GUIDELINES

TO

PETROLEUM (EXPLORATION & PRODUCTION)

(MEASUREMENT) REGULATIONS, 2016

(L.I. 2246)

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GUIDELINES TO THE PETROLEUM (EXPLORATION AND PRODUCTION) (MEASUREMENT) REGULATIONS, 2016

Preliminary Provisions

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Preliminary Provisions

1. Application (Regulation 1)

These Guidelines apply to the Petroleum (Exploration and Production) (Measurement) Regulations, 2016 (L.I 2246)

2. Supervision and inspection (Regulation 4)

The Commission may refer to these Guidelines in the supervision and inspection of a metering or management system to ensure compliance with the Guidelines by a contractor, licensee or the Corporation.

3. Use of Standards (Regulation 6)

Requirements and specifications set by nationally and internationally recognised standards that have been prepared under the auspices of ISO and IEC will be normative. The same applies to industry standards prepared under the auspices of AGA, API and ASTM and NORSOK.

Normative references are listed in these Guidelines. The latest edition of the referenced document, including any amendments, applies.

The solution that corresponds to the regulatory requirements shall be selected where the normative references describe several solutions.

The recommended solution becomes a recognised norm through this reference in the Guidelines for the Regulations.

Qualification of an alternative technology or method includes investigation and provision of objective evidence that the needs are satisfied with respect to the Regulations.

Requirement Relating to Management System

4. Quality management system (Regulation 7)

The quality assurance system should be consistent with the principles of the ISO 9001 standard and include

(a) reference to the Regulations;

(b) references to applied standards;

(c) description of equipment subject to the Regulations;

(d) operation and maintenance procedures;

(e) procedure for alarm and deviation handling;

(f) procedure for handling of mismeasurement;

(g) procedure for logging and transfer of information from shift to shift;

(h) a job description with responsibility for each position;

(i) qualifications requirements;

(j) procedures to identify training needs; and

(k) summary of qualifications, training and experience.

5. Responsibility and qualifications (Regulation 8)

A person responsible for the metering system as referred to in Regulation (8) (a) is required

(a) to exercise a professional responsibility to ensure that the metering systems and the allocation system at all times complies with these Regulations; and

(b) shall stay informed about the status of the metering systems and allocation systems under planning, design and testing.

General Requirements Relating to Allocation, Measuring and Metering System

6. Uncertainty requirements (Regulation 9)

The uncertainty analysis referred to in Regulation 9 (2) and 9 (3) should be in accordance with the rules for evaluating and expressing uncertainty in measurements as in ISO/IEC Guide 98:3.

The uncertainty analysis calculation tools at the website of the Norwegian Society for Oil and Gas Measurement, http://nfogm.no, may be used to carry out uncertainty analysis of metering systems under these Regulations.

There may be short periods, at start up and shut down of a meter run, where instruments are operating outside its calibrated range.

7. Calibration and traceability (Regulation 10)

An instrument should be adjusted by implementing calibration factors or calibration curve where a calibration reveals a bias, which may cause an error of more than 0.1 times the maximum allowable measurement uncertainty of the fiscal figure as set out in the First Schedule to the Regulations.

A laboratory accredited according to ISO 17025 should be used to calibrate instruments, field variables and geometrical dimensions used for fiscal calculations.

Where the use of an accredited laboratory for practical reasons is inappropriate, a competent laboratory may be used, provided that the laboratory can document competence and traceability to international or national measurement standards.

8. Units of measurement (Regulation 11)

The definitions concerning units should follow the principles laid down in ISO 80000-1:2009.

Conversion from standard cubic metres at 15 °C and 101.325 kPa to barrels should be in accordance with ASTM D1250 ADJ V11/12 table 52.

9. Reference conditions (Regulation 12)

The standard reference conditions for temperature and pressure and for measurements carried out on crude petroleum and its products, including liquefied petroleum gases, should be in accordance with ISO 5024.

Weight in vacuum expressed in SI units should be used for custody transfer and allocation of condensate and liquefied petroleum gases.

10. Bypass of metering system (Regulation 13)

Where oil is being loaded into tankers, a bypass line for recirculation at the measurement station may be allowed for maintenance purposes, provided that the bypass line is closed by a blind flange or a shutoff valve with double block and bleed system during an off-take of petroleum.

11. Allocation systems (Regulation 14)

The allocation of petroleum should be performed in a manner which is fair and equitable to all users, and can be demonstrated as such. Interested parties, including the Commission, should be kept informed during the development of an allocation system. The detailed method of the allocation system should be made available to a user on request.

Acceptance limits for a pipeline mass balance should be established based on measurement uncertainties.

12. General design considerations (Regulation 15)

The design, installation and testing of metering systems include a variety of internationally recognised standards, such as standards published by API, ISO, AGA etc.

The following standards are, in whole or in part, normatively referenced to in these Guidelines as relevant standards for flow metering:

(a) API MPMS Chapter 5 for liquid measurement by meters;

(b) API MPMS Chapter 4 for proving systems;

(c) ISO 5167 for the measurement of gas by pressure differential devices; where

(i) Parts 1 and 2, with minimum uncertainty specified, apply to flow measured by means of a orifice plate;

(ii) Part 4 applies to flow measured by means of Venturi tubes; and

(iii) Part 5 applies to flow measured by means of Cone meters;

(d) ISO 17089 for the measurement of gas by ultrasonic flow meter; where

(i) Part 1, Class 1 applies to an ultrasonic meter for custody transfer and allocation measurements; and

(ii) Part 1, Class 2 applies to an ultrasonic meter for fuel gas measurement; and

(iii) Part 2, Class 4 applies to an ultrasonic meter for flare gas measurements.

(e) AGA Report 7 for measurement of gas by turbine flow meter;

(f) AGA Report 11 for measurement of gas by Coriolis flow meter; and

(g) NORSOK I-106 for design of metering systems for gas and liquid.

Other internationally recognised standards on meters of relevance are

(a) ISO 12242 for measurement of liquid by ultrasonic meters;

(b) AGA Report 9 for measurement of gas by ultrasonic meters; and

(c) ISO 10790 for measurement of gas and liquid by Coriolis meters.

The NORSOK I-106 is based on internationally recognised standards and describes the functional and technical requirements for designing metering systems for liquid and gas flow, and may serve as a guide to the design and construction of metering systems under these Regulations. Clarifications related to standards should be taken into account.

13. Design of mechanical part of metering systems (Regulation 16)

The mechanical design shall be adapted to the method of measurement and should comply with the standard used for the meter.

Connections should be made for ventilation, draining and flushing in order to ensure access for maintenance. These connections should be secured by spectacle blinds or double block and bleed arrangements.

Regulation 16 (2) should form a basis for the mechanical design of a single phase metering system for allocation purpose. Simplifications should be supported by a risk-cost-benefit analysis. API MPMS Chapter 20, Section 1 may serve as a guideline for implementing allocation measurement.

A separator outlet measurement, which directly or indirectly forms a part of an allocation, shall be traceable to national and international measurement standards.

For a multiphase metering system that measures the total production from a tie-in field and is located at a host facility, a provision should be made for the verification of the multiphase metering system with single-phase measurements traceable to national and international measurement standards. Provisions should also be made for updating of compositional data as input to the equation of state (PVT data).

Thermowells should be in accordance with ANSI/ASME PTC 19.3 TW.

Insulation or screening of meter runs and shielding of instruments to prevent significant thermal effects on the measurement should be considered.

Recommendations in Norsok I-106 should be taken into consideration when selecting valves for a metering system.

14. Design of instruments parts (Regulation 17)

Instruments shall be suitable for the application and be designed in accordance with relevant recognised standards to meet the functional and technical requirements of the Regulations.

The signals from an instrument should be transmitted so that measurement uncertainty is minimised. Transmission should pass through as few signal converters as possible.

An ultrasonic flow meter should be provided with a tool for operational diagnostics. The meter should be capable of storing measurements for historical comparison and verification. A relevant set of measurements data such as speed of sound, flow profile and signal quality, should be available for conditioning monitoring.

A turbine meter should provide for direct transmission and dual pulse train.

A Coriolis meter should, where applicable, be provided with a diagnostic tool.

Special tool and maintenance equipment needed for inspections and maintenance of a displacement prover should be a part of the delivery.

A master meter proving system should be in accordance with API MPMS Chapter 4 Section 5. A flow variation of ± 10 % should not result in a change greater than 0.1% in meter factor of a master meter.

The ultrasonic transducers of a flare gas meter should have provisions for draining of liquid and replacement during normal operation.

An analyses system for gas by online gas chromatographs should be in accordance with ASTM D1945. NORSOK I-106 should serve as guide to the design of a gas chromatograph system.

A temperature measuring instrument should include a temperature element in accordance with IEC 60751, tolerance class A.

The gas density may be determined by continuous gas chromatography if uncertainty requirement as set out in the Second Schedule in the Regulations is met.

15. **Design of sampling system (Regulation 18)**

A sampling system for

(a) automatic liquid petroleum sampling should be in accordance with ISO 3171 or API MPMS 8.2 and 10.9;

(b) manual liquid sampling should be in accordance with ISO 3170; and

(c) gas sampling and sample handling should be in accordance with ISO 10715.

The sampling system for oil and condensate should include

(a) a daily and a monthly sample container in the case of sampling of a pipeline;

(b) at least one sample container in the case of sampling of an offtake to a tanker; and

(c) ability to take at least 10 000 grab samples during the sampling period.

The sampling system for gas should have instrument pipes and hoses of a material that ensures that gas molecule diffusion is prevented.

An automatic sampling equipment is not required as a part of metering system for fuel or flare gas.

16. **Design of computer part (Regulation 19)**

The computer part of the metering system should

(a) be designed in accordance with NORSOK I-106; and

(b) not have any functions other than those associated with the metering system.

The calculations of gas parameters should be in accordance with

(a) AGA 10 for the calculation of speed of sound in the gas;

(b) AGA 8, detailed characterization method, or ISO 12213-1 and ISO 12213-2, for the calculation of compressibility and density of the gas at line conditions; and

(c) ISO 6976 for the calculation of calorific values, Wobbe index and density and compressibility of the gas at reference conditions.

The calculations of oil volumes should be in accordance with

(a) API MPMS 11.2.2M for calculations of compressibility factors;

(b) ASTM D1250-08 for calculation of temperature and pressure correction factors; and

(c) API MPMS 12.2 and API MPMS 12.3 for calculation of volume correction factors and combining correction factors.

Date and time stamping should be in accordance with ISO 8601.

Pulse transmissions for liquid and gas turbine meters and positive displacement meters are according to ISO 6551, level A.

Pulse interpolations in a proving system for liquid petroleum meters are according to ISO 7278-3.

A computer part should be able to generate alarms for occurencies including

(a) deviations between duplicated instruments, where applicable;

(b) alarm conditions for individual instruments;

(c) operating conditions outside design limits;

(d) the acceptance of a proving result outside acceptance requirement;

(e) where proving has not been performed as required;

(f) sampling volume is outside expected range;

(g) flow conditions in sampling loops are outside user configurable limits for proper operation; and

(h) where difference in process conditions between parallel meter runs are outside user configurable limits.

The computer part should generate

(a) daily report, or batch report, for the reporting period with alarms, events and operator changes for the metering system; and

(b) quality report with measured value, reference value, deviation and deviation limit for each parameter at predefined times and on demand.

The computer part should, where multiphase meter are used for fiscal purpose, include software to perform PVT calculation (equation of state) to

(a) provide density inputs to the multiphase meters;

(b) calculate volumes and mass at standard conditions; and

(c) calibrate multiphase measurement flow towards single phase measurements.

17. General requirements on testing and calibration (Regulation 20)

Testing of a metering system prior to start-up implies testing and calibration of individual components, as well as testing of an assembled metering system before leaving a manufacturer and commissioning activities on-site at a plant.

The project specific procedures, referred to in regulation 20 (3), for tests on individual parts of a metering system, should, depending on the tests in question, include items such as

(a) purpose of testing;

(b) reference to relevant regulations and standards;

(c) definition of test runs and repeats;

(d) method for calculation of acceptance criteria;

(e) acceptance criteria for repeatability and linearity;

(f) relevant test certificates;

(g) description of test set-up and piping configuration;

(h) details of inspections needed before start of test; and

(i) method of implementation of calibration results.

The NORSOK I-106 may serve as a thorough guidance to the testing on metering systems and individual parts of a metering system.

18. Calibration of instrument parts (Regulation 21)

A flow test of a meter should be based on the standards used to design the meter. The flow test should involve testing of linearity and repeatability at the lowest and the highest part of the operating range, and at points naturally distributed between the minimum and the maximum values.

The flow test of a meter for custody transfer and allocation purposes should include the meter, the actual upstream and downstream meter run sections with thermowells and flow conditioner.

The base volume of a displacement prover, referred to in regulation 21 (5), shall be determined by calibration. The calibration methods should be in accordance with API

MPMS 4.9 Part 1 to 4. Where the displacement prover has multiple base volumes, each volume shall be determined by a separate and independent calibration.

A test on a gas chromatograph as described in Norsok I-106 Annex A fulfils the requirement in regulation 21 (6).

19. **Verification of computer part (Regulation 23)**

Alarm handling and reporting should be verified with manually entered measurements for each metering run and for the entire metering system.

The system should be tested for voltage failure and data link transmission failure.

Verification of pulse alarm for the turbine meters should be carried out and alarm should be activated if deviation occurs between the two pulse trains.

Operation and Maintenance of Metering System

20. **Operation and maintenance requirements for flow meters (Regulation 27)**

A flow meter should be operated in accordance with the normative reference for the meter in question.

The velocity of sound measured by an ultrasonic gas flow meter should be compared with calculated speed of sound, where available.

The diagnostic parameters arranged for in the design of a flow meter, should be used to evaluate the performance of the flow meter in operation.

21. **Operation and maintenance of proving device (Regulation 28)**

API MPMS 4.8 should serve as a guide to the operation of proving systems.

Determining acceptable meter factor or k-factor reproducibility is an operating company decision. Common practice for custody transfer applications is to accept new meter factors within 0.15 % of the previous meter factor. Statistical methods as described in API MPMS 13 may be used evaluate meter factors.

Troubleshooting should be carried out where a displacement prover volume deviates by more than ± 0.04 % compared to the volume at the previous calibration.

22. **Operational requirements for gas chromatographs (Regulation 29)**

A calibration gas should have a documented uncertainty limit for the individual components in accordance with NORSOK I-106.

23. **Operating requirements for computer part (Regulation 31)**

Alarms from the metering system should be reviewed in a systematic way, to reduce numbers and establish an effective interface against other control room equipment.

24. **Correction of mismeasured quantity of petroleum (Regulation 34)**

Where an instrument is drifting inside its variation range and this is detected by routine calibration, this should not constitute the basis for a correction of a fiscal figure.

Application, Documentation and Information

25. **Documentation related to the metering system in operation (Regulation 37)**

The archive referred to in regulation 37 (1) and (2) apply to all measuring referred to in these Regulations.

Documents as mentioned in regulation 37 (1) and (2) should include specifications, calculations and drawings relating to the metering system, as well as operating procedures and other relevant documentation.

The documents referred to in regulation 37 (1) and (2) should be available at the place of operation and available to the Petroleum Commission on request.

26. **Information to Commission (Regulation 38)**

A contractor, licensee or the corporation is advised to include when submitting information under regulation 38 (b) and (c), to the Commission

(a) the reason for the mismeasurement;

(b) the amount estimated to have been mismeasured; and

(c) the methodology used to determine the amount estimated to have been mismeasured.

Cargo claims procedures under regulation 38 (j) should be drawn up in such a way that when oil is sold in tanker loads from an offshore loading buoy, the correction limit should be the one which is internationally accepted for trade in oil, 0.5%. A correction should only be implementable when both the ship's figures in port and the terminal's figures deviate from the figures of the metering station by 0.5% or more. Furthermore, failure in connection with the official measuring equipment should be demonstrated before corrections may be carried out.

26. Exemptions (Regulation 40)

An application for an exemption under these Regulations, shall be made in writing to the Commission, and shall include the reason for the requirement for an exemption and where practicable, any solutions to cover the exemption.

An application for an exemption should be submitted where the solution applied for

(a) is different from the solution specified in the Regulations, or

(b) does not meet the standard required under the Regulations.

An application for an exemption should include

(a) a list of the provisions from which exemption is being requested;

(b) reasons for the application;

(c) a description of the internal procedure for treatment of non-conformance;

(d) an account of the deviation and its planned duration;

(e) where applicable, measures to compensate for the deviation, either in full or in part; and

(f) measures to correct the deviation where the deviation is of a temporary nature.

27. Interpretation (Regulation 41)

In these Guidelines, unless the context otherwise requires, the expressions in these Guidelines have the meaning assigned to them below:

"shall" means in the context of these Guidelines a reference to regulatory requirements; and

"should" means in the context of these Guidelines, the authorities' recommended way of fulfilling the requirements in the Regulations.

Second Schedule

(Regulations 9(4), 10(3)(b),17(1)(a), 17(4)(a), 17(7), 19(3)(a), 21(2), 21(5), 23(2), 25(4)(a), 28(1)(b) and 29(3))

Uncertainties related to a metering system

Total uncertainty limit is the uncertainty of the measured quantity as received in the flow computer. It thus includes component uncertainty, communication, possible calculations, repeatability and linearity.

Linearity band for a flow meter is the maximum span in meter factors or k-factors determined during a flow calibration. As an example: 0.30 % in range (5:1) means that the meter factors or k-factors cannot deviate more than 0.30 % (highest minus lowest) over the flow rates from maximum to 1/5 (20 %) of the maximum flow rate. The percentage is calculated relative to the lowest meter factor or k-factor.

For volume provers and flow meters, uncertainty related to repeatability is determined from the repeatability as defined in API MPMS Chapter 5.8, Annex B. Number of runs shall be from 3 to 20. The maximum allowable repeatability is given in the table below.

	Repeatability limits; Repeatability = ((High Counts – Low Counts) / Low Counts) x 100		
Runs	Uncertainty 0.011 %	Uncertainty 0.027 %	Uncertainty 0.22 %
3	0.0075 %	0.018 %	0.15 %
4	0.0142 %	0.035 %	0.28 %
5	0.0206 %	0.051 %	0.41 %
6	0.0266 %	0.065 %	0.53 %
7	0.0322 %	0.079 %	0.64 %
8	0.0375 %	0.092 %	0.75 %
9	0.0425 %	0.104 %	0.85 %
10	0.0473 %	0.116 %	0.95 %
11	0.0520 %	0.128 %	1.04 %
12	0.0564 %	0.138 %	1.13 %
13	0.0607 %	0.149 %	1.21 %
14	0.0649 %	0.159 %	1.30 %
15	0.0690 %	0.169 %	1.38 %
16	0.0729 %	0.179 %	1.46 %
17	0.0768 %	0.188 %	1.54 %
18	0.0805 %	0.198 %	1.61 %
19	0.0842 %	0.207 %	1.68 %
20	0.0878 %	0.215 %	1.76 %

Numbers in table represent maximum allowable repeatability for a specified number of runs in order to obtain the relative expanded uncertainty specified in each column.

Where prover calibration is carried out on low-density fluids, as condensate and LPG, the repeatability may be slightly higher because of a higher temperature sensitivity of the volume correction factor.

With regard to sampling and analysis of LNG reference is made to LNG Custody Transfer Handbook (CTH), NORSOK I- 106 and ISO 13398 Refrigerated light hydrocarbon fluids – Liquefied natural gas – Procedure for custody transfer on board ship.

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