



Paper 8: 2.2

**THE NORWEGIAN REGULATIONS RELATING TO
FISCALS MEASUREMENTS OF OIL AND GAS - 1997
UPDATE**

Authors:

Olav Selvikvåg, Norwegian Petroleum Directorate, Norway

Organiser:

Norwegian Society of Chartered Engineers
Norwegian Society for Oil and Gas Measurement

Co-organiser:

National Engineering Laboratory, UK

**Reprints are prohibited unless permission from the authors
and the organisers**

Regulations relating to fiscal measurement of oil and gas. Stipulated by the Norwegian Petroleum Directorate 3.7.1991 pursuant to Act. No. 11 of 22 March 1985 relating to petroleum activities, section 15, fourth paragraph, cf. regulations supplementing the Act relating to petroleum activities stipulated by Royal Decree of 14 June 1985, Section 15, 19 and 47. Cf. letter of delegation 28 June 1985. Last amended 20 January 1997.

In the "Regulation relating to fiscal measurement of oil and gas etc.", (unofficial translation) stipulated by the Norwegian Petroleum Directorate 3 July 1991, the following changes are made:

Section 3 Definitions:

New definition for Calibration factor will be:

Calibration factor:

Relationship between the measured value coming from a flow meter and the measured value from a reference measurement system.

Definition of Metering tube is applicable both for oil and gas.

Metering tubes (oil gas):

Straight pipe section where a flow meter is installed.

New definition of flow meter will be:

Flow meter:

Equipment located in or clamped to a pipe and its signal transformer, to provide a primary signal proportional to the amount of flow through the pipe.

Section 23. Design of the metering system (oil/gas)

The second part of the section will be:

When metering gas, the mechanical part of the metering system shall consist of gas metering tubes and orifice plates designed in accordance with recognised standards, or of one or more metering tubes equipped with multipath ultrasonic meters.

(replacing existing second part)

Section 24. Operation range of the metering system (oil/gas)

The last three parts are new (comes in addition to the last part in force). These parts will be:

When using ultrasonic flow meters, the maximum flow velocity shall not exceed 80% of the maximum rate specified by the vendor.

When using ultrasonic flow meters on sales gas metering stations, the metering station shall consist of at least two parallel tubes, each allowing for 100% capacity.

When using ultrasonic flow meters on allocation metering stations, one metering tube could be adequate, provided the requirements as given in section 28 are taken care of. It is the availability of the flow meter which determines whether a solution with one single metering tube can be allowed.

Section 25. Requirements for the isolation valves (oil/gas)

In the third sentence the word "testing" has been replaced with "verification".

Section 28. Requirements for the orifice plate (gas)

The title of this section is changed to:

Requirements for the flow meter (gas).

The section is divided into two points marked with a) and b).

a) Requirements for the orifice plate:

The diameter ratio shall not exceed 0.60, if the applied standard gives a flow coefficient with less accuracy for higher diameter ratios. (previous text is kept).

b) Requirements for the ultrasonic flow meter:

The ultrasonic flow meter shall have the number of sound paths which have been proven to be necessary to provide a representative velocity measurement for the cross section during the relevant flow conditions.

All geometric dimensions of the ultrasonic flow meter which affect the measurement result shall be measured using traceable equipment, at known temperatures. The material constants shall be available for corrections.

The meter shall be designed and installed so that any accumulation of impurities in the form of liquid and solid particles in the proximity of the transducers is avoided.

The meter shall either by its own design or by necessary piping arrangement always be available for necessary maintenance.

The meter shall be designed so that measurements of acceptable quality can be achieved when one transducer pair is out of service.

The ultrasonic flow meter shall be individually calibrated at a traceable laboratory at process conditions (velocity of flow, pressure and temperature) as similar to the operational conditions as possible. The influence of variations in pressure and temperature shall be determined. The zero point correction and the calibration factor shall be determined. The meter shall be individually identified, and a certificate shall be issued.

The ultrasonic flow meter shall be tested in the upper and lower part of the range, and at three points distributed between the minimum and the maximum values. Five repeats shall be made for each point. When the zero point correction and calibration factor correction are done the deviation from the reference shall be less than $\pm 0,5\%$. The requirement applies to velocities above 5% of maximum range. The calibration factor which derives from the calibration shall always be used.

Section 29. Requirements for metering tube (gas)

In addition to the last part, concerning requirements for orifice metering, four new parts have been added:

When using ultrasonic flow meters the minimum upstream length shall be 10 D. The minimum downstream length shall be 3 D. It shall further be verified that the ultrasonic meter is not influenced by the lay out of the piping upstream or downstream in such a way that overall uncertainty requirements laid down in section 16 are exceeded. If it is necessary, flow straighteners of recognised standard can be installed.

The ultrasonic flow meter must not be installed in the immediate vicinity of pressure reduction systems (valves etc.), which may affect the ultrasonic signals. An evaluation shall be carried out which shows that surrounding equipment (both upstream and downstream), will not affect the ultrasonic signals.

When doing ultrasonic measurement, quality requirements for the inner quality of the metering tubes shall be determined.

The ultrasonic flow meter with associated metering tube shall be insulated upstream and downstream in order to reduce temperature gradients.

Section 30. Requirements for the flow profile (gas)

In front of the text it has been added:

Requirements for the orifice measurement.

Section 31. Location of sensors (oil/gas)

After the text in force, a new part has been added:

The ultrasonic flow measurement requires that temperature, pressure and if applicable density measurement are to be carried out according to the same guidelines as applicable to conventional orifice measurement.

Section 33. General requirements for the instrument loops (oil/gas)

After the text in force, a new part has been added:

A certificate indicating the critical parameters related to electronic and transducers shall be issued. When a test cell is used, the pressure and temperature shall be as similar to the operational conditions as possible.

Section 37. Differential pressure loop (gas)

New heading to this section will be:

Instrument loop for primary signal (gas).

In the beginning of this section, a new sentence has been introduced:

In respect of orifice plates, the differential pressure is the primary signal.

In addition to the text in force, two new paragraphs have been added, which are:

With regard to ultrasonic flow meters, the signals between the acoustic transducers are the primary signals. Critical parameters related to electronic and transducers shall be determined. It shall be possible to verify the quality of the electric signal which represents the acoustic pulse by automatic monitoring procedures in the instrument or by connecting external test equipment.

The transducers shall be identified by serial number or similar, location in the meterhouse etc. A dedicated certificate stating critical parameters shall be attached.

Section 43. General requirements for the computer part (oil/gas)

The ninth paragraph has been changed to:

The computer part shall be designed so that during calibration the amounts shall be registered separately and independently of measured amounts.

Section 49. General (oil/gas)

In addition to the last paragraph in force, a new paragraph has been added, which is:

Ultrasonic flow meters for gas shall be individually tested at a traceable laboratory according to the requirements in section 28. Turbine meters for hydrocarbons in liquid phase shall be in a test facility to verify that the requirements laid down in section 27, can be achieved.

Section 62. Operating requirements for the turbine meters (oil)

New heading to this section will be:

Operating requirements for flow meters (oil/gas).

The section is divided into two points indicated by letters.

a) the existing text in section 62.

b) new text which will be:

After being pressurised before being put into operation, the ultrasonic flow meters shall be checked to verify velocity of sound and zero point for each individual sound path. Deviation limits for the various parameters shall be determined prior to or as soon as possible after the meters are put into service.

Section 65. Inspection of the metering tubes (gas)

Addition of a first sentence in this section:

*Requirements for the orifice measurement:
(the text onward as before)*

Section 66. Inspection of the orifice plates (gas)

New heading which will be:

Inspection of flow meters (gas)

In addition to the last paragraph in force a new paragraph is added. The text of this paragraph is the following:

During the operational phase, the parameters relevant to verify the condition of the meter shall be checked. Zero point check of the transducers by using an external test cell shall be done when necessary. If the acoustic signals from the transducers are weakened or if an alarm mode so indicates, the necessary verifications and corrections shall be done.

Guidelines to the regulations relating to fiscal measurement of oil and gas. Issued by the Norwegian Petroleum Directorate 3 July 1991. The following changes are made:

To section 23:

Gas Metering

The third paragraph is changed to:

Ultrasonic flow measurement may be used when metering gas for fiscal purposes.

To section 24

New paragraph:

If, on an allocation metering station a concept based on only one gas metering tube is selected, two meters in series should be used, or alternatively a spare meter for installation in the metering tube should be available if necessary.

To section 28:

New paragraph no six.

The number of sound paths which are required for ultrasonic flow measurement should be evaluated from the geometry of the sound paths and their coverage over the cross section.

New paragraph no seven:

When regulations require that the ultrasonic flow meter shall always be available for necessary maintenance, this means that combined oil/gas processing facilities may use one metering tube if the flow meter may be made available for maintenance by injecting gas. On gas processing facilities or riser platforms with higher availability requirements an extra metering tube should be installed. Meters equipped with transducers that can be replaced during operations, may contribute to increase availability.

New paragraph no eight:

For ultrasonic flow meters, the relevant parameters to be logged and documented during calibration should be:

- Gain factor*
- Velocity of sound and velocity of flow for each sound path*

New paragraph no nine:

The material constants in question will be the thermal expansion coefficient and Youngs modulus.

New paragraph no ten:

The most important part of a flow test is to determine that the transducers can handle the specified gas velocity. Accordingly, for large meters this will require a need to perform tests at lower pressure than the operational pressure, to increase the gas velocity.

To section 29.

Two new paragraphs which comes in addition to the previous four:

Paragraph no five:

The requirements determined for the inner quality of ultrasonic metering tubes, should be developed from similar requirements for the orifice plate measurement. Somewhat lesser requirements may however be acceptable on account of the fact that the ultrasonic flow meter is not as sensitive to the parameter flow profile as the orifice plate measurement.

Paragraph no six:

Reducer in the metering tube may be used to straighten the flow profile.

To section 30.

First sentence is changed to:

Recognised standard for orifice plate measurement will be: ISO 5167-1 or research results which are mutually accepted.

New paragraph no two:

Both for orifice plate measurement and ultrasonic flow measurement, flow straighteners of recognised type may be used to improve the flow conditions through the meter.

To section 31.

New paragraph in addition to the existing last paragraph:

During ultrasonic measurement of gas, the common pressure recovery method of density measurement can not be used. Gas will have to be vented to a vent/flare system or be recovered.

To section 33.

New paragraph no three:

Instrument loops based on pulse/frequency or digital communication may be used from the field to the control room. When using digital communication it is essential that the number of instruments on one communication line do not exceed the line capacity with regard to response/reading capacity.

New paragraph no four:

When using digital communication, calibration may normally be simplified compared to the regulatory requirements for analogue/digital communication. A rational calibration program should be developed to meet the requirements of the regulations and the capabilities of the equipment.

New paragraph no five:

Duplication of equipment on the instruments part for meters on transmitters will present a good basis for extending calibration and certification intervals for measuring and instrument equipment.

To section 41:

Three new paragraphs which comes in addition to the previous seven paragraphs.

New paragraph no eight:

When measuring dry gas, the use on one line gas chromatograph may be an alternative to provide composition and density data. Relevant standards to be followed may be ASTM 1945 (1991) and NORSOK standard I-SR-106, On line gas chromatograph. If such a system is selected, special attention should be paid to that the sample tubing into the chromatograph are properly designed, so that any liquid contamination is prevented. To achieve this the pressure should be reduced stepwise. Temperature sensors should be installed on critical locations and necessary heat supply to the sample line should be available.

New paragraph no nine:

On sales gas metering stations two chromatographs should be installed for mutual monitoring.

New paragraph no ten:

On allocation metering stations the parameter water in oil may be determined by using on line measurement equipment of recognised standard.

To section 43:

New paragraph no nine:

When doing ultrasonic flow measurement it should be possible to verify time measurement and pulse detection.

To section 46:

New paragraph:

The ultrasonic flow meter should either by direct read out or by internal check functions monitoring the velocity of flow and the velocity of sound for each ultrasonic path. Automatic alarms should be generated when deviation from present limits are detected.

To section 47:

New paragraph in addition to the existing paragraphs:

Litra d) of the section does not apply to ultrasonic flow measurement.

To section 62:

New second paragraph:

Ultrasonic flow meters should, as soon as possible after installation, be tested using a chosen flow rate. The vendor should inform about parameters of importance to monitor. It would be reasonable that parameters mentioned in the guidelines to section 46, are used for further follow up.

New third paragraph:

Zero point checks as mentioned in the regulations are done to determine basis figures for various parameters. These may then be used for further monitoring of the flow meter. Due to the relatively high uncertainties involved in this test, this is just meant to be a rough check of the flow meter.

To section 66:

New paragraphs are:

Ultrasonic flow meters should be recalibrated at a traceable laboratory when needed. A simple check to verify the various transducers would be to check the zero point in a test cell.

Trending of various critical parameters should be done.

Alarm list which defines critical alarms and describes the handling of them should be developed.

It should be defined how critical alarms are to be monitored by self diagnosis in the computer.

When using ultrasonic flow meters, the supervisory computer should calculate VOS (velocity of sound) based on P,T and gas composition to monitor the VOS calculated by the ultrasonic flow meters.

In addition also some corrections in the Guidelines for the Regulations have been performed. These have mainly been simplifications.

References

[1] Paper presented at the North Sea Flow Measurement Workshop, a workshop arranged by NFOGM & TUV-NEL

Note that this reference was not part of the original paper, but has been added subsequently to make the paper searchable in Google Scholar.