

	TECHNICAL SPECIFICATION		Nº: I-ET-XXXX.XX-1200-813-P4X-001							
	CLIENT:								SHEET 1 of 15	
	JOB:								--	
	AREA:									
SRGE	TITLE: FLOW METERING SYSTEM FOR LEASED UNITS							NP-1		
								ESUP		
MICROSOFT WORD / V. 2016 / I-ET-XXXX.XX-1200-813-P4X-001_A.DOCX										
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	JUL/31/20	DEC/30/20								
DESIGN	ESUP	ESUP								
EXECUTION	HRJ2	HRJ2								
CHECK	CX2W	CX2W								
APPROVAL	U4JB	U4JB								
INFORMATION IN THIS DOCUMENT IS PROPERTY OF PETROBRAS, BEING PROHIBITED OUTSIDE OF THEIR PURPOSE.										
FORM OWNED TO PETROBRAS N-0381 REV.L.										



TECHNICAL SPECIFICATION

Nº I-ET-XXXX.XX-1200-813-P4X-001

REV. A

SHEET 2 of 15

TITLE:

FLOW METERING SYSTEM FOR LEASED UNITS

NP-1

ESUP

SUMMARY

1	OBJECTIVE.....	3
2	REFERENCE DOCUMENTS, CODES AND STANDARDS	4
3	INTRODUCTION	6
4	FLOW METERING POINTS.....	6
5	ADDITIONAL REQUIREMENTS.....	10

1 OBJECTIVE

1.1 This Typical Technical Specification describes the minimum requirements for the project of the Flow Metering System (FMS) on LEASED UNIT.

1.2 Definitions

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

ALLOCATION MEASUREMENT Measurement 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.

OPERATIONAL MEASUREMENT Measurement for production control purposes.

CUSTODY TRANSFER MEASUREMENT Measurement for totalization of transferred fluids when changed their ownership

1.3 Abbreviations and Acronyms

The following abbreviations are used in this document:

ANP	Brazilian National Agency of Petroleum, Natural Gas and Biofuels
BS&W	Basic Sediments & Water
CPL	Correction for the effect of Pressure on Liquid
CSS	Control and Safety System
CTL	Correction for the effect of Temperature on Liquid
DBB	Double Block and Bleed valve
FE	Shrinkage Factor (in Portuguese: “ <i>Fator de Encolhimento</i> ”)
FMS	Flow Metering System
FPSO	Floating Production, Storage and Offloading
GSV	Gross Standard Volume
HMI	Human Machine Interface
INMETRO	Brazilian National Institute of Metrology, Quality and Technology
IV	Initial Verification per Inmetro
NSV	Net Standard Volume
PAM	<i>Portaria de Aprovação de Modelo de Instrumentos de Medição</i> (Inmetro certificate of type approval)
PI	Plant Information (software)
PVR	Reid Vapor Pressure
RS	Solubility Ratio (in Portuguese: “ <i>Razão de Solubilidade</i> ”)
RTM	ANP/Inmetro Technical Regulation of Measurement of Oil and Gas
SI	International System of Units
XML	Extensible Markup Language

2 REFERENCE DOCUMENTS, CODES AND STANDARDS

2.1 External references

2.1.1 International codes, recommended practices and standards

ISO - INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO	5167-1	MEASUREMENT OF FLUID FLOW BY MEANS OF PRESSURE DIFFERENTIAL DEVICES INSERTED IN CIRCULAR CROSS-SECTION CONDUITS RUNNING FULL - PART 1: GENERAL PRINCIPLES AND REQUIREMENTS
ISO	5167-2	MEASUREMENT OF FLUID FLOW BY MEANS OF PRESSURE DIFFERENTIAL DEVICES INSERTED IN CIRCULAR-CROSS SECTION CONDUITS RUNNING FULL - PART 2: ORIFICE PLATES
ISO	5167-5	MEASUREMENT OF FLUID FLOW BY MEANS OF PRESSURE DIFFERENTIAL DEVICES INSERTED IN CIRCULAR CROSS-SECTION CONDUITS RUNNING FULL - PART 5: CONE METERS
ISO	10012	MEASUREMENT MANAGEMENT SYSTEMS - REQUIREMENTS FOR MEASUREMENT PROCESSES AND MEASURING EQUIPMENT

API – AMERICAN PETROLEUM INSTITUTE

API	MPMS	MANUAL OF PETROLEUM MEASUREMENT STANDARDS – ALL PARTS
API	MPMS TR 2570	CONTINUOUS ON-LINE MEASUREMENT OF WATER CONTENT IN PETROLEUM (CRUDE OIL AND CONDENSATE)
API	RP 551	PROCESS MEASUREMENT – SECOND EDITION

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)	Nº 1	REGULAMENTO TÉCNICO DE MEDIÇÃO (RTM) DE PETRÓLEO E GÁS NATURAL, A QUE SE REFERE À RESOLUÇÃO CONJUNTA ANP/INMETRO Nº 1 DE 10 DE JUNHO DE 2013), RETIFICADA EM 17 DE JUNHO DE 2013.
--	------	---



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 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 ANP Nº
737 (27/ JULHO /2018)

ALTERAÇÃO DA RESOLUÇÃO ANP Nº 65 DE
10/DEZEMBRO/2014

INMETRO - INSTITUTO NACIONAL DE METROLOGIA, NORMALIZAÇÃO E QUALIDADE INDUSTRIAL

NIT-SEFLU-014
(SETEMBRO/2018)

VERIFICAÇÃO INICIAL DE SISTEMAS DE MEDIÇÃO CONFORME A PORTARIA INMETRO Nº 64/2003

PORTARIA Nº 64
(11/ABRIL/2003)

REGULAMENTO TÉCNICO METROLÓGICO DOS SISTEMAS DE MEDIÇÃO EQUIPADOS COM MEDIDORES DE FLUIDO, UTILIZADOS NA MEDIÇÃO DE PETRÓLEO, SEUS DERIVADOS LÍQUIDOS, ÁLCOOL ANIDRO E ÁLCOOL HIDRATADO CARBURANTE

PORTARIA Nº 499
(02/OUTUBRO/2015)

REGULAMENTO TÉCNICO METROLÓGICO APLICÁVEL AOS COMPUTADORES DE VAZÃO E CONVERSORES DE VOLUME, UTILIZADOS NA MEDIÇÃO DE PETRÓLEO E GÁS NATURAL.

PORTARIA Nº 476
(14/OUTUBRO/2016)

ALTERAÇÃO DA PORTARIA INMETRO Nº 499, DE
02/OUTUBRO/2015

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

2.1.5 Classification Society

2.1.5.1 Detail design phase documentation of the project shall be submitted to approval by Classification Society. The design and installation shall take into account their requirements and comments.

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

2.2 Internal references

2.2.1 I-ET-XXXX.XX-1200-941-P4X-001 – GENERAL TECHNICAL DESCRIPTION

3 INTRODUCTION

- 3.1 The Flow Metering System (FMS) shall comply with Brazilian legislation, including National Agency of Petroleum, Natural Gas and Biofuels (ANP) and Brazilian National Institute of Metrology, Quality and Technology (Inmetro) regulations.
- 3.2 The FMS shall be designed, selected, installed, commissioned and tested in order to comply with all technical requirements mentioned in the Technical Regulation of Measurement of Oil and Natural Gas, or just “RTM”, approved by “Resolução Conjunta ANP/Inmetro nº1 de 10/06/2013” (or other updated document which substitutes or complements it), with other supplementary regulations issued by ANP/Inmetro and with manufacturer’s recommendations, including all applicable standards and reference technical documents.
- 3.3 Standards, codes and recommendations that shall be followed in the design of the FMS are listed in RTM-Appendix D (or other updated document which substitutes or complements it) or explicitly referenced in this document.
- 3.4 A measurement management system shall be included and applied on the FPSO according to ISO 10012 “Measurement management systems - Requirements for measurement processes and measuring equipment” in order to assure the effectiveness and adequacy to the intended use, besides managing the risk of incorrect metering results. **CONTRACTORs measurement management system shall be submitted for PETROBRAS approval.**
- 3.5 The volume unit for oil and natural gas measurements shall be cubic meter (m³) under the Brazilian reference conditions of 20 °C for temperature and 101.325 kPa for pressure. The metering system shall consider the International System of Units (SI).

4 FLOW METERING POINTS

- 4.1 The following requirements for the FMS shall be interpreted as minimum and are in accordance with the RTM. Other metering points may be necessary depending on the plant philosophy adopted on the UNIT and it is CONTRACTOR responsibility to correct evaluate the need for additional meters, according to I-ET-XXXX.XX-1200-941-P4X-001 – GENERAL TECHNICAL DESCRIPTION. The following table is typical and some of its metering points may not be applicable.

Table 1 - Metering Points

Item	Fluids	Metering points	Duty	Type of meter	Accuracy (note 1)
1	Oil	Cargo pump discharge (offloading)	Custody transfer metering	Ultrasonic or Coriolis (note 2) or turbine meters (note 4); Minimum 1 spare meter installed	± 0.3% (system) ± 0.2% (sensor)
2	Oil	Cargo pump discharge (offloading)	Calibration of custody	Master meter and prover (note 2), or only prover	± 0.1% (system)

Item	Fluids	Metering points	Duty	Type of meter	Accuracy (note 1)
			transfer metering		
3	BS&W	Cargo pump discharge (offloading)	Online	Online analyzer (microwave, RF, capacitive)	
4	BS&W	Cargo pump discharge (offloading)	Sampler	Automatic and manual	
5	Oil	Transference pump discharge (from the process plant to the cargo tanks)	Fiscal metering	Ultrasonic or Coriolis (note 2) or turbine meters (note 4); Minimum 1 spare meter installed	± 0.3% (system) ± 0.2% (sensor)
6	Oil	Transference pump discharge (from the process plant to the cargo tanks)	Calibration of fiscal metering	Master meter and Prover (note 2), or only Prover	± 0.1% (system)
7	BS&W	Transference pump discharge (from the process plant to the cargo tanks)	Online	Online analyzer (microwave, RF, capacitive)	
8	BS&W	Transference pump discharge (from the process plant to the cargo tanks)	Sampler	Automatic and manual	
10	Oil	Well injection operations (diesel or oil)	Fiscal Metering	Positive displacement, Coriolis or turbine meter (notes 3, 5)	± 0.3% (system) ± 0.2% (sensor)
11	BS&W	Well injection operations (diesel or oil)	Sampler	Automatic and manual	
12	Oil	Test separator	Allocation metering	Coriolis (note 3)	± 1.0% (system) ± 0.6% (sensor)
13	BS&W	Test separator	Online	Online analyzer (microwave 0-100%)	
14	BS&W	Test separator	Sampler	Automatic and manual	
15	Oil	Production vessels oil outlet	Operational metering	Positive displacement, Coriolis or turbine meter	± 1.0% (system) ± 0.6% (sensor)
16	Gas	Export Line	Fiscal metering	Orifice plate meter; dual chamber orifice fittings and removable straight pipe sections to be provided	± 1.5%
17	Gas	Import Line	Fiscal metering	Orifice plate meter; dual chamber orifice fittings and removable straight pipe sections to be provided	± 1.5%
18	Gas	Fuel Gas Total	Fiscal Metering	Orifice plate meter; dual chamber orifice fittings and removable straight pipe sections to be provided	± 1.5%
19	Gas	HP Flare	Fiscal metering	Ultrasonic flare meter	± 5.0%
20	Gas	LP Flare	Fiscal metering	Ultrasonic flare meter	± 5.0%
21	Gas	Vent (if applicable)	Fiscal metering	Ultrasonic flare meter	± 5.0%

Item	Fluids	Metering points	Duty	Type of meter	Accuracy (note 1)
22	Gas	Test separator	Allocation metering	Orifice plate meter; dual chamber orifice fittings and removable straight pipe sections to be provided (note 6)	± 2.0%
23	Gas	Gas lift individual per well	Allocation metering	Orifice plate meter; dual chamber orifice fittings and removable straight pipe sections to be provided	± 2.0%
24	Gas	Gas lift total	Operational metering	Cone or orifice plate meter (dual chamber orifice fittings and removable straight pipe sections to be provided)	± 3.0%
25	Gas	Gas injection individual per Well	Operational metering (note 9)	Cone or orifice plate meter (dual chamber orifice fittings and removable straight pipe sections to be provided)	± 3.0%
26	Gas	Gas injection total	Operational metering	Cone or orifice plate meter (dual chamber orifice fittings and removable straight pipe sections to be provided)	± 3.0%
27	Gas	Production separators	Operational metering	Cone or orifice plate meter (dual chamber orifice fittings and removable straight pipe sections to be provided)	± 3.0%
28	Gas	Fuel Gas Consumers (note 7)	Operational Metering	Orifice plate or cone meter	± 3.0%
29	Gas	Flare Pilot	Operational metering (note 8)	Orifice plate meter	± 3.0%
30	Gas	Flare Purge	Operational metering (note 8)	Orifice plate meter	± 3.0%
31	Gas	Dilution for Flare	Operational metering (note 8)	Orifice plate, cone or ultrasonic flare meter	± 3.0%
32	Gas	Flare Assistant	Operational metering (note 8)	Orifice plate meter	± 3.0%
33	Water	Test separator	Allocation metering	Orifice plate, magnetic (spool type) or Coriolis meter (note 10)	± 1.0%
34	Water	Individual Injection	Operational metering	Orifice plate, cone or magnetic meter (spool type) (note 10)	± 1,0%
35	Water	Produced (note 11)	Operational metering	Orifice plate, cone or magnetic meter (spool type) (note 10)	± 1.0%
36	Water	Disposal	Operational metering	Orifice plate, cone or magnetic meter (spool type); Minimum 1 spare meter installed (note 10)	± 1.0%

Table 1 - Notes:

(1) Maximum allowable errors for liquid metering; uncertainty for gas metering.



(2) Ultrasonic meter shall have 4-channels as minimum. In case of using ultrasonic or Coriolis meters as duty meter, a master meter and a prover are required and the master meter shall be a turbine meter.

(3) The duty meter shall be calibrated against a master meter or a prover at the FPSO facilities. If a master meter is used, it shall be proved against a prover at the FPSO facilities.

(4) Positive displacement flow meters may be used on fiscal or custody transfer oil applications only when above listed technologies do not comply with expected range of Reynolds number of the flow.

(5) When using diesel or crude oil on well operations such as hydrate prevention on flow lines, a fiscal metering system shall be provided to measure injected volumes on production risers only, for discount purposes. If project foresees diesel and oil mixture for well service, there shall be foreseen segregated permanent metering systems for each fluid. Meter calibration shall be done with fluid similar to operational conditions. In case of diesel, the calibration may happen outside FPSO facility (a spare meter shall be considered to guarantee availability of the metering point).

(6) There shall be provided means to avoid condensate on gas test separator meter, such as piping thermal coating, meter location as close as possible to the test separator and piping downstream of flowmeter with no upward slope.

(7) CONTRACTOR shall provide means to measure separately the gas flow rates of the fuel gas consumers (if applicable): gas-turbines, turbogenerators and boilers; flow meters as part of those equipment packages are acceptable.

(8) Purge, pilot, dilution and assist for flare, in case foreseen in the project, shall be individually metered. These streams shall be classified as operational, therefore they shall be fiscally measured by other metering systems (e.g.: flare or fuel gas). Exceptions to classify these meters as fiscal shall be previously approved by PETROBRAS.

(9) In case project produces gas from different fields and gas injection is foreseen, the individual gas meters shall be classified as fiscal, comply with all fiscal gas requirements and use orifice plate on dual chamber orifice fittings.

(10) Water flow metering points shall be provided with at least one temperature transmitter. Test separator and injection individual meters shall also foresee a pressure transmitter. Water injection individual meters may share transmitters on the common header, depending on the design.

(11) The produced water meters shall account for all water from the production field. If project foresees the use of dilution water, this shall be discounted of the produced water.

5 ADDITIONAL REQUIREMENTS

5.1 GENERAL REQUIREMENTS

5.1.1 It is not allowed any kind of bypass at fiscal or custody transfer metering points.

5.1.2 Plant and piping arrangement shall be designed so that no flow stream is fiscally measured twice (e.g., if a gas stream is already measured at the flare fiscal meter, it shall not be accounted on the fuel gas fiscal meter). In case a process unit uses fuel gas and returns it to process, this fuel gas shall be derived upstream the fuel gas fiscal meter.

5.1.3 All fiscal, allocation, operational and custody transfer meters shall be connected to flow computers.

5.1.4 All fiscal, allocation, operational and custody transfer flowmeters (when regulated by Inmetro) and flow computers shall have valid Model / Type Approvals by Inmetro on the date of purchase order placement (procurement). All the technical requirements and constraints inside each of Inmetro Approval Document shall be complied. For flow computers note that it shall comply with "Portaria Inmetro 499/15", from 02-Oct-2015 (or other updated document which substitutes it).

5.1.5 The Inmetro Initial Verification process shall be carried out for the regulated flow meters and flow computers applied in metering systems for fiscal, allocation and custody transfer.

5.1.6 The Inmetro Initial Verification procedure shall be included in the scope of supply of the fiscal, allocation and custody transfer oil metering systems, according to Portaria Inmetro 64/2003 and NIT-SEFLU-014 (or any other that may substitute and complement it). The Initial Verification procedure, which is responsibility of the metering system manufacturer, shall be executed on a single-phase basis. The metering systems manufacturer shall submit its Initial Verification procedure for Inmetro approval before its execution. After Inmetro approval of this procedure, a copy of the document and evidence of Inmetro approval shall be presented to Petrobras for information only.

5.1.7 Fluid to be used during the Initial Verification test shall be compatible with the final installation fluid (similar density and viscosity) in accordance with RTM criteria.

5.1.8 Every flow meter shall at all times comply with nominal flow rate ranges and Reynolds number specified in Inmetro Type Approval. Thus, metering systems shall be envisaged considering flow rates at the beginning of operation (when not all systems will be available), unit at full capacity and end of life (lower flow rates and higher BS&W content). Also, the allocation metering system shall be capable of measuring each well individually during their respective life span.

5.1.9 Calibration, inspection procedures and maintenance of the metering systems shall not cause any impact (decrease or shutdown) on the Unit's production.



- 5.1.10 For operational meters, a bypass line or an installed spare meter shall be considered to allow calibration or maintenance without system interruption. Exceptions are accepted for individual gas/water injection meters.
- 5.1.11 All calibration and dimensional requirements: pressure, temperature and flow calibrations, as well as dimensional inspections (including for flare ultrasonic meters) shall be made through accredited laboratories (Inmetro or ILAC or IAAC).
- 5.1.12 Complete access for installation, maintenance and removal shall be provided (including lifting capacity, if necessary) to all flowmeters and associated components by means of walkways, stairs, or platforms. Temporary access, such as scaffolding, is not acceptable.
- 5.1.13 Secondary tapings such as pressure and temperature tapings shall be installed in piping or straight run at same diameter as primary meter. Meter flange diameter shall be considered as meter reference diameter.
- 5.1.14 Impulse lines shall be kept as short as possible. For fiscal, allocation and custody transfer applications, impulse lines tubings shall be 1 meter maximum.
- 5.1.15 As per API RP 551, pressure and differential pressure transmitters shall have their process connections and installation according to the applied fluid: for gas measurement, the impulse lines shall be mounted "above the taps", on horizontal pipes, taps from 9:00 to 3:00 o'clock on the top of the line with the 12:00 o'clock position being preferred; for liquid measurement, the impulse lines shall be mounted "below the taps", on horizontal pipes, tap position located 45° below the horizontal plane.

5.2 OIL METERING REQUIREMENTS

- 5.2.1 The crude oil to cargo tanks fiscal metering system shall be provided with at least 3 meter runs, one acting as stand-by meter.
- 5.2.2 Double block and bleed valves with drain shall be installed where tightness is required and to guarantee compliance with ANP/Inmetro requirement of periodically check valves for leaks. This includes upstream and downstream alignment stream valves, isolation and by-pass valves. These valves shall be submitted to leakage performance tests between intervals no longer than 1 year.
- 5.2.3 Control valves shall be used on oil calibration systems so that it is possible to calibrate the flow meters at any flow rate along its full range of flow. Control valves shall be located downstream of the flowmeters.
- 5.2.4 Routing hydrocarbon volumes directly to cargo tanks without fiscal metering is not acceptable; this requirement also includes any recovered oil volume and condensate streams from Flare K.O Drums, Closed Drain, overflow (oil stream) from hydrocyclones, overflow (oil stream) from the flotation unit, overflow (oil stream) from slop tanks and others; the Unit shall be also capable to collect and treat these streams and route them back to the process plant upstream oil fiscal metering system. Off-spec tanks, produced water tanks (and other tanks that may have crude oil not fiscal metered) alignments that do not return the oil to process plant shall have DBB valves



sealed controlled with open/close register on unit supervisory system (PI included), which shall be leak tested yearly, **or removable spools**. Unit shall have operational procedure to guarantee that the above-mentioned alignments are used only in special circumstances and crude oil not fiscal metered is not routed to cargo tanks.

5.3 GAS METERING REQUIREMENTS

5.3.1 The gas meter systems with dual chamber orifice fittings shall allow the change and/or retrieving of the orifice plates during normal operation under pressure.

5.3.2 Technical design and certifications of all orifice plate metering points shall comply with ISO 5167 standards, meeting a minimum internal pipe diameter of 2". All orifice plate metering points shall use Zanker flow conditioner as a mean to shorten the upstream straight run.

5.3.3 The piping lengths related to the flare gas flowmeter are based on the minimum number of straight pipe runs: 20 nominal diameters upstream and 10 nominal diameters downstream. CONTRACTOR shall provide to PETROBRAS technical studies (Computational Fluid Dynamics) in order to demonstrate that the uncertainties meet ANP/Inmetro requirements and to support uncertainty calculation reports.

5.3.4 For flare gas meters, the flow computation and data storage shall be done at flow computer (Inmetro approved flow computer), **using the uncorrected flow rate sent by the meter**. Flare meter electronic unit shall communicate with flow computer using field network (MODBUS RTU protocol). PIT and TIT signals shall be sent to flare electronic unit and to flow.

5.3.5 Flare meter shall be supplied in a spool, for easily disassemble for dimensional inspection. Flare sensors shall be of removable type in order to allow the dry calibration procedure.

5.3.6 The use of cone meters shall follow ISO 5167-5 and include means of dimensional verification and calibration. Cone meters shall be initially calibrated on all range of Reynolds number expected for the application.

5.3.7 In cases where process operation pressures are equal to or below 21 bar for gas measurements (e.g.: Flare, test separator, etc.), the PIT shall be of absolute pressure type.

5.3.8 The gas lift metering shall be designed to allow the gas lift flow rate measurement of each well separately and the total gas lift flow rate measurement.

5.3.9 The gas injection metering shall be designed to allow the gas injection flow rate measurement of each well separately and the total gas flow rate measurement.

5.4 SAMPLING REQUIREMENTS

5.4.1 Each gas metering points shall be provided with representative manual sampler devices (flare and vent included), as close as possible to its respective metering point, easily accessible by the operator. Exceptions are accepted for individual gas lift meters and individual gas injection meters, which may use their respective total gas



lift or total gas injection sampling points. It shall be guaranteed that no significant process change occurs between meter and its respective sampling point.

5.4.2 The gas manual sample points must comply with the recommendations of the API MPMS 14.1. The probe shall be intrusive, installed on top (12 o'clock position) of a horizontal pipe and at least 5 diameters downstream of any disturbing element. For orifice plate and cone meters, the manual sampler shall be installed upstream the meter. Lines that are operating at or near the gas stream's dew point may require special probes designed to overcome the problems of condensation in the gas.

5.4.3 The gas sample points shall be provided with sampling panels, tag labeled, which shall have bottle/cylinder support and means for gas purge before handling collection. Gas purged through sampling points shall be directed to Flare.

5.4.4 Flare and vent sampling system shall be able to collect representative samples even with the low pressure, so devices such as vacuum pump shall be foreseen.

5.4.5 All oil metering points shall have sample collecting points, tag labeled, which can operate at atmospheric pressure aiming to the determination of BS&W and density values. For oil allocation and fiscal oil to cargo tanks metering systems, the sampling points shall also allow the sample collection under the same pressure conditions of the process, aiming to the determination of shrinkage factor (FE) and solubility ratio (RS) values, as well as evaluation of the Reid Vapor Pressure (RVP) of the oil to cargo tanks.

5.4.6 Oil sampling systems shall be installed downstream of the flow meters and may be installed on the common header of the skid.

5.4.7 Online BS&W oil analyzers shall comply with API MPMS TR 2570.

5.4.8 Sampling probes for automatic sampler and BS&W analyzer on fiscal oil to cargo tanks skid shall be of retrievable type without process interruption.

5.4.9 The manual and automatic oil samplers shall comply with API MPMS 8.1 and 8.2 standards respectively.

5.4.10 The sampling system shall guarantee the oil sample homogeneity on all expected process conditions, so that a static mixer or other active mixing system shall be applied. During project, CONTRACTOR shall submit mixing calculation reports for PETROBRAS evaluation.

5.4.11 Regarding periodicity and procedures for oil and gas analysis and implementation of the results (physicochemical properties) into the flow computers, CONTRACTOR shall comply with "Resolução ANP 52/2013" (or other updated document which substitutes it), which details and complements "Resolução Conjunta ANP/Inmetro nº 1/2013".

5.5 FMS AUTOMATION REQUIREMENTS

5.5.1 The FMS Workstation shall enable all necessary functionalities for the full operation and calibration of the flowmeters, including the automatic remote actuation of the

valves alignment and calibration flowrate adjustments, besides the generation of metering reports, among others.

5.5.2 An interface with the Automation System (CSS) of the production unit shall be provided to enable the operational data transfer from the flow computers to the supervisory system of the unit and to the PI Server. PI data list to be available in onshore servers shall be confirmed during detailed phase.

5.5.3 All log files shall be created based at the actual data from the flow computers simply by uploading, keeping their inviolability; the files shall be kept at the FMS Workstation non-volatile memory / dedicated directory and a backup shall be made at least once per month.

5.5.4 The FMS Workstation shall retain all historical registers and reports for at least 10 years (RTM item 10.1.6), using hard disks (or solid-state disks) and on an incremental daily basis.

5.5.5 Daily volume production for all metering points shall be closed at 00:00 (midnight).

5.5.6 Metering reports (hourly, daily and monthly production; calibration; batch for well testing and offloading; alarm and events; audit trail) shall be readily available for ANP and/or PETROBRAS representatives on board, as well as recorded for further internal or authority audit; the measurement data shall also be available at the workstation in PETROBRAS Office onboard.

5.5.7 General log files to be generated by Flow Metering System (minimum):

- Daily Configuration Data Log (for each flow computer);
- Daily Input and Output Data Log (for each flow computer);
- Daily Audit Trail Log (for each flow computer);
- Daily Alarm Log (for each flow computer).

5.5.8 All log files shall be generated according to the formats defined in (last editions): API/MPMS 21.1, Electronic Gas Measurement; API/MPMS 21.2, Flow Measurement-Electronic Liquid Measurement.

5.5.9 Metering Reports in ".XML" files containing production, configuration and log data extracted from flow computers shall be automatically generated according to ANP specifications (Resolução ANP 65/2014 and other supplementary regulations issued by ANP/Inmetro). Data flow shall be designed to avoid data tampering, taking measures such as access control.

5.5.10 XML production files shall also consider individual gas injection meters and operational flare related meters (pilot, purge, etc.).

5.5.11 There shall be provided a communication link between the FMS Workstation and PETROBRAS Corporate Network, to make available the XML electronic files or the necessary data needed for their generation. This communication can be carried out by means of the onboard automation network, not requiring a direct link to the firewall.



5.5.12 In order to set up the better synchronicity between all Flow Computers and the FMS Workstation clocks, there shall be a mean of synchronization of the flow computers with the FMS, considering the FMS clock as reference.

5.5.13 FMS workstation and flow computers shall have control access to avoid inadvertent modifications. Flow computers shall only be configurable through FMS and not via CSS, with traceability to all modifications (audit log).

5.5.14 Fidelity between flow computers, FMS workstation and other automation systems - All production volumes at the FMS workstation shall be based on the variable "Previous Day Net (NSV) Totalizer" of each flow loop.

5.5.15 Note: NSV is an acronym to "Net Standard Volume" which means: The total volume of all petroleum liquids, excluding sediment and water and free water, corrected by the appropriate volume correction factor (CTL) for the observed temperature and specific gravity to a standard temperature and also corrected by the applicable pressure correction factor (CPL) and meter factor.

5.6 DOCUMENTATION

5.6.1 In the beginning of the Unit design, within six (6) months' time from Kick-Off-Meeting, CONTRACTOR shall provide to PETROBRAS the following documents (in Portuguese language) to be submitted to ANP for approval, according to Resolução Conjunta ANP/Inmetro nº1 de 10/06/2013: (1) "Schematic Diagram for Metering System/Diagrama Esquemático das Instalações"; and (2) "Technical description of the production unit metering system /Memorial Descritivo dos Sistemas de Medição".

5.6.2 Six (6) months before UNIT sailway (or 4 months prior to ANP inspection on shipyard), CONTRACTOR shall provide to PETROBRAS the documentation (in Portuguese language) of the metering system (design and operating description reports, diagrams and other related documents) to be submitted to ANP for approval, according to Resolução Conjunta ANP/Inmetro nº1 de 10/06/2013. The complete list of required documents will be sent by PETROBRAS on the beginning of the detailed phase.

5.6.3 CONTRACTOR is responsible to provide any additional information or document, as requested by ANP or Inmetro.

5.6.4 All calibration certificates, dimensional inspection, leak tests and uncertainty reports shall be updated and valid for ANP final inspection offshore.

5.6.5 For calibration and dimensional inspections certificates, as well as uncertainty report, additionally to the .pdf of the original document, CONTRACTOR shall also send XML files containing the results and relevant information of the documents. PETROBRAS will submit the files templates during detailed design phase.