installed downstream of the flowmeters, on the common header;
- A manual sampler (SC-FIT-5135015) installed downstream of the flowmeters, as per I-ET-3010.00-1200-588-P4X-001 - SAMPLE CONNECTIONS;
- Flow control valves downstream of the meters and master meter;
- Remote controlled double block and bleed valves with positioner for meter alignments;
- All required valves, PSV and piping;
- Blind spectacles on each metering stream, so as to allow each meter to become unavailable, for legal requirement purposes;
- Junction boxes and control panels, as required;
- Drain collector connected to the drain system of the unit;
- Removable upstream (FX-5135015A/B/C-1 and FX-5135015A/B/C-3) straight pipe run with flow conditioner (FX-5135015A/B/C-2) and downstream straight run (FY-5135015A/B/C) for each stream, in accordance with meter respective Inmetro type approval or ISO 17089, whichever it is more restrict;
- Access facilities for the meters and instruments.

5.2.3.2 All transmitters of each stream shall be connected to their respective flow computers, which process all signals to calculate and correct the volumes.

5.2.3.3 The instruments, field panels and equipment of Z-5135001 shall be furnished assembled on a single skid, to be lifted and mounted together on Topside of UNIT.

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

5.2.3.5 The meters 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 system shall be less than 1.0%.

5.2.3.6 Chromatograph analyzer shall read hydrocarbon composition (at least C9+), CO_2 and N_2 and have a maximum uncertainty of 0.3% on the compressibility factor.

5.2.3.7 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 HMI.

5.2.3.8 The HP Fuel Gas Metering Skid shall receive, from the flow computer, analogue 4-20 mA signals to be sent to each flow control valve in order to control process flow rate for calibration purposes and shall receive, from the FMS PLC, discrete signals to control each alignment valve.

5.2.3.9 There shall be one analogue 4-20 mA output from each flow control valve positioner, PIT and TIT on the skid, analogue pulse outputs from the flowmeters and a discrete signal for the Malfunction Unit Alarm (UAM) of the chromatograph analyzer to the flow computer. There shall be one analogue 4-20 mA output from limit switches of each alignment valve to the FMS PLC.

5.2.3.10 Upstream (FX-5135015A/B/C-1 and FX-5135015A/B/C-3) and downstream (FY-5135015A/B/C) straight pipe runs, as well as flow conditioners (FX-5135015A/B/C-2), shall have dimensional inspection certificate done by laboratory accredited by RBC or ILAC/IAAC.

5.2.3.11 The piping from HP Fuel Gas Metering Skid shall enter and exit according to the restrictions imposed by the layout in I-DE-3010.2D-1412-942-P4X-001 - M-02 – CO2 COMPRESSION - EQUIPMENT LAYOUT PLAN. Arrangement shall consider ways to avoid condensate on the meters. The final layout shall be confirmed during Detail Engineering Design Phase.

5.2.3.12 FIT-5135015A/B/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 Engineering Design Phase.

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

5.2.4 LP Fuel Gas

5.2.4.1 The LP Fuel Gas metering point shall be composed of at least:

- Dual chamber orifice fittings (FE-5135013), provided with drains (with double block and bleed valves);
- Orifice plates;
- Removable upstream (FX-5135013-1 and FX-5135013-3) and downstream (FY-5135013) straight pipe sections, according to ISO 5167-2 requirements;
- Zanker flow conditioner (FX-5135013-2);
- Flow (FIT-5135013-1/2), temperature (TIT-5135013) and pressure transmitters (PIT-5135013);
- Related sample panel (SC-FIT-5135013) upstream the flow meters, on the common process line;
- Double block and bleed valves;
- Access facilities for the meters and instruments.

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

5.2.4.3 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.

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

5.2.5 Gas Blanketing Recovery

5.2.5.1 The objective of this metering system is to account the gas at the outlet of the hydrocarbon blanketing system that returns to the process, at the outlet of the compression of the Structural Tanks Recovery Gas Unit (UC-1350001).

5.2.5.2 The system shall be composed of at least:

- Dual chamber orifice fittings (FE-1350007), provided with drains (with double block and bleed valves);
- Orifice plates;
- Removable upstream (FX-1350007-1 and FX-1350007-3) and downstream (FY-1350007) straight pipe sections, according to ISO 5167-2 requirements;
- Zanker flow conditioner (FX-1350007-2);
- Flow (FIT-1350007), temperature (TIT-1350007) and pressure transmitters (PIT-1350007);
- Related sample panel (SC-FIT-1350007) upstream the flow meter;
- Access facilities for the meters and instruments.

5.2.5.3 Total uncertainty of the loop shall be less than 1.5%.

5.2.5.4 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.

5.2.5.5 For more details see I-DE-3010.2D-1350-944-P4X-001 – STRUCTURAL TANKS GAS RECOVERY SYSTEM.

5.2.6 Gas Blanketing Inlet

5.2.6.1 The objective of this metering system is to account the gas consumed by the gas blanketing system, which does not return to the process, downstream Structural Tanks Recovery Gas K.O. Drum (V-1350001).

5.2.6.2 The system shall be composed of:

- Dual chamber orifice fittings (FE-1350006), provided with drains (with double block and bleed valves);
- Orifice plates;
- Removable upstream (FX-1350006-1 and FX-1350006-3) and downstream (FY-1350006) straight pipe sections, according to ISO 5167-2 requirements;
- Zanker flow conditioner (FX-1350006-2);
- Flow (FIT-1350006), temperature (TIT-1350006) and pressure transmitters (PIT-1350006);
- Related sample panels (SC-FIT-1350006) upstream the flow meter;
- Access facilities for the meters and instruments.

5.2.6.3 Total uncertainty of the loop shall be less than 1.5%.

5.2.6.4 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.

5.2.6.5 For more details see I-DE-3010.2D-1350-944-P4X-001 – STRUCTURAL TANKS GAS RECOVERY SYSTEM.

5.2.7 Gas Export Metering Skid (Z-1231001)

5.2.7.1 The Gas Export Metering Skid shall be composed of, at least:

- 2 (two) parallel ultrasonic duty flow meters (FIT-1231032A/B), at a 2 x 100% configuration, with local indicator;
- One ultrasonic master meter (FIT-1231032C) with local indicator, installed in series to the flow meters, for calibration of duty flow meters (FIT-1231032A/B). One additional master meter shall be supplied as a non-installed spare;
- One calibration stream (with virtual tag FIT-1231032D) with provision to install import gas meters for alternative calibration against the export gas master meter. It shall be provided blind flanges for when no meter is installed on the calibration stream;
- Temperature and pressure transmitters for each stream;
- Removable upstream (FX-1231032A/B/C/D-1 and FX-1231032A/B/C/D-3) straight run with flow conditioner (FX-1231032A/B/C/D-2) and downstream straight run (FY-1231032A/B/C/D) for each stream, in accordance with meter respective Inmetro type approval or ISO 17089, whichever it is more restrict;
- Manual sample panel (SC-FIT-1231032), installed downstream of the flow meters on the common header;
- One chromatograph analyzer (AIT-1231032), installed downstream of the flow meters, on the common header;
- Flow control valves downstream of the meters;
- Remote controlled double block and bleed valves with positioner for meter alignments (inlet, outlet and master meter alignment);
- All required valves, drains, PSV and piping;
- Blind spectacles on each metering stream, so as to allow each meter to become unavailable, for legal requirement purposes;
- Junction boxes and control panels, as required;
- Access facilities for the meters and instruments.

5.2.7.2 All transmitters of each stream shall be connected to their respective flow computers, which process all signals to calculate and correct the volumes.

5.2.7.3 The instruments, field panels and equipment of Z-1231001 shall be furnished assembled on a single skid, to be lifted and mounted together on Topside of UNIT.

5.2.7.4 It shall be foreseen cargo handling facilities (such as monorails or others) for flow meters, calibration stream and valves maneuver and maintenance. These facilities may either be supplied together on the skid or integrated on the module.

5.2.7.5 The meters 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 system shall be less than 1.0%.

5.2.7.6 Chromatograph analyzer shall read hydrocarbon composition (at least C9+), CO2, H_2S and N2 and have a maximum uncertainty of 0.3% on the compressibility factor.

5.2.7.7 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 HMI.

5.2.7.8 The Gas Export Metering Skid shall receive, from the flow computer, analogue 4-20 mA signals to be sent to each flow control valve in order to control process flow rate for calibration purposes and shall receive, from the FMS PLC, discrete signals to control each alignment valve.

5.2.7.9 There shall be one analogue 4-20 mA output from each flow control valve positioner, PIT and TIT on the skid, analogue pulse outputs from the flowmeters and a discrete signal for the Malfunction Unit Alarm (UAM) of the chromatograph analyzer to the flow computer. There shall be one analogue 4-20 mA output from limit switches of each alignment valve to the FMS PLC.

5.2.7.10 Upstream (FX-1231032A/B/C/D-1 and FX-1231032A/B/C/D-3) and downstream (FY-1231032A/B/C/D) straight pipe runs, as well as flow conditioners (FX-1231032A/B/C/D-2), shall have dimensional inspection certificate done by laboratory accredited by RBC or ILAC/IAAC.

5.2.7.11 FIT-1231032A/B/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 Engineering Design Phase.

5.2.7.12 The piping from Gas Export Metering Skid shall enter and exit according to the restrictions imposed by the layout in I-DE-3010.2D-1417-942-P4X-001 - M-07A – INJECTION AND EXPORT COMPRESSION - EQUIPMENT LAYOUT PLAN. Arrangement shall consider ways to avoid condensate on the meters. The final layout shall be confirmed during Detail Engineering Design Phase.

5.2.7.13 For more details see I-DE-3010.2D-1231-944-P4X-014 - LIFT GAS AND EXPORTATION HEADERS - PIG LAUNCHER/ RECEIVER.

5.2.8 Gas Import Metering Skid (Z-1231002)

5.2.8.1 The Gas Import Metering Skid shall be composed of:

- 2 (two) parallel ultrasonic duty flow meters (FIT-1231033A/B), at a 2 x 100% configuration, with local indication;
- One ultrasonic master meter (FIT-1231033C) with local indication, installed in series to the flow meters, for calibration of duty flow meters (FIT-1231033A/B). One additional master meter shall be supplied as a non-installed spare;

- Temperature and pressure transmitters for each stream;
- Removable upstream (FX-1231033A/B/C-1 and FX-1231033A/B/C-3) straight run with flow conditioner (FX-1231033A/B/C-2) and downstream straight run (FY-1231033A/B/C) for each stream, in accordance with meter respective Inmetro type approval or ISO 17089, whichever it is more restrict;
- Manual sample panel (SC-FIT-1231033), installed downstream of the flow meters on the common header;
- One chromatograph analyzer (AIT-1231033), installed downstream of the flow meters, on the common header;
- Flow control valves downstream of the meters;
- Remote controlled double block and bleed valves with positioner for meter alignments (inlet, outlet and master meter alignment);
- All required valves, drains, PSV and piping;
- Blind spectacles on each metering stream, so as to allow each meter to become unavailable, for legal requirement purposes;
- Junction boxes and control panels, as required;
- Access facilities for the meters and instruments.

5.2.8.2 Z-1223001 Gas Export Metering skid shall have provisions to calibrate gas import meters onboard, as an alternative calibration solution.

5.2.8.3 All transmitters of each stream shall be connected to their respective flow computers, which process all signals to calculate and correct the volumes.

5.2.8.4 The instruments, field panels and equipment of Z-1231002 shall be furnished assembled on a single skid, to be lifted and mounted together on Topside of UNIT.

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

5.2.8.6 The meters 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 system shall be less than 1.0%.

5.2.8.7 Chromatograph analyzer shall read hydrocarbon composition (at least C9+), CO2 and N2 and have a maximum uncertainty of 0.3% on the compressibility factor.

5.2.8.8 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 HMI.

5.2.8.9 The Gas Import Metering Skid shall receive, from the flow computer, analogue 4-20 mA signals to be sent to each flow control valve in order to control process flow rate for calibration purposes and shall receive, from the FMS PLC, discrete signals to control each alignment valve.

5.2.8.10 There shall be one analogue 4-20 mA output from each flow control valve positioner, PIT and TIT on the skid, analogue pulse outputs from the flowmeters and a discrete signal for the Malfunction Unit Alarm (UAM) of the chromatograph analyzer to the flow computer. There shall be one analogue 4-20 mA output from limit switches of each alignment valve to the FMS PLC.

5.2.8.11 Upstream (FX-1231033A/B/C-1 and FX-1231033A/B/C-3) and downstream (FY-1231033A/B/C) straight pipe runs, as well as flow conditioners (FX-1231033A/B/C-2), shall have dimensional inspection certificate done by laboratory accredited by RBC or ILAC/IAAC.

5.2.8.12 FIT-1231033A/B/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 Engineering Design Phase.

5.2.8.13 The piping from Gas Import Metering Skid shall enter and exit according to the restrictions imposed by the layout in I-DE-3010.2D-1417-942-P4X-002 – M-07B – INJECTION AND EXPORT COMPRESSION - EQUIPMENT LAYOUT PLAN. Arrangement shall consider ways to avoid condensate on the meters. The final layout shall be confirmed during Detail Engineering Design Phase.

5.2.8.14 For more details see I-DE-3010.2D-1231-944-P4X-014 – LIFT GAS AND EXPORTATION HEADERS – PIG LAUNCHER/ RECEIVER.

6 ALLOCATION METERING

6.1 Oil Flow Measurement

6.1.1 Oil from Test Separator

6.1.1.1 The Allocation Crude Oil Meters account the oil for the well test procedure and are installed downstream of the Test Separator Pumps (B-1223004A/B) at the outlet of the Test Separator (SG-1223002).

6.1.1.2 The system shall be composed of:

- 2 (two) parallel mass flow meters, Coriolis type (FIT-1223023A/B), at a 2 x 100% configuration, with local indication;
- Pressure and temperature transmitters for each stream;
- One static mixer installed downstream of the meters, on the common header;
- One in-line BS&W analyzer (AIT-1223005) microwave technology, installed downstream of the mixer;
- One automatic sampler (AX-1223005) installed downstream of the mixer;
- Manual sampler (SC-FIT-1223023) installed downstream of the mixer, 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;
- Double block and bleed valves for meter alignments;

- Access facilities for the meters and instruments;

6.1.1.3 Z-1359501 shall have provisions to calibrate FIT-1223023A/B onboard.

6.1.1.4 It shall be foreseen cargo handling facilities (such as monorails or others) to remove flow meters to calibrate them on Z-1359501 skid.

6.1.1.5 Flow, temperature, pressure transmitters and BS&W analyzer shall be connected to the flow computer (FQIT-12230023A/B) 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 Engineering Design Phase.

6.1.1.6 It shall be foreseen a discrete signal for the Unit Alarm Malfunction (UAM) of the BS&W analyzer to the oil flow computer.

6.1.1.7 The metering system shall be installed below the SG-1223002 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-1223004A/B are not operating.

6.1.1.8 FIT-1223023A/B 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 system.

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

6.1.1.10 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.

6.1.1.11 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.

6.1.1.12 The automatic sampler shall receive a 24 Vdc power supply from the FMS panel (PN-1223001).

6.1.1.13 The automatic sampler (AX-1223005) shall send two discrete signals (LSH-1223005-1/2) 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.

6.1.1.14 The automatic sampler (AX-1233005) 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).

6.1.1.15 FIT-1223023A/B 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 Engineering Design Phase.

6.1.1.16 For more details see I-DE-3010.2D-1223-944-P4X-019 – TEST SEPARATOR PUMPS.

6.2 Gas Flow Measurement

6.2.1 Gas from Test Separator

6.2.1.1 The flow metering point consists of:

- Dual chamber orifice fittings (FE-1223074), provided with drains (with double block and bleed valves);
- Orifice plates;
- Removable upstream (FX-1223074-1 and FX-1223074-3) and downstream (FY-1223074) straight pipe sections, according to ISO 5167-2 requirements;
- Zanker flow conditioner (FX-1223074-2);
- Flow, temperature and pressure transmitters;
- Related sample panel (SC-FIT-1223074) upstream the flow meter;
- Access facilities for the meters and instruments.

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

6.2.1.3 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.

6.2.1.4 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-1223002) and having an upward slope on piping.

6.2.1.5 For more details see I-DE-3010.2D-1223-944-P4X-017 – TEST HEATER / TEST SEPARATOR.

6.2.2 Gas Lift Individual per Well – Satellite Production Well A/B/C/D/E/F/G/H/J

6.2.2.1 Each flow metering point consists of:

- Dual chamber orifice fittings (FE-1244001A/J), provided with drains (with double block and bleed valves);
- Orifice plates;
- Removable upstream (FX-1244001A/J-1 and FX-1244001A/J-3) and downstream (FY-1244001A/J) straight pipe sections, according to ISO 5167-2 requirements;
- Zanker flow conditioner (FX-1244001A/J-2);
- Flow, temperature and pressure transmitters;
- Access facilities for the meters and instruments.

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

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

6.2.2.4 For sampling of individual gas lift, total gas lift sampling panel shall be used.

6.2.2.5 For more details, see I-DE-3010.2D-1244-944-P4X-001 – WELL PIG LAUNCHERS (LP-1244001A/B), I-DE-3010.2D-1244-944-P4X-002 – WELL PIG LAUNCHERS (LP-1244001C/D), I-DE-3010.2D-1244-944-P4X-003 – WELL PIG LAUNCHERS (LP-1244001E/F), I-DE-3010.2D-1244-944-P4X-004 – WELL PIG LAUNCHERS (LP-1244001G/H) and I-DE-3010.2D-1244-944-P4X-005 – WELL PIG LAUNCHER (LP-1244001J).

6.2.3 Gas Lift Individual per Well – Satellite Production pWAG Wells K/L/M/N/P

6.2.3.1 The flow metering of each point consists of:

- Dual chamber orifice fittings (FE-1244001K/P), provided with drains (with double block and bleed valves);
- Orifice plates;
- Removable upstream (FX-1244001K/P-1 and FX-1244001K/P-3) and downstream (FY-1244001K/P) straight pipe sections, according to ISO 5167-2 requirements;
- Zanker flow conditioner (FX-1244001K/P-2);
- Flow transmitters with range extension, temperature and pressure transmitters;
- Access facilities for the meters and instruments.

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

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

6.2.3.4 For sampling of individual gas lift, total gas lift sampling panel shall be used.

6.2.3.5 For more details see I-DE-3010.2D-1244-944-P4X-006 – WELL PIG LAUNCHERS (LP-1244002A/B), I-DE-3010.2D-1244-944-P4X-007 – WELL PIG LAUNCHERS (LP-1244002C/D) and I-DE-3010.2D-1244-944-P4X-008 – WELL PIG LAUNCHER (LP-1244002E).

7 CUSTODY TRANSFER METERING

7.1 Oil Flow Measurement

7.1.1 Offloading Metering Skid (Z-1359501)

7.1.1.1 The Offloading Metering Skid (Z-1359501) is part of the Hull offloading system, but it is installed on Topsides. The Offloading Metering Skid shall be specified, acquired, installed and commissioned by SELLER.

7.1.1.2 For the design flow rate of the Offloading Metering Skid (Z-1359501), the total maximum flow rate of the offloading pumps shall be considered, with addition of a 10% margin. See I-ET-3010.2E-1359-940-P4X-001 – OFFLOADING SYSTEM for further details.

7.1.1.3 The Offloading Metering Skid (Z-1359501) shall be composed of, at least:

- Four custody transfer turbine flow meters (FIT-1359501A/D) at a 4 x 33% configuration, with local indication;
- Filters upstream each turbine meter, with mesh according to vendor recommendation;
- One calibration run in series with the turbine meters, for calibration of the Crude Oil Well Service Pump meters (FIT-5133002A/B) and oil allocation meters (FIT-1223023A/B), 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;
- One compact prover (U-Z-1359501), which shall be mounted together on the skid structure;
- One static mixer installed downstream of the flow meters;
- One BS&W analyzer (AIT-1359501) installed downstream of the static mixer;
- One automatic sampler (AX-1359501) installed downstream of the static mixer, supplied together with the skid;
- A manual sampler (SC-Z-1359501) installed downstream of the static mixer;
- Pressure and temperature transmitters for each stream (including the calibration one) and for the compact prover;
- Flow control valves downstream of the meters and compact prover;
- Remote controlled double block and bleed valves with positioner for meter alignments (inlet, outlet and calibration alignment);
- All required valves, PSV and piping;
- Blind spectacles on each metering stream, so as to allow each meter to become unavailable, for legal requirement purposes;
- Junction boxes and control panels, as required;
- Drain collector connected to the drain system of the unit;
- Removable upstream (FX-1359501A/D-1 and FX-1359501A/D-3) straight pipe run of at least 10D (10 times the nominal diameter of the meter) and downstream (FY-1359501A/D) straight pipe run of at least 5D (5 times the nominal diameter of the meter) for each stream, according to API MPMS 5.3 or meter respective Inmetro type approval (PAM), whichever is more restrict;
- Access facilities for the meters and instruments.

7.1.1.4 Flow, temperature, and pressure transmitters of each flow meter shall be connected to their respective flow computer that receives and processes all signals to calculate and correct the flow.

7.1.1.5 Z-1359501 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 whole system. Compact prover shall have maximum uncertainty of 0.04%.

7.1.1.6 Upstream (FX-1359501A/D-1 and FX-1359501A/D-3) and downstream (FY-1359501A/D) straight pipe runs, as well as flow conditioners (FX-1359501A/D-2), shall have dimensional inspection certificate done by laboratory accredited by RBC or ILAC/IAAC.

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

7.1.1.8 A filter sized in accordance with ANSI/ ISA-RP31.1 recommendations or a more stringent filtration when specified or recommended by the MANUFACTURER shall be installed upstream of each turbine meter.

7.1.1.9 The calibration stream shall be designed to allow the calibration of the Crude Oil Well Service Pump meters (FIT-5133002A/B) or the allocation oil flow meters (FIT-1223023A/B) using the compact prover (U-Z-1359501). For calculation purposes, a virtual tag FIT-1359502 shall be implemented on flow computer for its calculations. 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.

7.1.1.10 The instruments, field panels and equipment of Z-1359501 shall be furnished assembled on a single skid, to be lifted and mounted together on Topside of UNIT.

7.1.1.11 It shall be foreseen cargo handling facilities (such as monorails or others) for flow meters, calibration stream and valves maneuver and maintenance. These facilities may either be supplied together on the skid or integrated on the module.

7.1.1.12 Temperature and pressure transmitters, BS&W analyzer and compact prover shall be connected to its respective flow computer. BS&W information shall be shared for all meter streams on the flow computer. The automatic sampler shall be connected to FMS PLC.

7.1.1.13 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.

7.1.1.14 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.

7.1.1.15 For the compact prover, electrical components 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).

7.1.1.16 All prover seals shall be filled PTFE. The flow tube, end flanges, connection flanges and internals shall be in AISI 316 L.

7.1.1.17 The Offloading Transfer Metering Skid (Z-1359501) shall receive, from the FMS panel (PN-1223001), all necessary 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.

7.1.1.18 The power supply to be provided from FMS panel (PN-1223001) to the BS&W analyzer (AIT-1359501) shall be confirmed during detailing design phase.

7.1.1.19 Among other necessary power supplies, the Offloading Transfer Metering Skid shall receive a 24 Vdc supply from the FMS panel for the Automatic Sampler (AX-1359501).

7.1.1.20 Among other necessary power supplies, the 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 (U-Z-1359501).

7.1.1.21 The Offloading Transfer Metering Skid shall receive, from the flow computer, analogue 4-20 mA signals to be sent to each HV in order to control process flow rate for calibration and shall receive from FMS PLC discrete signals to control each XV and the Automatic Sampler (AX-1359501).

7.1.1.22 There shall be one analogue 4-20 mA output from each HV positioner, PIT and TIT on the skid, analogue pulse outputs from the turbine flowmeters and a discrete signal for the Unit Alarm Malfunction (UAM) of BS&W analyzer (AIT-1359501) to the offloading custody transfer flow computers. There shall be a discrete output from the automatic sampler and a discrete output from the limit switches to the FMS PLC.

7.1.1.23 The automatic sampler (AX-1359501) 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.

7.1.1.24 The automatic sampler (AX-1359501) 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).

7.1.1.25 There shall be communication between the BS&W analyzer (AIT-1359501) and the flow computer. The communication physical media and protocol between analyzer and flow computers shall be confirmed during detailing design phase. The amount of water which passed on the offloading skid shall not be accounted in the total quantity of crude oil offloaded (batch).

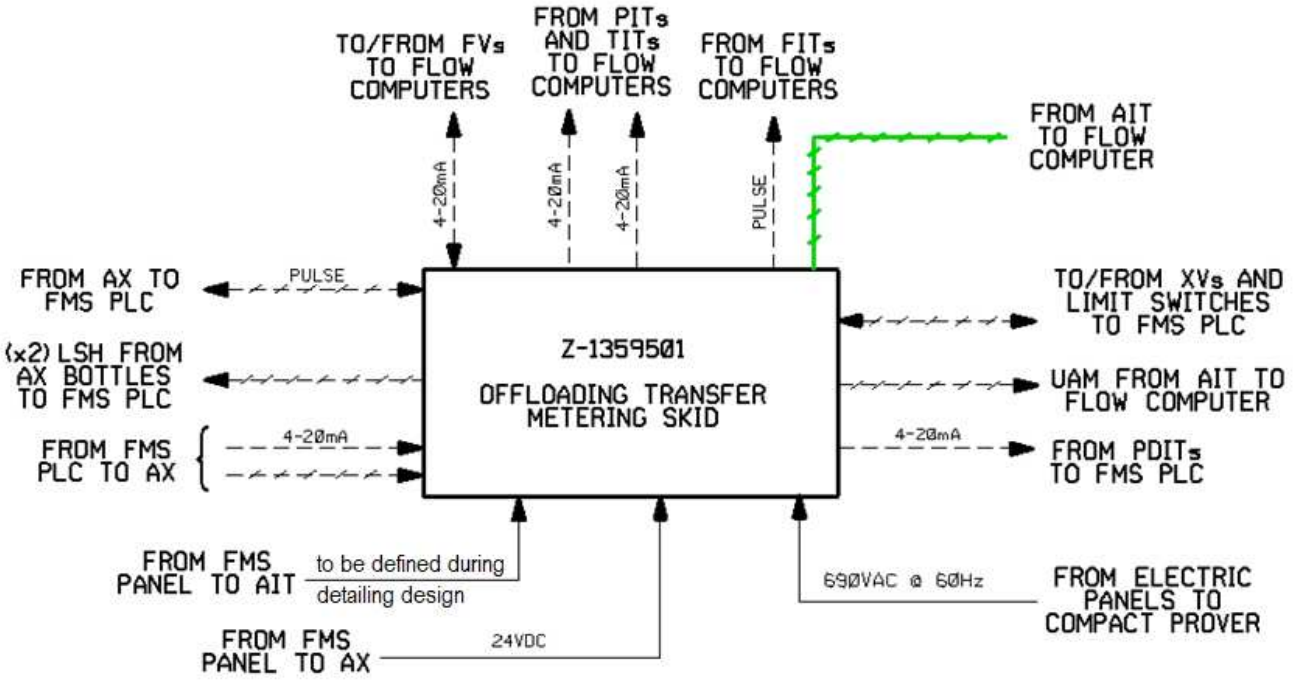

Figure 2 – Custody Oil Metering Skid (Z-1350501) signal interfaces.

7.1.1.26 The piping from offloading skid shall enter and exit according to the restrictions imposed by the layout in I-DE-3010.2D-1414-942-P4X-001– M-04 – CO2 REMOVAL - EQUIPMENT LAYOUT PLAN. The final layout shall be confirmed during Detail Engineering Design Phase.

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

8 OPERATIONAL METERING

8.1 Oil Flow Measurement

8.1.1 Oil from Free Water Separator

8.1.1.1 Each oil flow measurement at the outlet of Free Water Separators (SG-1223001A/B) consists of:

- 3 parallel mass flow meters for each production train, Coriolis type (FIT-1223054A-1/2/3 for production train A and FIT-1223054B-1/2/3 for production train B) at a 3 x 50% configuration, with local indication;
- Pressure and temperature transmitters for each stream;

- One static mixer installed downstream of the meters (of each production train);
- One in-line BS&W analyzer for each production train (AIT-1223054A and AIT-1223054B) installed downstream of its respective static mixer;
- A manual sampler for each production train (SC-FIT-1223054A and SC-FIT-1223054B) installed downstream of its respective static mixer;
- Bypass and block valves;
- Access facilities for the meters and instruments.

8.1.1.2 Flow, temperature and pressure transmitters and BS&W analyzers shall be connected to its respective flow computer (FQIT-1223054A/B) that receives and processes all signals to calculate and correct the flow.

8.1.1.3 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.

8.1.1.4 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.

8.1.1.5 FIT-1223054A-1/3 and FIT-1223054B-1/3 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 Engineering Design Phase.

8.1.1.6 For more details see I-DE-3010.2D-1223-944-P4X-003 – FREE WATER SEPARATOR “A” and I-DE-3010.2D-1223-944-P4X-004 – FREE WATER SEPARATOR “B”.

8.1.2 Diesel Well Service Metering

8.1.2.1 The Diesel Well Service Metering shall be composed of:

- 1 (one) mass flow meters, Coriolis type (FIT-5133003), with local indicator;
- Pressure and temperature transmitters;
- A manual sampler (SC-FIT-5133003) installed downstream of the static mixer, as per I-ET-3010.00-1200-588-P4X-001 - SAMPLE CONNECTIONS;
- Access facilities for the meters and instruments;

8.1.2.2 Flow, temperature and pressure transmitters shall be connected to the flow computer (FQIT-5133003) that receives and processes all signals to calculate and correct the flow. For more details see I-DE-3010.2D-5133-944-P4X-001 – DIESEL INJECTION SYSTEM.

8.1.2.3 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.

8.2 Gas Flow Measurement

8.2.1 Gas from Free Water Separator

8.2.1.1 Each gas flow measurement at the gas outlet of the Free Water Separators (SG-1223001A/B) consists of:

- Dual chamber orifice fittings (FE-1223053A/B), provided with drains (with double block and bleed valves);
- Orifice plates;
- 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;
- Zanker flow conditioner (FX-1223053A-2 and FX-1223053B-2);
- Flow (FIT-1223053A/B), temperature (TIT-1223053A/B) and pressure transmitters (PIT-1223053A/B);
- Related sample panel (SC-FIT-1223053A/B) upstream its respective flow meter;
- Access facilities for the meters and instruments.

8.2.1.2 Total uncertainty of the loop shall be less than 3.0%.

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

8.2.1.4 For more details see I-DE-3010.2D-1223-944-P4X-003 – FREE WATER SEPARATOR “A” and I-DE-3010.2D-1223-944-P4X-004 – FREE WATER SEPARATOR “B”.

8.2.2 Gas from V-TO-1223001A/B

8.2.2.1 Each flow metering point at the gas outlet of the Pre-Oil Dehydrator Degassers (V-TO-1223001A/B) consists of:

- A cone meter (FE-1223065A/B);
- Flow transmitters with range extension (FIT-1223065A/B-1/2), temperature (TIT-1223065A/B) and pressure transmitters (PIT-1223065A/B);
- Upstream and downstream straight pipe sections, according to ISO 5167-5 requirements;
- By-pass and block valves;
- Related sample panel (SC-FIT-1223065A/B) upstream its respective flow meter;
- Access facilities for the meters and instruments.

8.2.2.2 Total uncertainty of the loop shall be less than 3.0%.

8.2.2.3 Flow, temperature and pressure transmitters shall be connected to its respective flow computer (FQIT-1223065A/B) that receives and processes all signals to calculate and correct the flow.

8.2.2.4 For more details see I-DE-3010.2D-1223-944-P4X-009 – PRE OIL DEHYDRATOR "A" and I-DE-3010.2D-1223-944-P4X-010 – PRE OIL DEHYDRATOR "B".

8.2.3 Gas from V-TO-1223002A/B

8.2.3.1 Each flow metering point at the gas outlet of the Oil Dehydrator Degassers (V-TO-1223002A/B) consists of:

- A cone meter (FE-1223068A/B);
- Flow transmitters with range extension (FIT-1223068A/B-1/2), temperature (TIT-1223068A/B) and pressure transmitters (PIT-1223068A/B);
- Upstream and downstream straight pipe sections, according to ISO 5167-5 requirements;
- By-pass and block valves;
- Related sample panel (SC-FIT-1223068A/B) upstream its respective flow meter;
- Access facilities for the meters and instruments.

8.2.3.2 Total uncertainty of the loop shall be less than 3.0%.

8.2.3.3 Flow, temperature and pressure transmitters shall be connected to its respective flow computer (FQIT-1223068A/B) that receives and processes all signals to calculate and correct the flow.

8.2.3.4 For more details see I-DE-3010.2D-1223-944-P4X-011 – OIL DEHYDRATOR "A" and I-DE-3010.2D-1223-944-P4X-012 – OIL DEHYDRATOR "B".

8.2.4 Total Gas Lift

8.2.4.1 The flow metering point consists of:

- Dual chamber orifice fittings (FE-1231031), provided with drains (with double block and bleed valves);
- Orifice plates;
- Removable upstream (FX-1231031-1 and FX-1231031-3) and downstream (FY-1231031) straight pipe sections, according to ISO 5167-2 requirements;
- Zanker flow conditioner (FX-1231031-2);
- Flow (FIT-1231031), temperature (TIT-1231031) and pressure transmitters (PIT-1231031);
- Related sample panel (SC-FIT-1231031) upstream of the flow meter;
- Access facilities for the meters and instruments.

8.2.4.2 Total uncertainty of the loop 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-3010.2D-1231-944-P4X-014 – LIFT GAS AND EXPORTATION HEADERS – PIG LAUNCHER/ RECEIVER.

8.2.5 Total Gas Injection

8.2.5.1 The flow metering point consists of:

- A cone meter (FE-1252012);
- Flow transmitters with range extension (FIT-1252012-1/2), temperature (TIT-1252012) and pressure transmitters (PIT-1252012);
- Upstream and downstream straight pipe sections, according to ISO 5167-5 requirements;
- By-pass and double block and bleed valves;
- Related sample panel (SC-FIT-1252012) upstream the flow meter and upstream the V-UC-1252001A/B;
- Access facilities for the meters and instruments.

8.2.5.2 Total uncertainty of the loop shall be less than 3.0%.

8.2.5.3 Flow, temperature and pressure transmitters shall be connected to the flow computer (FQIT-1252012) that receives and processes all signals to calculate and correct the flow.

8.2.5.4 For more details see I-DE-3010.2D-1252-944-P4X-003 – INJECTION GAS HEADER and I-DE-3010.2D-1252-944-P4X-001 – INJECTION GAS COMPRESSION UNIT – TRAIN A.

8.2.6 Individual Gas Injection – Satellite pWAG Injection Wells K/L/M/N/P

8.2.6.1 Each flow metering point consists of:

- A cone meter (FE-1210015K/P);
- Flow transmitters with range extension (FIT-1210015K/P-1/2), temperature (TIT-1210015K/P) and pressure transmitters (PIT-1210015K/P);
- Upstream and downstream straight pipe sections, according to ISO 5167-5 requirements;
- Access facilities for the meters and instruments.

8.2.6.2 Total uncertainty of each loop shall be less than 3.0%.

8.2.6.3 Flow, temperature and pressure transmitters shall be connected to the flow computer (FQIT-1210015K/P) that receives and processes all signals to calculate and correct the flow.

8.2.6.4 For sampling of individual gas injection, total gas injection sampling panel shall be used.

8.2.6.5 For more details see I-DE-3010.2D-1210-944-P4X-010 – WAG INJECTION AND SATELLITE PRODUCTION WELL “K”, I-DE-3010.2D-1210-944-P4X-011 – WAG INJECTION AND SATELLITE PRODUCTION WELL “L”, I-DE-3010.2D-1210-944-P4X-012 – WAG INJECTION AND SATELLITE PRODUCTION WELL “M”, I-DE-3010.2D-1210-944-P4X-013 – WAG INJECTION AND SATELLITE PRODUCTION WELL “N” and I-DE-3010.2D-1210-944-P4X-014 – WAG INJECTION AND SATELLITE PRODUCTION WELL “P”.

8.2.7 Individual Gas Injection – Piggyback WAG Injection Wells Q/R/S/T/U/V/W – Position 1

8.2.7.1 The flow metering of each point consists of:

- A cone meter (FE-1210001Q/W);
- Flow transmitters with range extension (FIT-1210001Q/W-1/2), temperature (TIT-1210001Q/W) and pressure transmitters (PIT-1210001Q/W);
- Upstream and downstream straight pipe sections, according to ISO 5167-5 requirements;
- Access facilities for the meters and instruments.

8.2.7.2 Total uncertainty of each loop shall be less than 3.0%.

8.2.7.3 Flow, temperature and pressure transmitters shall be connected to the flow computer (FQIT-1210001Q/W) that receives and processes all signals to calculate and correct the flow.

8.2.7.4 For sampling of individual gas injection, total injection gas sampling panel shall be used.

8.2.7.5 For more details see I-DE-3010.2D-1210-944-P4X-015 – WAG INJECTION WELL "Q", I-DE-3010.2D-1210-944-P4X-016 – WAG INJECTION WELL "R", I-DE-3010.2D-1210-944-P4X-017 – WAG INJECTION WELL "S", I-DE-3010.2D-1210-944-P4X-018 – WAG INJECTION WELL "T", I-DE-3010.2D-1210-944-P4X-019 – WAG INJECTION WELL "U", I-DE-3010.2D-1210-944-P4X-020 – WAG INJECTION WELL "V" and I-DE-3010.2D-1210-944-P4X-021 – WAG INJECTION WELL "W".

8.2.8 Individual Gas Injection – Piggyback WAG Injection Wells Q/R/S/T/U/V/W – Position 2

8.2.9 The flow metering of each point consists of:

- A cone meter (FE-1210003Q/W);
- Flow transmitters with range extension (FIT-1210003Q/W-1/2), temperature (TIT-1210003Q/W) and pressure transmitters (PIT-1210003Q/W);
- Upstream and downstream straight pipe sections, according to ISO 5167-5 requirements;
- Access facilities for the meters and instruments.

8.2.9.1 Total uncertainty of each loop shall be less than 3.0%.

8.2.9.2 Flow, temperature and pressure transmitters shall be connected to the flow computer (FQIT-1210003Q/W) that receives and processes all signals to calculate and correct the flow.

8.2.9.3 For sampling of individual gas injection, total injection gas sampling panel shall be used.

8.2.9.4 For more details see I-DE-3010.2D-1210-944-P4X-015 – WAG INJECTION WELL "Q", I-DE-3010.2D-1210-944-P4X-016 – WAG INJECTION WELL "R", I-DE-3010.2D-1210-944-P4X-017 – WAG INJECTION WELL "S", I-DE-3010.2D-1210-944-P4X-018 – WAG INJECTION WELL "T", I-DE-3010.2D-1210-944-P4X-019 – WAG INJECTION WELL "U", I-DE-3010.2D-1210-944-P4X-020 – WAG INJECTION WELL "V" and I-DE-3010.2D-1210-944-P4X-021 – WAG INJECTION WELL "W".

8.2.10 Flare Pilot

8.2.10.1 The flow metering point consists of:

- Dual chamber orifice fittings (FE-5412009), provided with drains (with double block and bleed valves);
- Orifice plates;
- Removable upstream (FX-5412009-1 and FX-5412009-3) and downstream (FY-5412009) straight pipe sections, according to ISO 5167-2 requirements;
- Zanker flow conditioner (FX-5412009-2);
- Flow, temperature and pressure transmitters;
- Access facilities for the meters and instruments.

8.2.10.2 Total uncertainty of the loop shall be less than 3.0%.

8.2.10.3 Flow, 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.

8.2.10.4 In case dimensioning of metering point requires a flow meter with diameter smaller than 2”, alternative technologies may be submitted for PETROBRAS approval.

8.2.10.5 For sampling of Flare Pilot point, LP Fuel Gas sampling panel shall be used.

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

8.2.11 Flare Assist Gas

8.2.11.1 The flow metering point consists of:

- Dual chamber orifice fittings (FE-5412012), provided with drains (with double block and bleed valves);

- Orifice plates;
- Removable upstream (FX-5412012-1 and FX-5412012-3) and downstream (FY-5412012) straight pipe sections, according to ISO 5167-2 requirements;
- Zanker flow conditioner (FX-5412012-2);
- Flow, temperature and pressure transmitters;
- Access facilities for the meters and instruments.

8.2.11.2 Total uncertainty of the loop shall be less than 3.0%.

8.2.11.3 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.

8.2.11.4 For sampling of Flare Assist Gas point, LP Fuel Gas sampling panel shall be used.

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

8.2.12 Purge Gas to Flare

8.2.12.1 The flow metering point consists of:

- Dual chamber orifice fittings (FE-5412052), provided with drains (with double block and bleed valves);
- Orifice plates;
- Removable upstream (FX-5412052-1 and FX-5412052-3) and downstream (FY-5412052) straight pipe sections, according to ISO 5167-2 requirements;
- Zanker flow conditioner (FX-5412052-2);
- Flow, temperature and pressure transmitters;
- Access facilities for the meters and instruments.

8.2.12.2 Total uncertainty of the loop shall be less than 3.0%.

8.2.12.3 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.

8.2.12.4 In case dimensioning of metering point requires a flow meter with diameter smaller than 2”, alternative technologies may be submitted for PETROBRAS approval.

8.2.12.5 For sampling of Purge Gas to Flare point, LP Fuel Gas sampling panel shall be used.

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

8.3 Water Flow Measurement

8.3.1 Produced Water from Test Separator

8.3.1.1 The flow metering point at the water outlet of the Test Separator (SG-1223002) consists of:

- One magnetic flow meter (FIT-1223073), spool type;
- Temperature and pressure transmitters;
- 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;
- Related sampling panel (SC-FIT-1223073) downstream of the flow meter;
- Access facilities for the meters and instruments.

8.3.1.2 FIT-1223073 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-1223073) that receives and processes all signals to calculate and correct the flow.

8.3.1.4 For more details see I-DE-3010.2D-1223-944-P4X-017 – TEST HEATER / TEST SEPARATOR.

8.3.2 Discharged Produced Water

8.3.2.1 This metering system accounts for the water on the outlet of Produced Water Treatment package.

8.3.2.2 The metering point shall have two flow totalization variables to account for the water that flows through both FIT-5331023A/B meters: one to account for on-spec water when discharged overboard and the other to account for off-spec water diverted to Produced Water Tank. Discharged water totalization shall occur only if XV-5331034-2 is not closed (i.e. if ZSL limit switch is not active). Otherwise, if XV-5331034-2 is closed, then volume totalization shall occur on off-spec water volume variable.

8.3.2.3 XV-5331034-2 limit switch shall be connected to FMS Panel for volume totalization accountability.

8.3.2.4 The flow metering point consists of:

- 2 (two) parallel magnetic flow meters (FIT-5331023A/B), spool type, in 2 x 100% arrangement;
- Pressure and temperature transmitters for each stream;
- 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;

- Related sample panels (SC-FIT-5331023A for FL-5331001A outlet and SC-FIT-5331023B for FL-5331001B outlet) close to the flow meter;
- Access facilities for the meters and instruments;

8.3.2.5 FIT-5331023A/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.

8.3.2.6 Flow, temperature and pressure transmitters shall be connected to the flow computer (FQIT-5331023) that receives and processes all signals to calculate and correct the flow.

8.3.2.7 For more details see I-DE-3010.2D-5331-944-P4X-003 – GAS FLOTATION UNIT "A".

8.3.3 Produced Water to Injection

8.3.3.1 This metering system accounts for the water at the outlet of the Produced Water Booster Pumps.

8.3.3.2 The metering point shall have two flow totalization variables to account for the water that flows through both FIT-5331028A/B meters: one to account for on-spec water when discharged overboard and the other to account for off-spec water when directed to reservoir injection. Discharged water totalization shall occur only if XV-5331035-2 is not closed (i.e., if ZSL limit switch is not active). Otherwise, if XV-5331035-2 is closed, then volume totalization shall occur on off-spec water volume variable.

8.3.3.3 XV-5331035-2 limit switch shall be connected to FMS Panel for volume totalization accountability.

8.3.3.4 The flow metering point consists of:

- 2 (two) parallel magnetic flow meters (FIT-5331028A/B), spool type, in 2 x 100% arrangement
- Pressure and temperature transmitters at each stream;
- 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;
- Related sample panel (SC-FIT-5331028) close to the flow meter;
- Access facilities for the meters and instruments.

8.3.3.5 FIT-5331028A/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.

8.3.3.6 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.

8.3.3.7 For more details see I-DE-3010.2D-5331-944-P4X-007 – PRODUCED WATER BOOSTER PUMP AND FILTER.

8.3.4 Water from Free Water Separators

8.3.4.1 Each flow metering point at the water outlet of the Free Water Separators (SG-1223001A/B) consists of:

- A magnetic flow meter for each production train (FIT-1223056A/B);
- Pressure and temperature transmitters at each stream;
- 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;
- Related sample panel (SC-FIT-1223056A/B) upstream its respective flow meter;
- Bypass and block valves;
- Access facilities for the meters and instruments.

8.3.4.2 Flow, temperature and pressure transmitters shall be connected to its respective flow computer (FQIT-1223056A/B) that receives and processes all signals to calculate and correct the flow.

8.3.4.3 FIT-1223056A/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.

8.3.4.4 For more details see I-DE-3010.2D-1223-944-P4X-003 – FREE WATER SEPARATOR “A” and I-DE-3010.2D-1223-944-P4X-004 – FREE WATER SEPARATOR “B”.

8.3.5 Water from TO-1223001A/B

8.3.5.1 Each flow metering point at the water outlet of the Pre-Oil Dehydrators (TO-1223001A/B) consists of:

- A magnetic flow meter for each production train (FIT-1223062 for train A and FIT-1223132 for train B);
- Pressure and temperature transmitters for each stream;
- 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;
- Related sample panel (SC-FIT-1223062 and SC-FIT-1223132) upstream its respective flow meter;
- Bypass and block valves;
- Access facilities for the meters and instruments.

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

8.3.5.3 FIT-1223062/132 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.

8.3.5.4 For more details see I-DE-3010.2D-1223-944-P4X-013 – PRE-OIL DEHYDRATOR RECIRCULATION WATER PUMP A/D.

8.3.6 Water from TO-1223002A/B

8.3.6.1 Each flow metering point at the water outlet of the Oil Dehydrators (TO-1223002A/B) consists of:

- A magnetic flow meter for each production train (FIT-1223147 for train A and FIT-1223148 for train B);
- Pressure and temperature transmitters for each stream;
- 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;
- Related sample panel (SC-FIT-1223147 and SC-FIT-1223148) upstream its respective flow meter;
- Access facilities for the meters and instruments.

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

8.3.6.3 FIT-12230147/148 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.

8.3.6.4 For more details see I-DE-3010.2D-1223-944-P4X-014 – OIL DEHYDRATOR RECIRCULATION WATER PUMP A/D.

8.3.7 Total Injected Water

8.3.7.1 The flow metering point consists of:

- A magnetic flow meter (FIT-1251005);
- Pressure and temperature transmitters;
- 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;
- Access facilities for the meters and instruments.

8.3.7.2 Sample collection may be done in individual injection water.

8.3.7.3 Flow, temperature and pressure transmitters shall be connected to the flow computer (FQIT-1251005) that receives and processes all signals to calculate and correct the flow.

8.3.7.4 FIT-1251005 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.

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

8.3.8 Water Injection Satellite pWAG Wells K/L/M/N/P

8.3.8.1 Each flow metering point consists of:

- A magnetic flow meter (FIT-1210005K/P);
- Pressure and temperature transmitters for each stream;
- 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;
- Related sample panel (SC-FIT-1210005K/P) upstream its respective flow meter;
- Access facilities for the meters and instruments.

8.3.8.2 Flow, temperature and pressure transmitters shall be connected to the flow computer (FQIT-1210005K/P) that receives and processes all signals to calculate and correct the flow.

8.3.8.3 FIT-1210005K/P 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-3010.2D-1210-944-P4X-010 – WAG INJECTION AND SATELLITE PRODUCTION WELL “K”, I-DE-3010.2D-1210-944-P4X-011 – WAG INJECTION AND SATELLITE PRODUCTION WELL “L”, I-DE-3010.2D-1210-944-P4X-012 – WAG INJECTION AND SATELLITE PRODUCTION WELL “M”, I-DE-3010.2D-1210-944-P4X-013 – WAG INJECTION AND SATELLITE PRODUCTION WELL “N” and I-DE-3010.2D-1210-944-P4X-014 – WAG INJECTION AND SATELLITE PRODUCTION WELL “P”.

8.3.9 Water Injection Piggyback WAG Injection Wells Q/R/S/T/U/V/W – Position 1

8.3.9.1 The flow metering of each well position 1 consists of:

- A magnetic flow meter (FIT-1210027Q/W);
- Pressure and temperature transmitters for each stream;
- 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;
- Related sample panel (SC-FIT-1210027Q/W) upstream its respective flow meter;
- Access facilities for the meters and instruments.

8.3.9.2 Flow, temperature and pressure transmitters shall be connected to the flow computer (FQIT-1210027Q/W) that receives and processes all signals to calculate and correct the flow.

8.3.9.3 FIT-1210027Q/W 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-3010.2D-1210-944-P4X-015 – WAG INJECTION WELL "Q", I-DE-3010.2D-1210-944-P4X-016 – WAG INJECTION WELL "R", I-DE-3010.2D-1210-944-P4X-017 – WAG INJECTION WELL "S", I-DE-3010.2D-1210-944-P4X-018 – WAG INJECTION WELL "T", I-DE-3010.2D-1210-944-P4X-019 – WAG INJECTION WELL "U", I-DE-3010.2D-1210-944-P4X-020 – WAG INJECTION WELL "V" and I-DE-3010.2D-1210-944-P4X-021 – WAG INJECTION WELL "W".

8.3.10 Water Injection Piggyback WAG Wells Injection Wells Q/R/S/T/U/V/W – Position 2

8.3.10.1 The flow metering of each well position 2 consists of:

- A magnetic flow meter (FIT-1210015Q/W);
- Pressure and temperature transmitters for each stream;
- 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;
- Related sample panel (SC-FIT-1210015Q/W) upstream its respective flow meter;
- Access facilities for the meters and instruments.

8.3.10.2 Flow, temperature and pressure transmitters shall be connected to the flow computer (FQIT-1210015Q/W) that receives and processes all signals to calculate and correct the flow.

8.3.10.3 FIT-1210015Q/W 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.

8.3.10.4 For more details see I-DE-3010.2D-1210-944-P4X-015 – WAG INJECTION WELL "Q", I-DE-3010.2D-1210-944-P4X-016 – WAG INJECTION WELL "R", I-DE-3010.2D-1210-944-P4X-017 – WAG INJECTION WELL "S", I-DE-3010.2D-1210-944-P4X-018 – WAG INJECTION WELL "T", I-DE-3010.2D-1210-944-P4X-019 – WAG INJECTION WELL "U", I-DE-3010.2D-1210-944-P4X-020 – WAG INJECTION WELL "V" and I-DE-3010.2D-1210-944-P4X-021 – WAG INJECTION WELL "W".

9 AUTOMATION SYSTEM OF THE FMS

9.1 Flow Metering System Workstation

9.1.1 The FMS Workstation comprises of FMS Virtual Server (running in Topsides SOS Process Cluster PN-5523009) and its clients FMS Local HMI (installed at PN-1223001) and Flow Metering System Monitor (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 The 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 The FMS panel shall accommodate the following components, at least:

- FMS LAN Ethernet Switches;
- FMS Local HMI (thin client to access FMS Virtual Server);
- All FMS flow computers;
- Spare flow computers;
- FMS PLC;
- Power supply conditioning circuits and components;
- Optical Converters and Optical Distributor (DIO);
- 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 The 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.

9.3 Flow Computers

9.3.1 There shall be independent flow computers for:

- Crude oil to cargo tanks fiscal metering;
- Crude oil well service fiscal metering;
- Crude oil allocation metering;
- Offloading custody transfer metering;
- Crude oil and water operational metering.
- Gas fiscal export metering;
- Gas fiscal import metering;
- Gas fiscal HP fuel gas metering;
- Gas fiscal additional metering;
- Gas allocation metering;
- 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.

9.3.4 Flow computers shall be installed inside the FMS Panel (PN-1223001) and shall be linked to the FMS Virtual Server running in Topsides SOS Process Cluster (PN-5523009). The FMS Virtual Server shall communicate to the FMS Local HMI, installed at the FMS Panel and to the Flow Metering System Monitor (PN-1223002). Additionally, the FMS Virtual Server shall also communicate, through Topside Package Servers virtual images, 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-3010.2D-1200-813-P4X-002 – FLOW METERING SYSTEM (FMS) ARCHITECTURE;
- I-DE-3010.2D-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. For further details, see item 12 and Piping and Instrument Diagrams (item 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. For flow computer quantity estimation, refer to item 12 ANNEX – METERING LOOPS.

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.

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 detailed 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 Virtual Server and the FMS Remote HMI are both physically connected to the Package Units LAN by Gigabit Ethernet links. FMS Local HMI and all flow computers are all physically connected to the FMS LAN by Gigabit Ethernet links.

9.4.4 Flow computers shall communicate with the FMS Virtual Server. 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 Virtual Server.

9.4.5 FMS Virtual Server shall communicate with Topside Package Servers virtual image, 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 Virtual Server by OPC-UA.

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

9.4.8 The FMS Virtual Server communicates with the FMS Local HMI and with the FMS Remote HMI, both HMI 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-3010.2D-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 LAN shall be connected to two switches on the Package Units LAN ring. For additional information see I-DE-3010.2D-5520-800-P4X-004 – NETWORK INTERCONNECTION DIAGRAM.

9.4.11 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-3010.2D-5520-800-P4X-004 - NETWORK INTERCONNECTION DIAGRAM.

9.4.12 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 Virtual Server and SOS Package Units RTDS all necessary data for XML file generation. This also includes a OPC Server at the FMS Virtual Server to provide the database.

9.4.13 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 Flow Metering System Monitor (PN-1223002) shall be accessible from onshore.

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

9.4.15 The FMS Virtual Server 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 Virtual Server and the supervisory system shall use SNTP packets circulating in the automation rings. For more details see I-MD-3010.2D-5520-800-P4X-003 – AUTOMATION NETWORK DESCRIPTION.

10 WARRANTY

10.1 SUPPLIER 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 SUPPLIER 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.

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 must not be used together for protecting the same compartment.

12 ANNEX – METERING LOOPS

FLOW COMPUTER GROUP	METERING LOOP TAG	METERING POINTS	BS&W or CGA (AIT)	AUTOMATIC SAMPLER (AX)	OUTPUT TYPE (FIT) (1)	4-20 mA OUTPUT CARD (FQIT)
CRUDE OIL FISCAL 1 flow computer	F-1212008A	Oil to Cargo Tanks – Train A	Yes (x2)	Yes (x2)	Pulse	Yes
	F-1212008C	Oil to Cargo Tanks – Standby Train A/B				
	F-1212008B	Oil to Cargo Tanks – Train B				
	F-12120011	Oil to Cargo Tanks – low flow				
	U-Z-1212001	Fiscal Compact Prover				
CRUDE OIL FISCAL 1 flow computer	F-5133002A	Crude Oil Well Service Pump Meter	Yes	Yes	Pulse	Yes
	F-5133002B	Crude Oil Well Service Pump Meter - Standby			Pulse	Yes
OFFLOADING CRUDE OIL CUSTODY TRANSFER 2 flow computers	F-1359501A	Offloading crude oil	Yes	Yes	Pulse	No
	F-1359501B	Offloading crude oil				
	F-1359501C	Offloading crude oil				
	F-1359501D	Offloading crude oil				
	F-1359502	Offloading Calibration Stream				
	U-Z-1359501	Offloading Compact Prover				
GAS EXPORT FISCAL 1 flow computer	F-1231032A	Gas Export	Yes	N/A	Pulse	No
	F-1231032B	Gas Export				
	F-1231032C	Gas Export – Master Meter				
	F-1231032D	Gas Export – Calibration stream				
GAS IMPORT FISCAL 1 flow computer	F-1231033A	Gas Import	Yes	N/A	Pulse	No
	F-1231033B	Gas Import				
	F-1231033C	Gas Import – Master Meter				
HP FUEL GAS FISCAL 1 flow computer	F-5135015A	HP Fuel Gas	Yes	N/A	Pulse	No
	F-5135015B	HP Fuel Gas				
	F-5135015C	HP Fuel Gas – Master Meter				
GAS FISCAL 2 flow computers	F-5412011	HP Flare Gas			MODBUS RTU	No
	F-5412010	LP Flare Gas			MODBUS RTU	Yes
	F-5135013	LP Fuel Gas			4-20 mA	No
	F-1350006	Gas Blanketing Inlet			4-20 mA	No
	F-1350007	Gas Blanketing Recovery			4-20 mA	No
CRUDE OIL ALLOCATION 1 flow computer	F-1223023A	Oil from Test Separator SG-1223002	Yes	Yes	Pulse	No
	F-1223023B	Oil from Test Separator SG-1223002			Pulse	No
GAS ALLOCATION	F-1223074	Gas from Test Separator SG-1223002			4-20 mA	No
	F-1244001A	Individual Gas Lift - Satellite Production Well A			4-20 mA	Yes
	F-1244001B	Individual Gas Lift - Satellite Production Well B			4-20 mA	Yes

FLOW COMPUTER GROUP	METERING LOOP TAG	METERING POINTS	BS&W or CGA (AIT)	AUTOMATIC SAMPLER (AX)	OUTPUT TYPE (FIT) (1)	4-20 mA OUTPUT CARD (FQIT)
4 flow computers	F-1244001C	Individual Gas Lift - Satellite Production Well C			4-20 mA	Yes
	F-1244001D	Individual Gas Lift - Satellite Production Well D			4-20 mA	Yes
	F-1244001E	Individual Gas Lift - Satellite Production Well E			4-20 mA	Yes
	F-1244001F	Individual Gas Lift - Satellite Production Well F			4-20 mA	Yes
	F-1244001G	Individual Gas Lift - Satellite Production Well G			4-20 mA	Yes
	F-1244001H	Individual Gas Lift - Satellite Production Well H			4-20 mA	Yes
	F-1244001J	Individual Gas Lift - Satellite Production Well J			4-20 mA	Yes
	F-1244001K	Individual Gas Lift - Satellite pWAG Well K			4-20 mA	Yes
	F-1244001L	Individual Gas Lift - Satellite pWAG Well L			4-20 mA	Yes
	F-1244001M	Individual Gas Lift - Satellite pWAG Well M			4-20 mA	Yes
	F-1244001N	Individual Gas Lift - Satellite pWAG Well N			4-20 mA	Yes
	F-1244001P	Individual Gas Lift - Satellite pWAG Well P			4-20 mA	Yes
CRUDE OIL AND WATER OPERATIONAL 10 flow computers	F-1223054A-1	Oil from Free Water Separator SG-1223001A	Yes	No	Pulse	No
	F-1223054A-2	Oil from Free Water Separator SG-1223001A			Pulse	No
	F-1223054A-3	Oil from Free Water Separator SG-1223001A			Pulse	No
	F-1223054B-1	Oil from Free Water Separator SG-1223001B	Yes	No	Pulse	No
	F-1223054B-2	Oil from Free Water Separator SG-1223001B			Pulse	No
	F-1223054B-3	Oil from Free Water Separator SG-1223001B			Pulse	No
	F-5133003	Diesel Well Service Metering	No	No	Pulse	Yes
	F-1223073	Produced Water from Test Separator SG-1223002			Pulse	No
	F-1223056A	Water from Free Water Separator SG-1223001A			Pulse	No
	F-1223056B	Water from Free Water Separator SG-1223001B			Pulse	No
	F-5331023A	Discharged Produced Water			Pulse	No
	F-5331023B	Discharged Produced Water			Pulse	No
	F-5331028A	Produced Water to Injection			Pulse	No
	F-5331028B	Produced Water to Injection			Pulse	No
	F-1223062	Water from TO-1223001A			Pulse	No
	F-1223132	Water from TO-1223001B			Pulse	No
	F-1223147	Water from TO-1223002A			Pulse	No
	F-1223148	Water from TO-1223002B			Pulse	No
	F-1251005	Total Injected Water			Pulse	Yes
	F-1210005K	Water injection Satellite pWAG Well K			Pulse	No
	F-1210005L	Water injection Satellite pWAG Well L			Pulse	No
	F-1210005M	Water injection Satellite pWAG Well M			Pulse	No
	F-1210005N	Water injection Satellite pWAG Well N			Pulse	No
	F-1210005P	Water injection Satellite pWAG Well P			Pulse	No
	F-1210027Q	Water injection Piggyback Well Q - Position 1			Pulse	No
	F-1210027R	Water injection Piggyback Well R - Position 1			Pulse	No
	F-1210027S	Water injection Piggyback Well S - Position 1			Pulse	No
	F-1210027T	Water injection Piggyback Well T - Position 1			Pulse	No

FLOW COMPUTER GROUP	METERING LOOP TAG	METERING POINTS	BS&W or CGA (AIT)	AUTOMATIC SAMPLER (AX)	OUTPUT TYPE (FIT) (1)	4-20 mA OUTPUT CARD (FQIT)
	F-1210027U	Water injection Piggyback Well U - Position 1			Pulse	No
	F-1210027V	Water injection Piggyback Well V - Position 1			Pulse	No
	F-1210027W	Water injection Piggyback Well W - Position 1			Pulse	No
	F-1210015Q	Water injection Piggyback Well Q - Position 2			Pulse	No
	F-1210015R	Water injection Piggyback Well R - Position 2			Pulse	No
	F-1210015S	Water injection Piggyback Well S - Position 2			Pulse	No
	F-1210015T	Water injection Piggyback Well T - Position 2			Pulse	No
	F-1210015U	Water injection Piggyback Well U - Position 2			Pulse	No
	F-1210015V	Water injection Piggyback Well V - Position 2			Pulse	No
	F-1210015W	Water injection Piggyback Well W - Position 2			Pulse	No
GAS OPERATIONAL 8 flow computers	F-1223053A	Gas from Free Water Separator A SG-1223001A			4-20 mA	No
	F-1223053B	Gas from Free Water Separator B SG-1223001B			4-20 mA	No
	F-1223065A	Gas from V-TO-1223001A			4-20 mA	No
	F-1223065B	Gas from V-TO-1223001B			4-20 mA	No
	F-1223068A	Gas from V-TO-1223002A			4-20 mA	No
	F-1223068B	Gas from V-TO-1223002B			4-20 mA	No
	F-1231031	Total Gas Lift			4-20 mA	No
	F-1252012	Total Gas Injection			4-20 mA	No
	F-1210015K	Individual Gas Injection - pWAG Well K			4-20 mA	No
	F-1210015L	Individual Gas Injection - pWAG Well L			4-20 mA	No
	F-1210015M	Individual Gas Injection - pWAG Well M			4-20 mA	No
	F-1210015N	Individual Gas Injection - pWAG Well N			4-20 mA	No
	F-1210015P	Individual Gas Injection - pWAG Well P			4-20 mA	No
	F-1210001Q	Individual Gas Injection - Piggyback Well Q - Pos.1			4-20 mA	No
	F-1210001R	Individual Gas Injection - Piggyback Well R - Pos.1			4-20 mA	No
	F-1210001S	Individual Gas Injection - Piggyback Well S - Pos.1			4-20 mA	No
	F-1210001T	Individual Gas Injection - Piggyback Well T - Pos.1			4-20 mA	No
	F-1210001U	Individual Gas Injection - Piggyback Well U - Pos.1			4-20 mA	No
	F-1210001V	Individual Gas Injection - Piggyback Well V - Pos.1			4-20 mA	No
	F-1210001W	Individual Gas Injection - Piggyback Well W - Pos.1			4-20 mA	No
	F-1210003Q	Individual Gas Injection - Piggyback Well Q - Pos.2			4-20 mA	No
	F-1210003R	Individual Gas Injection - Piggyback Well R - Pos.2			4-20 mA	No
	F-1210003S	Individual Gas Injection - Piggyback Well S - Pos.2			4-20 mA	No
	F-1210003T	Individual Gas Injection - Piggyback Well T - Pos.2			4-20 mA	No
	F-1210003U	Individual Gas Injection - Piggyback Well U - Pos.2			4-20 mA	No
	F-1210003V	Individual Gas Injection - Piggyback Well V - Pos.2			4-20 mA	No
	F-1210003W	Individual Gas Injection - Piggyback Well W - Pos.2			4-20 mA	No
	F-5412009	Flare Pilot			4-20 mA	No
	F-5412012	Flare Assist Gas			4-20 mA	Yes
	F-5412052	Purge Gas to Flare			4-20 mA	No
SPARE		SPARE gas flow computer				
		SPARE oil flow computer				

(1) Output signal from flow meter to transmit the flow rate to the flow computer. Some meters may require additional interface communication for diagnostics purposes. For this, please refer to chapter of each specific metering point.