

NORSOK STANDARD
COMMON REQUIREMENTS
FISCAL MEASUREMENT SYSTEMS

I-CR-100

Rev. 1, January 1995

1 FOREWORD

This standard has been developed by the NORSOK standardisation work group and agreed by the Norwegian industry for the widest possible national and international application.

ANNEX A is normative. ANNEX B is informative.

2 SCOPE

This standard provides criteria for selection of fiscal flow measurement systems and sampling/analysis equipment for fiscal purposes. Further the standard provides general and technical requirements for such systems or main components thereof.

3 NORMATIVE REFERENCES

AGA 7	Measurement of gas by turbine meters - Transmission Measurement Committee Report No. 7.
AGA 8	Natural Gas density and compressibility factor executable program and Fortran code. Committee Report No. 8.
API MPMS	Ch. 4, 5, also ch. 11-13, if applicable.
API MPMS	clause 8.2 Automatic sampling of petroleum and petroleum products.
API MPMS	clause 10.9 (corresponds to IP 386/90)
ASTM-D-4928-89	(corresponds to IP 386/90)
CEN/TC 234-WG5 N40	Draft "Functional requirements for gas metering systems for natural gas"
IEC 751	Industrial Platinum Resistance Thermometer sensors
IP 386/90	Water in crude oil by Coulometric Karl Fischer titration.
IP PMP No. 2	Guidelines for users of Petroleum Measurement Tables
IP PMM Part VII	Continuous Density Measurement
ISO 1000	SI units and recommendations for use of their multiples and of certain other units.
ISO 3170:	Petroleum Liquids - Manual Sampling
ISO 3171:	Petroleum Liquids - Automatic pipeline sampling.
ISO 5024	Measurement - Standard reference conditions
ISO 6978:	"Calculation of heating value and reference density".
ISO 5167	"Measurement of fluid flow by means of orifice plates, nozzles and venturi tubes inserted in circular cross-section conduits running full"
ISO 6551	Petroleum Liquids and Gases - Fidelity and Security of Dynamic Measurement - Cabled Transmissions of Electric and/or Electric Pulsed Data.
ISO 7278 Part 3	Liquid hydrocarbons - Dynamic measurement - Proving systems for volumetric meters"
ISO DP 9857	Continuous Density Measurement
ISO DIS 9951	Measurement of gas flow in closed conduits - Turbine meters
ISO/CD 10715	"Natural Gas - Sampling Guidelines".

NORSOK standards:

I-SR-100	Automatic oil sampler
I-SR-101	Automatic gas sampler
I-SR-102	Fuel gas measurement
I-SR-103	Flare gas measurement
I-SR-104	Fiscal metering system for gas
I-SR-105	Fiscal metering system for crude oil and condensate.

4 DEFINITIONS AND ABBREVIATIONS

4.1 Definitions

Fiscal quantity	Measured quantity of hydrocarbons used for sale, custody transfer, ownership allocation or calculation of royalty or tax. Note: The term "fiscal " refers to the function of the measurement system, not its level of measurement uncertainty.
Allocation	Distribution of sold/produced quantities of hydrocarbons between licensees and owner companies.
Quantity	Measure of the hydrocarbon medium, by volume, mass or energy.

4.2 Abbreviations

AGA	American Gas Association
CEN/TC	The European Committee for Standardization/ Technical Committee
IP PMP	Institute of Petroleum, Petroleum Measurement Paper
IP PMM	Institute of Petroleum, Petroleum Measurement Manual
ISO	The International Organization of Standardization
IEC	International Electrotechnical Commission
NPD	Norwegian Petroleum Directorate
PD meter	Positive Displacement meter
VDU	Visual Display Unit

5 GENERAL REQUIREMENTS

Fiscal measurement systems include all systems for:

- Fiscal metering of gas and crude oil/condensate.
- Measurement of fuel and flare gas.
- Automatic sampling of gas and crude oil/condensate.

This standard is based on the standards listed in clause 3.

All systems shall give readings in SI-units according to ISO 1000.

The reference conditions shall be 15.0C, 1.011325 bar abs, ref. ISO 5024.

Algorithms and uncertainty analyses for the systems shall be either:

- based on international standards,
- as recommended by manufacturer, or,
- as specified by end user.

Ref.: Relevant Norsok I-SR standards.

Uncertainty:

Table 1 below specifies normally applied uncertainty limits.

Table 1. System uncertainty limits.

SYSTEM	MAX UNCERTAINTY (95 % conf. level)
Fiscal oil metering	± 0.30 % of standard volume
Fiscal gas metering	± 1.0 % of standard volume
Fuel metering	± 1.8 % of standard volume
Flare metering	± 5.0 % of standard volume

Other uncertainty limits may be applicable for fiscal metering stations if validated by a cost-benefit analysis (see clause 6).

For system concepts with no system specific requirements in NORSOK standards, the design shall to the greatest possible extent, be based on (in order of priority):

- international standards, preferably CEN/ISO or ISO.
- the manufacturer's recommendations.

6 SYSTEM SELECTION CRITERIA

6.1 General

The measurement system with the lowest life cycle cost shall be selected.

6.2 Cost/benefit analysis of alternative metering concepts

The cost of using a concept with high accuracy (class A) may be unreasonable in relation to the monetary value of the additional measurement uncertainty of a less accurate/less expensive concept (class B). The selection of metering concept shall be based on an alternative cost analysis as outlined below.

An analysis shall be performed to quantify:

1. Monetary value of 1 % reduction in measurement uncertainty for oil and gas. (Owners will use 0.5 NOK max to reduce measurement uncertainty by 1.0 NOK)
2. Uncertainty of well-test concept for oil and gas (No measurement). For metering systems on marginal field tied into existing platforms such monetary value shall be based on difference in ownership between marginal field owners and existing fields owners .
3. A matrix (table) showing the monetary value of reducing uncertainty of well-test concept towards 0 % uncertainty for oil and gas.

The key parameter is this analysis for decision making is the value of the total cost of using a metering system with a specified uncertainty compared to potential monetary value of corresponding reduction in uncertainty for oil and gas.

All monetary values above shall be calculated as net present values.

6.3 Special consideration for fuel gas system

Orifice meter should be preferred to gas turbine meter unless the cost of long upstream meter run lengths of the orifice meter outweighs:

- Cost of annual flow calibrations at operating conditions of the gas turbine meter, and.
- cost of one spare gas turbine meter (in stores).

Also, a gas turbine meter shall be preferred if the flow range of the fuel stream requires frequent changes of orifice plates during regular operation.

For very small fuel gas streams, in particular non-fuel streams withdrawn from the fuel distribution system downstream of the main fuel metering system, the following methods should be considered:

- For gas streams withdrawn manually at intervals: No meter, just an estimation.
- For continuous streams smaller than specified by ISO 5167 and AGA 7, one of the following methods shall be used;
 - Small, fullbore, gas turbine meters, designed to manufacturer's standard (minimum 6 mm).
 - Integral orifice meters (Smaller than 12 mm).
 - Other suitable type of small flowmeter with equivalent accuracy.

6.4 Special consideration for fiscal sampling system

If it can be documented by a cost-benefit analysis (ref. clause 6.2), the sampling concept shall be in order of priority:

- no sampling equipment (e.g. usage of other analysis).
- manual sampling point.
- automatic sampling system.

6.5 Alternatives to sampling equipment

For determination of water content in oil, a continuous water-in-oil monitor shall be considered as alternative to automatic sampling and subsequent lab. analysis.

On-line gas chromatograph shall only be used if they are found to be more cost-effective than sampling and subsequent lab. analysis, and if required by any agreement.

7 TECHNICAL REQUIREMENTS

7.1 Fiscal metering system, oil and gas

7.1.1 General

The requirements below are only relevant if the specified component is part of the metering concept.

It is indicated in the headings below if the subsequent text is applicable only for oil or gas metering systems.

7.1.2 Mechanical part (oil)

7.1.2.1 Sizing

A sufficient number of meter runs shall be installed, each sufficiently equipped to determine the quantity of oil or gas for all expected flow rates, with required accuracy, reliability and regularity.

7.1.2.2 Meter runs

Design	According to API MPMS Ch. 5
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7.1.2.3 Flow meters design

Turbine meters	Ref. API MPMS Ch. 5.3. Robust design with rotor shaft supported upstream and downstream of rotor.
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PD meters	Ref. API MPMS Ch. 5.2.
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There shall be dual pulse train for turbine & PD meter, with direct transmission of flow meter pulses to the computer part. The pulse integrity shall be to ISO 6551, grade A, or equivalent.

7.1.2.4 Block valves (for critical application)

Type	Block valves critical for meter calibration and calibration of meter calibration unit shall be double-block-and-bleed of plug type, with positive shut-off (dual expanding seals). Ball valves not to be used. For batch systems, other type of valves may be considered for stream inlet.
Leakage	Automatic or manual monitoring of block valves. Automatic monitoring of flow diverter valves (if applicable).
Actuation	Motor operated valves for stream control and meter calibration control. Type of motor: project specific.

7.1.2.5 Calibration unit

1. Option Conventional Pipe Prover

Design	Bi-directional or unidirectional, according to API MPMS Ch. 4. Interpolation may be used to achieve 0.01% pulse resolution. 4 distinct, calibrated volumes (two detector switches either end). Quick opening cover on displacer home chamber. Closely matching flanges in prerun/calibrated section. The inner surface, rubber sealings, lining of prover, etc. shall be of a material that is compatible with and can withstand the oil flowing through.
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2. Option Compact Prover

Design	According to API MPMS Ch. 4.3. or to be defined.
Uncertainty	$\pm 0,10$ % of calibrated volume.
Repeatability	0.020 % (band) for 5 successive repeats.

7.1.3 Mechanical part (gas)

Each meter run shall have:

- a connection to flare for depressuring the meter run.
- a connection for nitrogen purging.
- a small bore by-passes across the inlet and outlet valves for pressuring the meter run.

7.1.4 Computer Part

7.1.4.1 General

The computer part consists of a computer performing the below specified functions, VDU and printers for reporting and communication system for transferring signals to other systems.

This clause specifies the requirements for Class A systems for oil and gas (i.e. +/- 0.30% uncertainty limits for oil and +/- 1.0% for gas) and Class B systems for gas (i.e. +/- 1.8% uncert. limits). Ref. NORSOK I-SR-104 & I-SR-105 for definition of the classes. For Class B systems for oil and Class C systems for gas (i.e concept selected from cost-benefit analysis, ref. clause 6.2 above) some of the requirements may be omitted or changed (application specific).

7.1.4.2 Calculations

- The computer part shall calculate flow rates and accumulated quantities for i) actual volume flow, ii) standard volume flow and iii) mass and energy(application specific).

7.1.4.3 Calculation (gas)

- Conversion of gas composition to calorific value shall be done according to ISO 6976.
- Calculation of mass flowrate, volume flowrate and energy flowrate shall be calculated as required from selected equipment. ISO standards method shall be used when existing and applicable.

7.1.4.4 Check

- Comparison between duplicated instruments for the same measurand (if any such instruments, e.g. differential pressure for orifice plate and densitometers for oil or gas installed on the manifold) , comparison between same parameter in different meter runs averaged over a moving time window to be operator selectable between wide intervals (e.g. 10 seconds and 10 minutes).
- Facilities shall be included to enable user verification of functions, parameters and accuracy in input, calculated and output values.

7.1.4.5 Alarms

- Raise and print out alarms if any comparison checks exceed operator selected limits and if any measurands is outside predetermined limits and in case if indications of instrument failures, computer failure or failure in valve operations.

7.1.4.6 Events

- Print all events as a result of system or operator action.

7.1.4.7 Report of data for continuous oil metering:

- Quantity reports for the following time intervals: 2-hourly, daily and monthly totals.
- Proving reports. All correction factors applied in the calculation and all data required for manual checks of the calculated correction factors shall be included in the report.
- Instantaneous values for flow rate and all signals from the instrument loops.
- Print and display. The reports in litra i)-iii) above shall be printed automatically but it shall also be possible to surpress the printing of the reports. The reports shall also on request be shown on VDU.

The reported data shall be per meter run and total for the metering station.

7.1.4.8 Report of data for batch metering (oil)

- Quantity reports for: Accumulated quantity from start of batch, hourly intervals and for total batch.

The other requirements are the same as for continuous oil metering (see above).

7.1.4.9 Storing of data (oil)

- Above specified reports to be store for a sufficient period of time (Application specific).

7.1.4.10 Report of data (gas)

- The computer part shall report hourly averaged values and hourly totals and daily averaged values and daily totals and monthly totals.
- The reports shall also contain gas quality parameters as measured by on-line equipment or manually entered.
- Any report should be possible to transfer to floppy-discs.
- Print and display shall be as specified for oil metering above.
- Optionally trend curves shall be available on VDU and printers as well as on table format for selectable time periods (e.g. from one hour to 60 days).

7.1.4.11 Storing of data (gas)

- Hourly reports to be stored in computer memory for 60 days, daily reports for minimum 4 months and monthly reports for minimum one year.
- All measured and calculated values averaged over the moving time windows in memory for 60 days.

7.1.4.12 Regularity

- The computer part shall have fault tolerant design to maintain fiscal measurement, calculations and file storage during error conditions.
- The computer part shall be a redundant system, meaning if failure occurs in one component of the computer part, other parts shall take over the functions normally performed by the faulty component.

7.1.5 Maintenance Requirements

7.1.5.1 Calibration

It shall be possible to calibrate all instruments and separate components in the electronic loop either without moving them from their permanent installations and without disconnecting any cables or by using transmitters fitted with quick connectors (for removal for calibration/ maintenance).

Exception for flow meter(s) which require off-line calibration.

There shall be connections for in-situ calibration of the prover/master meter.

7.1.5.2 Maintenance

- It shall be easy access to any part requiring regular calibration and maintenance. Facilities to ease the calibration shall be included in the system or offered as an option.
- It shall be possible to maintain the mechanical part of the system without dismantling the manifolds (or similar).

7.1.6 Class A oil metering station

Special requirements for Class A oil metering stations based on turbine- or pd-meters and provers are given in annex A .

7.2 Automatic oil sampler systems

7.2.1 Introduction

The automatic oil sampler system shall be designed in accordance with ISO-3171 with amendments and supplements as detailed below. Amendments and/or supplements (=Amd), more precise definition (=P= and additions (=A) to ISO 3171-88 are listed below. The headings are the same as in relevant chapters in ISO 3171. There are also some additional headings which are indicated in the text.

The phrase "should" in ISO 3171 in connection with design requirements shall mean "shall" if not otherwise stated below.

See typical sampling systems in fig. 9, ISO 3171.

7.2.2 Initial selection of automatic probe location (P)

The probe shall be located close to the metering system on the same stream (flowline).

7.2.2.1 Mixing devices (P)

The need for conditioning shall be determined according to Annex A in ISO 3171.

7.2.3 Selection of mixing device (A)

The type of mixing device(s) shall be determined in the same priority order as the devices are described in ISO 3171, clause 5.4

7.2.4 Position of the sampling probe (P)

The probe (either sampling probe or sample probe with actuator, ref. ISO 3171, fig.2) shall be installed in a horizontal position on the main pipeline.

7.2.5 Checking the location of the sampling probe (P)

Lab. tests shall be considered if the homogenisation acc. to ISO 3171, A is disputable.

7.2.6 Sampling probe design (P)

If by-pass loop is used the sampling probe shall be a pitot-tube type probe entry as described in ISO 3171, clause 7.2 - 7.3.

7.2.7 Sampler design and installation (Amd)

7.2.7.1 Design

- The sampling system shall be of the intermitted type (see ISO 3171, fig. 9). Both the intermittent systems (see ISO 3171 clause 8.1.1) may be selected.
- The type of system shall be determined from a cost-benefit analysis, except that the in line grab system shall be preferred when:
- For bypass loop system the velocity shall be kept within $\pm 10\%$ of the velocity in main pipe at probe entry.
- The bypass loop shall be equipped with:
- the need for a mixer immediately upstream of the separating device, to remix the by-pass-stream shall be determined according to Annex A in ISO 3171.
- The grab size volume shall be adjustable in the range 0.5 - 1.5 ml (by for e.g. different cup sizes).
- The two subsystems (separating device/pump and receiver) shall be most possible independent of each other. It shall be possible to shut down one of the subsystem (e.g. for maintenance) while the other subsystem is operating (and vice versa). Each separating device/pump shall be manually operable from a panel.

7.2.7.2 Precautions

- The temperature of the fluid in the sampling system shall be kept at least 5 °. C over the wax appearance (if applicable) or pour point temperature, whichever are the highest. This shall, if necessary, be achieved by heat tracing and insulation of the piping and sample receiver.

7.2.7.3 Flow measurement (P)

- Fiscal flow meters can be used to pace the samplers.

7.2.8 Sample receivers and containers (Amd, A)

7.2.8.1 Sample receiver

- The receiver should, if possible, be a portable type (for transportation to the laboratory).
- For unstabilised oil/condensate (i.e. RVP > 12 psi) a piston type sample receiver shall be used with back pressure of an inert gas (argon or helium).
- For stabilised oil (i.e. RVP < 12 psi) a fixed volume receiver shall be used.
- The piston type sample receiver shall be equipped with magnetic piston position indicator.
- The stationary type sample receiver shall be equipped with an internal homogenizer. The mixing requirements shall be acc. to IP 386/90, App. A.
- Table 2 in ISO 3171 shall be used for determination of sampling intervals and subsequently for sizing of the receivers, if not otherwise determined in transportation agreements or other agreements. The degree of filling for design purpose shall be 2/3 of the total sample receiver volume.

7.2.8.2 Sample container

- The sample container for unstabilised oil/condensate (i.e. RVP > 12 psi) shall be equipped with an internal homogenizer.

7.2.8.3 Sampling handling

- For Newtonian fluids homogenization by high-shear mixer or similar device should be used. For different non-Newtonian fluids one must be more careful and specific concerning shear rate(s).
- The verification of the efficiency of mixing shall be done for water content up to 5 volume %.
- The Karl Fisher method according to IP 386/90 shall be used, when applicable, for determination of water content.

7.2.8.4 Back pressure system (A)

For the piston type receiver there shall be a back pressure system including booster facility with inert gas (argon, helium or nitrogen).

7.2.8.5 Proving the sampling system (Amd, P)

The following Factory Acceptance Tests shall be done:

- The test in ISO 3171, sect 15.3 f).
- Verification of the efficiency of mixing according to ISO 3171, sect. 12.3.
- Flow test to check that a known sample (with max water) is coming through to the receiver.

7.3 For automatic gas sampler system

This clause is an integral part of NORSOK I-SR-101 .

7.3.1 Initial selection of automatic probe location

The sample point shall be chosen to provide a representative sample of the flowing gas in the pipe, thus this location shall be devoid of stagnants gas which cause turbulent flow (blowdown stack) and devoid of free liquids and aerosols (downstream of piping elbows or orifice fittings).

The sampling point shall be installed at least 20 Diameters downstream of the nearest bend. On horizontal pipe the probe shall be installed in a 10 - 2 o'clock position.

7.3.2 Design considerations for sampling systems

7.3.3 Probe design

The probe shall be a pitot-tube with a chamfered entry extending into the middle 1/3 diameter of the flow stream.

7.3.3.1 Separating device

There shall be two parallel separating devices which shall be self-purging and be designed to operate under line conditions. The grab size volume shall be adjustable in the range 0.5 - 1.5 ml (by e.g. different cup sizes).

The separating devices shall be located above and as close to the probe as is practically and possible. Filters, drip pots, screens, regulators and such conditioning equipment shall not be placed between the probe and the sampler.

7.3.3.2 Controller

The controller shall provide a flow- or time-proportional sampling signal (Both options shall be available).

7.3.3.3 Sample receiver

- There shall be two parallel sample receivers (one for back-up).
- Heat tracing and insulation shall be provided to keep the temperature minimum 5 °. C above the condensation temperature. (See also clause 3.4 below).
- The receiver shall be of the floating piston type with back pressure of an inert gas.
- The receiver shall be portable (max. weight 15 kg incl. transportation container) (normal size 1000 ml).
- The receivers shall be equipped with magnetic piston positions indicator for remote/local indication of piston position, and a limit switch for max. filling.

7.3.3.4 Piping and valves

- The piping shall slope downwards from the sample pump to the sample receiver.
- If the condensation temperature is above the ambient temperature, then the piping and sample receivers shall be heat traced and/or insulated to keep the temperature 5 °. C above the condensation temperature, even when there is no flow through the sample system.
- The valves for the sampling system shall be of type full bore ball valves.

7.3.3.5 Back pressure system

There shall be a back pressure system with inert gas (argon or helium). This shall include a booster facility. The following requirements apply:

- The back-up volume shall at least be five times larger than the receiver volume.
- The booster shall have capacity to boost the pressure at least 5 % above maximum operating line pressure (at the probe location).

7.3.3.6 Testing procedure

The Manufacturer shall prepare a test procedure for approval by the Purchaser. Such procedure shall demonstrate that the system is designed according to this standard and is functioning properly contain tests of:

- All functions.
- Leak tightness.
- Alarms.

Compliance of sample receivers filling. When sampling with the same frequencies to each of the sample receivers, the sample volume (at actual conditions) shall be within $\pm 5\%$ of the average volume of the two sample volumes

ANNEX A Class A Oil Metering Station (Normative)

A ANNEX A CLASS A OIL METERING STATION BASED ON TURBINE- OR PD-METERS AND PROVER (NORMATIVE)

A.1 Class A oil metering station based on turbine- or pd-meters and prover.

A.1.1 General

This Annex provides the additional requirements for a conventional fiscal oil metering system.

The metering system shall consist of:

- a mechanical part with meter run(s), flow meter(s) and integral, in-line calibration unit (prover).
- an instrument part.
- a computer part performing calculation of quantities, reporting and system control functions.

A.1.2 Mechanical part

A.1.2.1 Sizing

Any flowrate, from process design minimum to maximum, shall be measured with the meters working within 80 %/90 % of their standard range (not extended) for continuous metering/batch respectively.

A.1.2.2 Block valves

Actuation	Valves for non critical application (stream inlet/prover outlet) may be manual.
Leakage	Automatic monitoring by differential pressure transmitters, not pressure switches.

A.1.2.3 Flow meters

Type	Turbine meters, is recommended for low viscosity product. Positive displacement meters is recommended for high viscosity product
Linearity	0.50 % (band) for 1:10 turndown on 1 mPa.s water.
Linearity	0.50 % (band) for max. stated turndown on product.
Linearity	0.30 % (band) for optimal stated turndown on product.
Repeatability	0.040 % (band) within linear range on water and product (5 successive repeats).
Calibration	Initial calibration by manufacturer, normally using water as fluid. Optional calibration on product of viscosity similar to application.
Sizing	Capacity corresponding to flow meter maximum standard range.
Flow control	Active flow control to achieve flow at target value. FCV to be located downstream of flow meter/calibrated volume combination. Optional the flow control shall maintain stable flow at target value during calibration.
Calibration	By accredited organisation, traceable to national or international standards. Connections to enable serial and parallel calibration.
Actuation	4 way valve of larger size should have a hydraulic actuator.

A.1.2.4 Flow control valves

Flow control valves to move to open position on power supply failure or signal failure.

A.1.2.5 Relief valves

Upstream of flow meter and downstream of diverter/change-over valve, if calibration unit is downstream of flow meters.

A.1.2.6 Drain and vent systems

Open and closed drain, and vent system, each with single connection at system limit.

Double block-and-bleed valve arrangement in drain and vent lines.

A.1.3 Instrument Part

A.1.3.1 Signal

There shall be digital transmission of measured value to the computer part if not other wise specified below.

A.1.3.2 Enclosures

Use	Pressure transmitters for stream and calibration unit.
Stream temperature	
Type	Pt-100 elements to IEC 751, class A, or equivalent.
Installation	Downstream of flow meter, ref. API MPMS Ch. 5. Design to avoid vibration to flow meter max. extended range.
Uncertainty	Less than ± 0.3 degree C, for the instrument loop.

A.1.3.3 Density meter temperature, if applicable

Type, uncertainty and signal	as for stream temperature above.
Installation	Close to the density sensing element.

A.1.3.4 Stream pressure

Type	Electronic pressure transmitter.
Installation	Downstream of flow meter, ref. API MPMS Ch. 5.
Uncertainty	Less than the higher of ± 20 kPa or ± 0.30 % of calibrated span for the instrument loop. Transmitter specified uncertainty ± 0.10 % of calibrated span, or better.

A.1.3.5 Density meter pressure, if applicable

Type, uncertainty and signal	as for stream pressure above.
Installation	Close to the density sensing element

A.1.3.6 Differential pressure

Type	Differential pressure transmitter
Installation	Across strainers, block valve cavities.
Uncertainty	Transmitter specified uncertainty ± 0.50 % of calibrated span, or better.
Signal	Digital or analogue transmission of measured value to the computer part.

A.1.3.7 Density

Applications	Required for continuous metering systems (pipeline). May be omitted for batch metering systems (tanker loading).
Type	Vibrating element
Design	ISO/DP 9857 and IP PMM Part VII
Signal	Direct transmission of transducer pulses/frequency signal to the computer part.
Installation	Each meter run or dual system (reciprocal cross-checking) in inlet or outlet header.
Uncertainty	± 0.15 % of measured value, for complete density circuit, including drift between calibrations. Transducer specified uncertainty ± 0.50 kg/m ³ , or better Transducer specified repeatability ± 0.02 % or better.

A.1.4 Computer Part

A.1.4.1 Control panel

Power supply	Dual feed from UPS/Normal supply. Dual 100 % (DC) power supplies to feed panel equipment and field transmitters.
Manual operation	It shall be possible to measure the oil flow, operate the system and perform proving even if the supervisory computer fails completely. Keyswitch to select Automatic/Manual operation.

A.1.4.2 Computer specification and requirements

Features	The software for calculation of fiscal quantities shall be stored in an secure and resident manner.
Flow meter signal	Pulse integrity handling according to ISO 6551, level A. Pulse interpolation to meet requirement for 1/10000 volume resolution during meter calibration, according to ISO 7278, Part 3.
Displacer detector signal	Calibration unit displacer detectors read as interrupt.
Other read signals	From all instruments in one meter run during 1 second, except for density which may be read every 5 seconds. Signals from duplicated instruments shall be read within 0.1 second. Signal shall be read with an accuracy resulting in a total uncertainty of measurand not exceeding limits given in the Instrument Part section above.
Manual input	The system shall accept any manual input necessary to perform calculations mentioned below for any measurand. Manual input values to be verifiable.
Outputs	FCV control.

	Control of block valves and diverter valve for stream switching and meter calibration control.
	Control of flow proportional sampler.
	User configurable analogue outputs.
Security	Self check and self diagnostics at cold start, warm start and continuously during normal operation: watchdog and check sum (PROM/EPROM and RAM) every 10 seconds.
	The algorithms and fixed parameters important for accurate computation of fiscal quantities shall be secured in a way that makes direct access impossible, unless an established security routine is followed.
	There shall be protection against unauthorised data entry by password or keyswitch.
Calculations	Temperature and pressure corrected meter factor from calibration, with all correction factors C _{tlm} , C _{plm} , C _{tsp} , C _{psp} , C _{tlp} and C _{plp} , according to API MPMS Ch. 11 and 12. The correction factors C _{tsm} and C _{psm} shall also be implemented. Ref. NPD's fiscal metering regulation referred to in annex A of this standard.
	Calculation of standard density from operating density and vice versa
	Calculation parameters to be user selectable.
	Flow control function, with valve position control and flowrate setpoint (PI control algorithm)
	Calculations of the required data for reports and VDU
	Total roll-over handling: Roll-over period 62 days minimum at maximum design flowrate
	Full calculation cycle, including meter factor calculation less than 10 sec.
	Algorithm and truncation/rounding errors to be less than ± 0.001 %, verifiable.
Storing of data for continuous metering system	2-hourly reports to be stored to computer file for 62 days, daily reports for 1 year, monthly reports for 3 years, calibration reports for 1 year.
	Only reports for successful meter calibration to be stored.
	Alarm and event reports to be stored to computer file for 10 days.
Storing of data for batch metering system	1-hourly reports to be stored to computer file for 62 batches, batch reports for 200 batches, calibration reports for 200 batches.
	Only reports for successful meter calibration to be stored.
	Alarm and event reports to be stored to computer file for 10 days.
Computer spare capacity	Maximum 50 % CPU load,
	Minimum 30 % memory spare capacity.
	Minimum 25 % harddisk spare capacity.
Isolation and sectioning of signals	Fields cable terminal block with knives and test lead capacity.

ANNEX B Norwegian Laws, Regulations and Guidelines (Informative)

A ANNEX B NORWEGIAN LAWS, REGULATIONS AND GUIDELINES (INFORMATIVE)

NDP	"Regulation for fiscal measurement of oil and gas in the petroleum industry", revised by NPD in 1993, ISBN 82-7257-400-4.
NPD	"Regulations relating to measurement of fuel and flare gas for calculation of CO ₂ tax in the petroleum activities", issued in 1993.