

Regulation on requirements to measuring systems for the continuous and dynamic measurement (quantities for liquids other than water)

Established by the Norwegian Metrology Service dd.dd.yyyy in accordance with the Units of measurement, measurement and standard time Act of 26 January 2007 no 4 § 35, cf. § 7 and § 10, and § 8, § 19, § 20 and § 30 and regulation December 20th 2007 no. 1723 on measuring units and measurements § 5-2 second subsection.

Chapter 1 – Introductory provisions

§ 1. Scope

The regulation prescribes the requirements which applies to meters, cf. regulation December 20th 2007 no. 1723 on measuring units and measurements chapter 3 and supplementary provisions on control and approval in service.

The requirements of this regulation applies when

- a) such meters are sold or offered for sale, cf. regulation on measuring units and measurements § 3-1 and when
- b) the measurement result of such meters will be used in economic transactions, cf. regulation on measuring units and measurements § 3-4.

This regulation does not prescribe requirements to electromagnetic disturbance. Electromagnetic disturbance is regulated by regulation August 10th 1995 no. 713 on electric equipment.

§ 2. Definitions

In this regulation, the following definitions apply:

- a) *Meter*: An instrument designed to measure continuously, memorise and display the quantity at metering conditions of liquid flowing through in a closed, fully charged conduit. Only instruments intended for liquids other than water is covered of the definition.
- b) *Measurand*: the particular quantity subject to measurement
- c) *Influence quantity*: A quantity that is not the measurand but that affects the result of measurement
- d) *Rated operating conditions*: The values for the measurand and influence quantities making up the normal working conditions of the meter
- e) *Disturbance*: An influence quantity having a value within the limits specified in the appropriate requirement but outside the specified rated operating conditions of the meter. An influence quantity is a disturbance if for that influence quantity the rated operating conditions are not specified.

- f) *Critical change value*: The value at which the change in the measurement result is considered undesirable.
- g) *Direct sales*: A trading transaction is direct sales if:
 - 1. The measurement result serves as the basis for the price to pay
 - 2. At least one of the parties involved in the transaction related to measurement is a consumer or any other party requiring a similar level of protection, and
 - 3. All the parties in the transaction accept the measurement result at that time and place.
- h) *Climatic environments*: The conditions in which the meter may be used. To cope with climatic differences between the Member States of the EEC, a range of temperature limits has been defined.

§ 3. Requirements to meters

Meters shall as a minimum fulfill the essential requirements established in chapter 2. Maximal permissible errors for measuring systems is established in § 29.

Meters which have been national type examined during a former legislation, shall in service fulfill the requirements which applied when the meter was national type examined, including the requirements for measurement accuracy in service.

Meters which are not lawfully conformity marked or has a valid national type examination and national verification, is not allowed in service.

§ 4. Surveillance and approval of sale of meters

Meters which are sold or offered for sale shall have a valid conformity assessment according to the provisions in regulation on measuring units and measurements chapter 4.

Meters which are national type examined according to the general national regulation 25/81, can have a national verification according to this up to and including the year 2008. The national verification shall in such cases be carried out according to the rules about national conformity assessment in regulation on measuring units and measurements § 4-7 to § 4-9. This only applies if the national type examination for the relevant meter is maximum 10 years when the meter has a national verification.

§ 5. Surveillance of a meter in service

A meter is subject to periodic surveillance. The surveillance period for a meter is one year. The surveillance period is two years for a meter which is used for sale directly to a consumer and which measures

- a) fuel and other fuel liquids than liquid gasses
- b) washer liquid

c) excipients associated to the fuel consumption

Testing of the meter in conjunction with the surveillance shall be carried out according to relevant parts of the applicable OIML R117, OIML R118, OIML R105 and the procedures of the Norwegian metrology service, unless the Norwegian metrology service considers that the testing should be carried out in a more appropriate and metrologically justifiable manner.

The metrological tests shall normally be carried out with the same liquids as the measuring system uses during normal operation.

Necessary amount of liquid to the test as well as necessary handling equipment, qualified personnel and control instrument must be available nearby during the test.

Chapter 2 - Requirements to meters

Section I - General requirements

§ 6. *Metrological protection and level of quality*

A meter shall provide a high level of metrological protection in order that any party affected can have confidence in the result of measurement, and shall be designed and manufactured to a high level of quality in respect of the measurement technology and security of the measurement data.

§ 7. *Intended use and foreseeable misuse*

The solutions adopted in the pursuit of the requirements shall take account of the intended use of the meter and any foreseeable misuse thereof.

§ 8. *Allowable errors*

Under rated operating conditions and in the absence of a disturbance, the error of measurement shall not exceed the maximum permissible error value as laid down in § 29. Unless stated otherwise in section II, the maximum permissible error is expressed as a bilateral value of the deviation from the true measurement value.

Under rated operating conditions and in the presence of a disturbance, the performance requirement shall be as laid down in section II.

Where the meter is intended to be used in a specified permanent continuous electromagnetic field the permitted performance during the radiated electromagnetic field-amplitude modulated test shall be within the maximum permissible error.

§ 9. Influence quantities

The manufacturer shall specify the climatic, mechanical and electromagnetic environments in which the meter is intended to be used, power supply and other influence quantities likely to affect its accuracy, taking account of the requirements laid down in section II.

§ 10. Climatic environments

The manufacturer shall specify the upper temperature limit and the lower temperature limit from any of the values in table 1, and indicate whether the meter is designed for condensing or non-condensing humidity as well as the intended location for the instrument is open or closed.

Table 1

Upper temperature limit	30 °C	40 °C	55 °C	70 °C
Lower temperature limit	5 °C	-10 °C	-25 °C	-40 °C

§ 11. Mechanical environments

Mechanical environments are classified into the following classes:

Table 2

M1	This class applies to meter used in locations with vibration and shocks of low significance, e.g. for instruments fastened to light supporting structures subject to negligible vibrations and shocks transmitted from local blasting or pile-driving activities, slamming doors, etc.
M2	This class applies to meters used in locations with significant or high levels of vibration and shock, e.g. transmitted from machines and passing vehicles in the vicinity or adjacent to heavy machines, conveyor belts, etc.
M3	This class applies to meters used in locations where the level of vibration and shock is high and very high, e.g. for instruments mounted directly on machines, conveyor belts, etc.

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The following influence quantities shall be considered in relation with mechanical environments:

- a) Vibration
- b) Mechanical shock.

§ 12. Electromagnetic environments

Unless otherwise laid down in section II, electromagnetic environments are classified into the following classes:

Table 3

E1	This class applies to meters used in locations with electromagnetic disturbances corresponding to those likely to be found in residential, commercial and light industrial buildings.
E2	This class applies to meters used in locations with electromagnetic disturbances corresponding to those likely to be found in other industrial buildings.
E3	This class applies to meters supplied by the battery of a vehicle. Such instruments shall comply with the requirements of E2 and the following additional requirements: voltage reductions caused by energising the starter-motor circuits of internal combustion engines, and load dump transients occurring in the event of a discharged battery being disconnected while the engine is running.

The following influence quantities shall be considered in relation with electromagnetic environments:

- a) Voltage interruptions
- b) Short voltage reductions
- c) Voltage transients on supply lines and/or signal lines, electrostatic discharges,
- d) Radio frequency electromagnetic fields
- e) Conducted radio frequency electromagnetic fields on supply lines and/or signal lines
- f) Surges on supply lines and/or signal lines.

Other influence quantities to be considered, where appropriate, are:

- a) Voltage variation
- b) Mains frequency variation
- c) Power frequency magnetic fields
- d) Any other quantity likely to influence in a significant way the accuracy of the instrument.

§ 13. Basic rules for testing and the determination of errors

Essential requirements specified in § 8 shall be verified for each relevant influence quantity. Unless otherwise specified in section II, these essential requirements apply when each influence quantity is applied and its effect evaluated separately, all other influence quantities being kept relatively constant at their reference value.

Metrological tests shall be carried out during or after the application of the influence quantity, whichever condition corresponds to the normal operational status of the meter when that influence quantity is likely to occur.

§ 14. Ambient humidity

According to the climatic operating environment in which the meter is intended to be used either the damp heat-steady state (non-condensing) or damp heat cyclic (condensing) test may be appropriate.

The damp heat cyclic test is appropriate where condensation is important or when penetration of vapour will be accelerated by the effect of breathing. In conditions where non-condensing humidity is a factor the damp-heat steady state is appropriate.

§ 15. Reproducibility

The application of the same measurand in a different location or by a different user, all other conditions being the same, shall result in the close agreement of successive measurements. The difference between the measurement results shall be small when compared with the maximum permissible error.

§ 16. Repeatability

The application of the same measurand under the same conditions of measurement shall result in the close agreement of successive measurements. The difference between the measurement results shall be small when compared with the maximum permissible error.

§ 17. Discrimination and sensitivity

A meter shall be sufficiently sensitive and the discrimination threshold shall be sufficiently low for the intended measurement task.

§ 18. Durability

A meter shall be designed to maintain an adequate stability of its metrological characteristics over a period of time estimated by the manufacturer, provided that it is properly installed, maintained and used according to the manufacturer's instruction when in the environmental conditions for which it is intended.

§ 19. Reliability

A meter shall be designed to reduce as far as possible the effect of a defect that would lead to an inaccurate measurement result, unless the presence of such a defect is obvious.

§ 20. Suitability

A meter shall be:

- a) Suitable for its intended use taking account of the practical working conditions and shall not require unreasonable demands of the user in order to obtain a correct measurement result.
- b) Robust and its materials of construction shall be suitable for the conditions in which it is intended to be used.
- c) Designed so as to allow the control of the measuring tasks after the meter has been placed on the market and put into use. If necessary, special equipment or software for this control shall be part of the measuring instrument. The test procedure shall be described in the operation manual.
- d) Insensitive to small fluctuations of the value of the measurand, or it shall take appropriate action, when the measuring instrument is designed for measurement of values of measurand that are constant over time

A meter shall have no feature likely to facilitate fraudulent use, whereas possibilities for unintentional misuse shall be minimal.

When a meter has associated software which provides other functions besides the measuring function, the software that is critical for the metrological characteristics shall be identifiable and shall not be inadmissibly influenced by the associated software.

§ 21. Protection against corruption

If the meter gets connected to another device, direct or by any remote device that communicates with it, shall its metrological characteristics not be influenced in any inadmissible way.

The hardware components that are critical for metrological characteristics shall be designed so that they can be secured. Security measures foreseen shall provide for evidence of an intervention.

Software that is critical for metrological characteristics shall be identified as such and shall be secured. Software identification shall be easily provided by the meter. Evidence of an intervention shall be available for a reasonable period of time.

Measurement data, software that is critical for measurement characteristics and metrologically important parameters stored or transmitted shall be adequately protected against accidental or intentional corruption.

§ 22. Information to be borne by and to accompany the meter

A meter shall bear the manufacturer's mark or name and information in respect of its accuracy. When applicable the meter shall also bear the following information:

- a) Relevant information in respect of the conditions of use
- b) Measuring capacity
- c) Measuring range
- d) Identity marking
- e) Number of the EC-type examination certificate or the EC design examination certificate
- f) Information whether or not additional devices providing metrological results comply with the regulations on legal metrological control.

Information on its operation shall accompanied the meter, unless the simplicity of the meter makes this unnecessary. Information shall be easily understandable and shall include where relevant:

- a) Rated operating conditions
- b) Electromagnetic environment
- c) The upper and lower temperature limit, if condensation is possible or not, open or closed location
- d) Instructions for installation, maintenance, repairs, permissible adjustments
- e) Instructions for correct operation and any special conditions of use;

f) Conditions for compatibility with interfaces, sub-assemblies or measuring instruments.

All marks and inscriptions required shall be clear, unambiguous, non-erasable and non-transferable. Groups of identical meters do not require individual instruction manuals.

§ 23. *Specification of measured value*

Unless specified in section II, the scale interval for a measured value shall be in the form $1 \times 10n$, $2 \times 10n$, or $5 \times 10n$, where n is any integer or zero. The unit of measurement or its symbol shall be shown close to the numerical value.

The units of measurement and symbols used shall be in accordance with regulations on measuring units and measurements.

§ 24. *Indication of result*

Indication of the result shall be by means of a display or hard copy. In the case of hard copy the print or record shall also be easily legible and non-erasable.

The indication of any result shall be clear and unambiguous and accompanied by such marks and inscriptions necessary to inform the user of the significance of the result. Easy reading of the presented result shall be permitted under normal conditions of use. Additional indications may be shown provided they cannot be confused with the metrologically controlled indications.

A meter for direct sales trading transactions shall be designed to present the measurement result to both parties in the transaction when installed as intended. When critical in case of direct sales, any ticket provided to the consumer by an ancillary device not complying with the appropriate requirements of this regulation shall bear an appropriate restrictive information.

§ 25. *Further processing of data to conclude the trading transaction*

The meter shall record by a durable means the measurement result accompanied by information to identify the particular transaction, when the measurement is non-repeatable and the measuring instrument is normally intended for use in the absence of one of the trading parties.

Additionally, a durable proof of the measurement result and the information to identify the transaction shall be available on request at the time the measurement is concluded.

§ 26. *Conformity evaluation*

A meter shall be designed so as to allow ready evaluation of its conformity with the appropriate requirements of this regulation.

Section II - Specific requirements

§ 27. Definitions

In this section, the following definitions applies:

- a) *Calculator*: A part of a meter that receives the output signals from the measurement transducer(s) and possibly, from associated measuring instruments and displays the measurement results.
- b) *Direct indication*: The indication, either volume or mass, corresponding to the measure and that the meter is physically capable of measuring. The direct indication may be converted into another quantity using a conversion device.
- c) *Conversion Device*: A part of the calculator which by taking account of the characteristics of the liquid (temperature, density, etc.) measured using associated measuring instruments, or stored in a memory, automatically converts:
 - 1. the volume of the liquid measured at metering conditions into a volume at base conditions and/or into mass, or
 - 2. the mass of the liquid measured at metering conditions into a volume at metering conditions and/or into a volume at base conditions.A conversion device includes the relevant associated measuring instruments.
- d) *Interruptible/non interruptible*: A measuring system is considered as interruptible/non interruptible when the liquid flow can/cannot be stopped easily and rapidly.
- e) *Fuel dispenser*: A measuring system intended for the refuelling of motor vehicles, small boats and small aircraft.
- f) *Minimum measured quantity (MMQ)*: The smallest quantity of liquid for which the measurement is metrologically acceptable.
- g) *Measuring System*: A system that comprises the meter itself and all devices required to ensure correct measurement or intended to facilitate the measuring operations.
- h) *Base conditions*: The specified conditions to which the measured quantity of liquid at metering conditions is converted.
- i) *Self-service device*: A specific device that is part of a self-service arrangement and which allows one of more measuring systems to perform in this self-service arrangement.
- j) *Self-service arrangement*: An arrangement that allows the customer to use a measuring system for the purpose of obtaining liquid for his own use.

- k) *Flowrate range*: The range between the minimum flowrate (Q_{min}) and maximum flowrate (Q_{max}).
- l) *Associated measuring instrument*: An instrument connected to the calculator for measuring certain quantities which are characteristic of the liquid, with a view to make a correction and/or conversion.

§ 28. Rated operating conditions

The manufacturer shall specify the rated operating conditions for the meter, in particular:

- a) The flowrate range: The flowrate range is subject to the following conditions:
 1. the flowrate range of a measuring system shall be within the flowrate range of each of its elements, in particular the meter.
 2. meter and measuring system:

Table 4

Specific measuring system	Characteristic of liquid	Minimum ratio of $Q_{max} : Q_{min}$
Fuel dispensers	Not Liquefied gases	10:1
	Liquefied gases	5:1
Measuring system	Cryogenic gases	5:1
Measuring system of pipeline and system for loading ships	All liquids	Suitable for use
All other measuring systems	All liquids	4:1

b) The properties of the liquid to be measured by the meter by specifying the name or type of the liquid or its relevant characteristics, for example:

- temperature range
- pressure range

- density range
 - viscosity range.
- c) The nominal value of the AC voltage supply and/or limits of the DC voltage supply
- d) The base conditions for converted values.

§ 29. Accuracy classification and maximum permissible errors

For quantities equal to or greater than 2 litres the maximum permissible error on indications is indicated in table 5. A applies to complete measuring systems in field under normal conditions, B applies to testing of the meters in a test setup. For quantities less than two litres the maximum permissible error on indications is indicated in table 6.

Table 5

Accuracy Class					
	0,3	0,5	1,0	1,5	2,5
Measuring systems (A)	0,3 %	0,5 %	1,0 %	1,5 %	2,5 %
Meters (B)	0,2 %	0,3 %	0,6 %	1,0 %	1,5 %

Table 6

Measured volume V	Maximum permissible errors
$V < 0,1 \text{ l}$	4 × value in table 5, applied to 0,1 l
$0,1 \text{ l} \leq V < 0,2 \text{ l}$	4 × value in table 5
$0,2 \text{ l} \leq V < 0,4 \text{ l}$	2 × value in table 5, applied to 0,4 l
$0,4 \text{ l} \leq V < 1 \text{ l}$	2 × value in table 5

$1 \text{ l} \leq V < 2 \text{ l}$	Value in table 5, applied to 2 l
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However, no matter what the measured quantity may be, the magnitude of the maximum permissible error is given by the greater of the following two values:

- a) the absolute value of the maximum permissible error given in table 5 or table 6,
- b) the absolute value of the maximum permissible error for the minimum measured quantity (E_{\min}).

For minimum measured quantities greater than or equal to 2 litres the following conditions apply:

- a) E_{\min} shall fulfil the condition: $E_{\min} \geq 2 R$, where R is the smallest scale interval of the indication device.
- b) E_{\min} is given by the formula: $E_{\min} = (2MMQ) \times (A/100)$, where:
 1. MMQ is the minimum measured quantity,
 2. A is the numerical value specified in line A of table 5.

For minimum measured quantities of less than two litres, the above mentioned condition in third subsection, paragraph (a) applies and E_{\min} is twice the value specified in table 6, and related to line A of table 5.

In the case of a converted indication the maximum permissible errors are as in line A of table 5. Maximum permissible errors on converted indications due to a conversion device are equal to $\pm (A - B)$, A and B being the values specified in table 5. Parts of conversion devices that can be tested separately:

- (a) *Calculator*: Maximum permissible errors on quantities of liquid indications applicable to calculation, positive or negative, are equal to one-tenth of the maximum permissible errors as defined in line A of table 5.
- (b) *Associated measuring instruments*: Associated measuring instruments shall have an accuracy at least as good as the values in table 7. These values apply to the indication of the characteristic quantities of the liquid displayed by the conversion device.
- (c) *Accuracy for calculating function*: The maximum permissible error for the calculation of each characteristic quantity of the liquid, positive or negative, is equal to two fifths of the value fixed in (b).

The requirement in fifth subsection, paragraph (b) applies to any calculation, not only conversion.

Table 7

Maximum permissible errors on measurement	Accuracy classes of the measuring system				
	0,3	0,5	1,0	1,5	2,5
Temperature	± 0,3 °C	± 0,5 °C			± 1,0 °C
Pressure	Less than 1 MPa: ± 50 kPa, From 1 to 4 MPa: ± 5 %, Over 4 MPa: ± 200 kPa				
Density	± 1 kg/m ³		± 2 kg/m ³		± 5 kg/m ³

The measuring system shall not exploit maximal permissible errors or systematically favour a certain part.

§ 30. Maximum permissible effect of disturbances

The effect of an electromagnetic disturbance on a measuring system shall be one of the following;

- a) The change in the measurement result is not greater than the critical change value as defined in second subsection
- b) The indication of the measurement result shows a momentary variation that cannot be interpreted, memorised or transmitted as a measuring

result. Furthermore, in the case of an interruptible system, this can also mean the impossibility to perform any measurement

c) The change in the measurement result is greater than the critical change value, in which case the measuring system shall permit the retrieval of the measuring result just before the critical change value occurred and cut off the flow.

The critical change value is the greater of maximum permissible errors divided by 5 for a particular measured quantity or E_{min} .

§ 31. Durability

After an appropriate test, taking into account the period of time estimated by the manufacturer, has been performed, the following criterion shall be satisfied: The variation of the measurement result after the durability test, when compared with the initial measurement result, shall not exceed the value for meters specified in line B of table 5.

§ 32. Suitability

For any measured quantity relating to the same measurement, the indications provided by various devices shall not deviate one from another by more than one scale interval where devices have the same scale interval. In the case where the devices have different scale intervals, the deviation shall not be more than that of the greatest scale interval.

However, in the case of a self-service arrangement the scale intervals of the main indicating device on the measuring system and the scale intervals of the self-service device shall be the same and results of measurement shall not deviate one from another.

It shall not be possible to divert the measured quantity in normal conditions of use unless it is readily apparent.

Any percentage of air or gas not easily detectable in the liquid shall not lead to a variation of error greater than:

- a) 0,5 % for liquids other than potable liquids and for liquids of a viscosity not exceeding 1 mPa.s, or
- b) 1 % for potable liquids and for liquids of a viscosity exceeding 1 mPa.s.

However, the allowed variation shall never be smaller than 1 % of MMQ. This value applies in the case of air or gas pockets.

§ 33. Instruments for direct sales

A measuring system for direct sales shall be provided with means for resetting the display to zero. It shall not be possible to divert the measured quantity. Measuring systems for direct sales shall be interruptible.

The display of the quantity on which the transaction is based, shall be permanent until all parties in the transaction have accepted the measurement result.

Any percentage of air or gas in the liquid shall not lead to a variation of error greater than the values specified in § 32 fourth subsection.

§ 34. Fuel Dispensers

Displays on fuel dispensers shall not be capable of being reset to zero during a measurement. The start of a new measurement shall be inhibited until the display has been reset to zero.

Where a measuring system is fitted with a price display, the difference between the indicated price and the price calculated from the unit price and the indicated quantity shall not exceed the price corresponding to Emin. However this difference need not be less than the smallest monetary value.

§ 35. Power supply failure

A measuring system shall either be provided with an emergency power supply device that will safeguard all measuring functions during the failure of the main power supply device or be equipped with means to save and display the data present in order to permit the conclusion of the transaction in progress and with means to stop the flow at the moment of the failure of the main power supply device.

§ 36. Requirements for accuracy classes on meters sold for different use

Table 8 sets requirements to accuracy classes for meters which are sold for different applications. However, the manufacturer may specify a better accuracy for certain types of measuring system.

Table 8

Accuracy Class	Types of measuring systems
0,3	All measuring systems on pipeline -Measuring systems used for the levying of duties on mineral oils when (un)loading ships and rail and road tankers.

0,5	<p>All measuring systems if not different stated elsewhere in this table, in particular:</p> <ul style="list-style-type: none"> - Fuel dispensers (not for liquefied gases), - Measuring systems on road tankers for liquids of low viscosity (< 20 mPa.s), - Measuring systems for (un)loading ships and rail and road takers, - Measuring systems for milk, - Measuring systems for refuelling aircraft.
1,0	<p>Measuring systems for liquefied gases under pressure measured at a temperature equal to or above – 10 °C</p> <p>Measure systems normally in class 0,3 or 0,5 but used for liquids</p> <ul style="list-style-type: none"> - Whose temperature is less than -10 °C or greater than 50 °C - Whose dynamic viscosity is higher than 1 000mPa.s - Whose maximum volumetric flowrate is not higher tah 20 L/h.
1,5	<p>Measuring systems for liquefied carbon dioxide</p> <p>Measuring systems for liquefied gases under pressure measured at a temperature below – 10 °C (other than cryogenic liquids).</p>
2,5	<p>Measuring systems for cryogenic liquids (temperature below -153 °C).</p>

§ 37. Units of measurement

The measured quantity shall be displayed in millilitres, cubic centimetres, litres, cubic metres, grams, kilograms or tons.

Chapter 3 - Concluding provisions

§ 38. Infringement penalty

Violation of the requirements in this regulation may lead to order of infringement penalty, determined by the provisions of regulation on measuring units and measurements chapter 7.

§ 39. *Entry into force*

This regulation enters into force on xx.