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ISO/TC 30 / SC 7

Title

**Measurement of fluid flow in
closed conduits – Volume methods
including water meters**

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Water meters intended for the metering of cold potable water and hot water — Part 1: Metrological and technical requirements

Compteurs d'eau potable froide et d'eau chaude — Partie 1: Exigences métrologiques et techniques

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Foreword

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ISO 4064-1 was prepared by Technical Committee ISO/TC 30, *Measurement of fluid flow in closed conduits*, Subcommittee SC 7, *Volume methods including water meters*.

This fourth edition cancels and partially replaces the third edition (ISO 4064-1:2005), which has been technically revised. Some provisions of the third edition are addressed in the new Part 4.

ISO 4064 consists of the following parts, under the general title *Water meters intended for the metering of cold potable water and hot water*:

- *Part 1: Specification of metrological and technical requirements*
- *Part 2: Specification of test methods*
- *Part 3: Specification of test report format*
- *Part 4: Specification of non-metrological requirements not covered in Part 1*
- *Part 5: Specification of installation requirements*

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This publication - reference OIML R 49-1, edition 2011 (E) - was developed by the OIML Technical Subcommittee TC 8/SC 5 *Water meters*. It was approved for final publication by the International Committee of Legal Metrology in 2011 and will be submitted to the International Conference of Legal Metrology in 2011 for formal sanction. This Edition supersedes the previous edition of OIML R 49-1 (Edition 2006).

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Introduction

Water meters intended for the metering of cold potable water and hot water — Part 1: Metrological and technical requirements

1 Scope

1.1 This Standard/Recommendation applies to water meters used to meter the volume of cold potable water and hot water flowing through a fully charged, closed conduit. These water meters shall incorporate devices which indicate the integrated volume.

1.2 This Standard/Recommendation sets out the conditions with which the water meters shall comply to meet the requirements of the Services of Legal Metrology in countries where these instruments are subject to State controls.

1.3 This Standard/Recommendation also applies to water meters based on electrical or electronic principles, and to water meters based on mechanical principles incorporating electronic devices, used to meter the volume flow of hot water and cold potable water. It also applies to electronic ancillary devices. As a rule ancillary devices are optional. However, national or international regulations may make some ancillary devices mandatory in relation to the utilization of the water meter.

1.4 In addition to the metrological requirements included in this Part 1 the methods of examination and testing are included in Part 2, the Test Report Format is included in Part 3, and there are additional technical requirements in Part 4 and installation requirements in Part 5.

2 Terminology

Many of the definitions used in this Standard/Recommendation conform to the *International Vocabulary of Basic and General Terms in Metrology* (VIM) [1], the *International Vocabulary of Terms in Legal Metrology* (VIML) [2] and OIML International Document D 11 [3]. For the purposes of this Standard/Recommendation, the definitions below shall apply.

2.1 Water meter and its constituents

2.1.1 Water meter

Instrument intended to measure continuously, memorize and display the volume of water passing through the measurement transducer at metering conditions.

NOTE 1 A water meter includes at least a measurement transducer, a calculator (including adjustment or correction devices, if present) and an indicating device. These three devices may be in different housings.

NOTE 2 A water meter may be a combination meter comprising one large meter, one small meter and a changeover device that, depending on the magnitude of the flowrate passing through the meter, automatically directs the flow through either the small or large meter or both. Meter reading is obtained from two independent totalizers or one totalizer, which adds up the values from both water meters.

2.1.2 Measurement transducer

Part of the meter which transforms the flow or the volume of the water to be measured into signals which are passed to the calculator. It can be based on a mechanical, or an electrical, or an electronic principle. It may be autonomous or use an external power source.

NOTE For the purposes of this Standard/Recommendation, the measurement transducer includes the flow sensor or volume sensor.

2.1.3 Flow sensor or volume sensor

Part of the water meter (such as a disc, piston, wheel, turbine element, electromagnetic coil, or other transducer) which senses the flowrate or volume of water passing through the meter.

2.1.4 Calculator

Part of the meter which receives the output signals from the transducer(s) and, possibly, from associated measuring instruments, transforms them and, if appropriate, stores the results in memory until they are used. In addition, the calculator may be capable of communicating both ways with ancillary devices.

2.1.5 Indicating device

Part of the meter which displays the measurement results..

2.1.6 Adjustment device

Device incorporated in the meter that only allows the error curve to be shifted generally parallel to itself, with a view to bringing errors (of indication) within the maximum permissible errors.

2.1.7 Correction device

Device connected to or incorporated in the meter for automatically correcting the volume at metering conditions, by taking into account the flowrate and/or the characteristics of the water to be measured (e.g. temperature and pressure) and the pre-established calibration curves. The characteristics of the water to be measured may either be measured using associated measuring instruments, or be stored in a memory in the instrument.

2.1.8 Ancillary device

Device intended to perform a particular function, directly involved in elaborating, transmitting or displaying measurement results.

NOTE 1 The main ancillary devices are:

- a) zero setting device;
- b) price indicating device;
- c) repeating indicating device;
- d) printing device;
- e) memory device;
- f) tariff control device;

- g) pre-setting device;
- h) self service device;
- i) flow sensor movement detector (for detecting movement of the flow sensor before this is clearly visible on the indicating device); and
- j) remote reading device (which may be permanently incorporated or added temporarily).

NOTE 2 An ancillary device may or may not be subject to legal metrological control according to national regulations.

2.1.9 Tariff control device

Device that allocates measurement results into different registers depending on tariff or other criteria, each register having the possibility to be displayed individually.

2.1.10 Pre-setting device

Device which permits the selection of the quantity to be measured and which automatically stops the flow of the water at the end of the measurement of the selected quantity.

2.1.11 Associated measuring instruments

Instruments connected to the calculator or the correction device, for measuring certain quantities which are characteristic of water, with a view to making a correction and/or a conversion.

2.1.12 Meter for two constant partners

Meter permanently installed and only used for deliveries from one supplier to one customer.

2.1.13 In-line meter

Type of water meter fitted into a closed conduit by means of the meter end connections (either threaded or flanged) provided.

2.1.14 Complete meter

Meter that does not have separable measurement transducer (including flow or volume sensor) and calculator (including indicating device).

2.1.15 Combined meter

Meter which has separable measurement transducer (including flow or volume sensor) and calculator (including indicating device).

2.1.16 Combination meter

Meter comprising one large meter, one small meter and a changeover device that, depending on the magnitude of the flowrate passing through the meter, automatically directs the flow through either the small or the large meter or both.

2.1.17 Equipment under test (EUT)

Complete water meter, sub-assembly of a water meter or ancillary device that is subjected to a test.

2.1.18 Concentric meter

Type of water meter fitted into a closed conduit by means of an intermediate fitting called a manifold. The inlet and outlet passages of the meter and the manifold, at the interface between them, are coaxial.

2.1.19 Concentric meter manifold

Pipe fitting specific to the connection of a concentric meter.

2.1.20 Cartridge meter

Type of water meter fitted into a closed conduit by means of an intermediate fitting called a connection interface. The inlet and outlet passages of the meter and the connection interface are either concentric or axial as detailed in Annex ? of Part 4.

2.1.21 Cartridge meter connection interface

Pipe fitting specific to the connection of an axial or concentric cartridge meter.

2.1.22 Meters with interchangeable inserts

Meter with $Q_3 = 16 \text{ m}^3/\text{h}$, comprising a body and an interchangeable measuring insert, from the same pattern approval.

2.1.23 Measuring insert

Self-contained unit comprising a measurement transducer and an indicating device or alternatively a calculator including indicating device where applicable

2.2 Metrological characteristics

2.2.1 Reference volume, V_a

Total volume of water passing through the water meter, disregarding the time taken. This is the measurand.

2.2.2 Indicated volume, V_i

Volume of water indicated by the meter, corresponding to the reference volume.

2.2.3 Primary indication

Indication (displayed, printed or memorized) which is subject to legal metrological control.

2.2.4 Error (of indication)

Indicated volume minus a reference volume [adapted from VIM 2.16]

2.2.5 Relative error (of indication)

Error (of indication) divided by a known reference volume

2.2.6 Maximum permissible error (mpe)

Extreme value of the relative error (of indication) of a water meter, with respect to a known reference volume, permitted by this Standard/Recommendation [adapted from VIM 4.26]

2.2.7 Intrinsic error

Error (of indication) of a water meter determined under reference conditions.

2.2.8 Initial intrinsic error

Intrinsic error of a water meter as determined prior to all performance tests.

2.2.9 Fault

Difference between the error (of indication) and the intrinsic error of a water meter [adapted from OIML D 11].

2.2.10 Significant fault

Fault, the magnitude of which is greater than one half of the maximum permissible error in the upper flowrate zone [adapted from OIML D 11].

The following are not considered to be significant faults:

- faults arising from simultaneous and mutually independent causes in the water meter itself or in its checking facilities; and
- transitory faults being momentary variations in the indication which cannot be interpreted, memorized or transmitted as a measurement result.

2.2.11 Durability

Capability of the water meter to maintain its performance characteristics over a period of use [adapted from OIML D 11].

2.2.12 Metering conditions

Conditions of the water, the volume of which is to be measured, at the point of measurement (example: temperature and pressure of the water).

2.2.13 First element of an indicating device

Element which, in an indicating device comprising several elements, carries the graduated scale with the verification scale interval.

2.2.14 Verification scale interval

Lowest value scale division of the first element of an indicating device.

2.2.15 Resolution (of an indicating device)

Smallest difference between indications of an indicating device that can be meaningfully distinguished [adapted from VIM 4.15].

NOTE For a digital device, this is the change in the indication when the least significant digit changes by one step.

2.3 Operating conditions

2.3.1 Flowrate, Q

Quotient of the reference volume of water passing through the water meter and the time taken for this volume to pass through the water meter.

2.3.2 Permanent flowrate, Q_3

Highest flowrate within the rated operating conditions at which the water meter is required to operate in a satisfactory manner within the maximum permissible error. Flowrate is expressed in m^3/h in this Standard/Recommendation.

2.3.3 Overload flowrate, Q_4

Highest flowrate at which a water meter is required to operate, for a short period of time, within its maximum permissible error, whilst maintaining its metrological performance when it is subsequently operated within its rated operating conditions.

2.3.4 Transitional flowrate, Q_2

Flowrate which occurs between the permanent flowrate, Q_3 , and the minimum flowrate, Q_1 , that divides the flowrate range into two zones, the upper flowrate zone and the lower flowrate zone, each characterized by its own maximum permissible error.

2.3.5 Minimum flowrate, Q_1

Lowest flowrate at which the water meter is required to operate within the maximum permissible error.

2.3.6 Combination meter changeover flowrate, Q_x

Change-over flowrate Q_{x1} is when flow stops in the larger meter with decreasing flowrate.

Change-over flowrate Q_{x2} is when flow starts in the larger meter with increasing flowrate.

2.3.7 Minimum and maximum admissible temperature (mAT and MAT)

Minimum and maximum water temperatures that a water meter can withstand permanently, within its rated operating conditions, without deterioration of its metrological performance. mAT and MAT are respectively the lower and upper of the rated operating conditions (ROC).

2.3.8 Maximum admissible pressure (MAP)

Maximum internal pressure that a water meter can withstand permanently, within its rated operating conditions, without deterioration of its metrological performance.

2.3.9 Working temperature, T_w

Water temperature in the pipe measured upstream of the water meter.

2.3.10 Working pressure, P_w

Average water pressure in the pipe measured upstream and downstream of the water meter.

2.3.11 Pressure loss, Δp

Pressure loss, at a given flowrate, caused by the presence of the water meter in the pipeline. .

2.3.12 Test flowrate

Mean flowrate during a test, calculated from the indications of a calibrated reference device. The quotient of the reference volume passing through the water meter divided by the time for that volume to pass through the water meter.

2.4 Test conditions**2.4.1 Influence quantity**

Quantity that does not affect the quantity that is actually measured, but affects the relation between the indicated volume and the known reference volume [VIM 2.52].

2.4.2 Influence factor

Influence quantity having a value within the rated operating conditions of the water meter, as specified in this Standard/Recommendation.

2.4.3 Disturbance

Influence quantity having a value within the limits specified in this Standard/Recommendation, but outside the specified rated operating conditions of the water meter.

NOTE An influence quantity is a disturbance if for that influence quantity the rated operating conditions are not specified.

2.4.4 Rated operating conditions (ROC)

Operating condition that must be fulfilled during measurement in order that a water meter perform as designed [adapted from VIM 4.9].

Note: the rated operating conditions specify intervals of values for the flowrate and for the influence quantities for which the errors (of indication) of the water meter are required to be within the maximum permissible errors.

2.4.5 Reference conditions

Operating condition prescribed for evaluating the performance of a water meter [adapted from VIM 4.11].

Note: the reference conditions are a set of reference values, or reference ranges, of influence quantities, prescribed for testing the performance of a water meter, or for the intercomparison of the results of measurements.

2.4.6 Limiting conditions

Extreme conditions, including flowrate, temperature, pressure, humidity and electromagnetic interference, that a water meter is required to withstand without damage, and without degradation of its error (of indication), when it is subsequently operated within its rated operating conditions [adapted from VIM 4.10].

2.4.7 Performance test

Test intended to verify whether the water meter (equipment under test, EUT) is capable of accomplishing its intended functions.

2.4.8 Endurance test

Test intended to verify whether the water meter is able to maintain its performance characteristics over a period of use.

2.4.9 Temperature stability

Temperature stability has been reached when all parts of the equipment under test are within 3 °C of each other, or as otherwise specified in the relevant specification of its final temperature.

2.4.10 Pre-conditioning

Treatment of the equipment under test, with the object of eliminating or partially counteracting the effects of its previous history. Where called for, this is the first process in the test procedure.

2.4.11 Conditioning

Exposure of the equipment under test to an environmental condition (influence factor or disturbance) in order to determine the effect of such a condition on it.

2.4.12 Recovery

Treatment of the equipment under test, after conditioning, in order that the properties of the equipment under test may be stabilized before measurement.

2.4.13 Nominal diameter

Insert definition from ISO 6708.

2.5 Electronic and electrical equipment

2.5.1 Electronic device

Device employing electronic sub-assemblies and performing a specific function. Electronic devices are usually manufactured as separate units and are capable of being tested independently.

NOTE Electronic devices, as defined above, may be a complete meter or part of meters, for example as defined in 2.1.1 to 2.1.5 and 2.1.8.

2.5.2 Electronic sub-assembly

Part of an electronic device, employing electronic components and having a recognizable function of its own.

2.5.3 Electronic component

Smallest physical entity which uses electron or hole conduction in semi-conductors, gases, or in a vacuum.

2.5.4 Checking facility

Facility incorporated in a water meter with electronic devices and which enables significant faults to be detected and acted upon.

NOTE The checking of a transmission device aims at verifying that all the information which is transmitted (and only that information) is fully received by the receiving equipment.

2.5.5 Automatic checking facility

Checking facility operating without the intervention of an operator.

2.5.6 Permanent automatic checking facility (type P)

Automatic checking facility operating during the entire measurement operation.

2.5.7 Intermittent automatic checking facility (type I)

Automatic checking facility operating at certain time intervals or per fixed number of measurement cycles.

2.5.8 Non-automatic checking facility (type N)

Checking facility which requires the intervention of an operator.

2.5.9 Power supply device

Device which provides the electronic devices with the required electrical energy, using one or several sources of AC or DC.

3 Metrological requirements**3.1 Values of Q_1 , Q_2 , Q_3 and Q_4**

3.1.1 The flowrate characteristics of a water meter shall be defined by the values of Q_1 , Q_2 , Q_3 , and Q_4 .

3.1.2 A water meter shall be designated by the numerical value of Q_3 in m^3/h and the ratio Q_3 / Q_1 .

3.1.3 The value of Q_3 shall be chosen from the following list:

1	1.6	2.5	4	6.3
10	16	25	40	63
100	160	250	400	630
1 000	1 600	2 500	4 000	6 300

where the Q_3 values are expressed in m^3/h .

The list may be extended to higher or lower values in the series.

3.1.4 The value of the ratio Q_3 / Q_1 shall be chosen from the following list:

40	50	63	80	100
125	160	200	250	315
400	500	630	800	1000

The list may be extended to higher values in the series.

NOTE The values in 3.1.3 and 3.1.4 are taken from the R5 and R10 lines of ISO 3:1973 [4] respectively.

3.1.5 The ratio Q_2 / Q_1 shall be 1.6.

3.1.6 The ratio Q_4 / Q_3 shall be 1.25.

3.2 Accuracy class and maximum permissible error

Water meters shall be designed and manufactured such that their errors (of indication) do not exceed the maximum permissible errors as defined in 3.2.1 or 3.2.2 under rated operating conditions.

These requirements shall be met durably.

Water meters shall be designated as either accuracy class 1 or accuracy class 2, according to the requirements of 3.2.1 or 3.2.2.

The meter manufacturer shall specify the accuracy class.

3.2.1 Accuracy class 1 water meters

The maximum permissible error for the upper flowrate zone ($Q_2 = Q = Q_4$) is ± 1 %, for temperatures from 0.1°C to 30°C , and ± 2 % for temperatures greater than 30°C .

The maximum permissible error for the lower flowrate zone ($Q_1 = Q < Q_2$) is ± 3 % regardless of the temperature range.

Accuracy class 1 designation shall be applied only to water meters with $Q_3 \geq 100 \text{ m}^3/\text{h}$ regardless of the temperature range.

3.2.2 Accuracy class 2 water meters

The maximum permissible error for the upper flowrate zone ($Q_2 = Q = Q_4$) is ± 2 %, for temperatures from 0.1°C to 30°C , and ± 3 % for temperatures greater than 30°C .

The maximum permissible error for the lower flowrate zone ($Q_1 = Q < Q_2$) is ± 5 % regardless of the temperature range.

Accuracy class 2 designation shall be applied to all water meters with $Q_3 < 100 \text{ m}^3/\text{h}$ and may be applied to water meters with values of $Q_3 = 100 \text{ m}^3/\text{h}$ regardless of the temperature range.

3.2.3 Meter temperature classes

The meters form water temperature classes corresponding to the various ranges, chosen by the manufacturer from the values given in Table 1.

The water temperature shall be measured at the inlet of the meter.

Table 1 — Meter temperature classes

Class	mAT (°C)	MAT (°C)
T30	0.1	30
T50	0.1	50
T70	0.1	70
T90	0.1	90
T130	0.1	130
T180	0.1	180
T30/70	30	70
T30/90	30	90
T30/130	30	130
T30/180	30	180

3.2.4 Water meters with separable calculator and measurement transducer

The calculator (including indicating device) and the measurement transducer (including flow sensor or volume sensor) of a water meter, where they are separable and interchangeable with other calculators and measurement transducers of the same or different designs, may be the subject of separate type approvals.

3.2.5 The maximum permissible errors of the combined indicating device and measurement transducer shall not exceed the values given in 3.2.1 or 3.2.2 according to the accuracy class of the meter. The relative error (of indication) is expressed as a percentage, and is equal to:

$$\frac{(V_i - V_a)}{V_a} \times 100$$

3.2.6 The manufacturer shall specify whether or not the water meter is designed to measure reverse flow.

If a meter is designed to measure reverse flow, the volume passed during reverse flow shall either be subtracted from the indicated volume or the meter shall record it separately. The maximum permissible error of 3.2.1 or 3.2.2 shall be met for both forward and reverse flow.

If a meter is not designed to measure reverse flow, the meter shall either prevent reverse flow, or it shall withstand accidental reverse flow without deterioration or change in its metrological properties for forward flow.

For meters designed to measure reverse flow, the permanent flowrate and the measuring range may be different in each direction.

3.2.7 The requirements relating to the maximum permissible errors shall be met for all temperature and pressure variations occurring within the rated operating conditions of the water meter.

3.2.8 The water meter totalization shall not change in the absence either of flow or of water.

3.3 Requirements for meters and ancillary devices

3.3.1 Connections between electronic parts

The connections between the measurement transducer, the calculator and the indicating device shall be reliable and durable in accordance with 4.1.3 and B.2.

These provisions shall also apply to connections between the primary and secondary devices of electromagnetic meters.

NOTE Definitions of primary and secondary devices of electromagnetic meters are given in ISO 4006 [5].

3.3.2 Adjustment device

Meters may be provided with an electronic adjustment device, which may replace a mechanical adjustment device.

3.3.3 Correction device

Meters may be fitted with correction devices; such devices are always considered as an integral part of the meter. The whole of the requirements which apply to the meter, in particular the maximum permissible errors specified in 3.2, are therefore applicable to the corrected volume at metering conditions.

In normal operation, non-corrected volume shall not be displayed.

The aim of a correction device is to reduce the errors (of indication) to as close to zero as possible. Water meters with correction devices shall satisfy the performance tests of A.5.

All the parameters which are not measured and which are necessary for correcting shall be contained in the calculator at the beginning of the measurement operation. The type approval certificate may prescribe the possibility of checking parameters which are necessary for correctness at the time of verification of the correction device.

The correction device shall not allow the correction of a pre-estimated drift, for example in relation to time or volume.

Associated measuring instruments, if any, shall comply with the applicable International Standards or Recommendations. Their accuracy shall be good enough to permit the requirements on the meter to be met, as specified in 3.2.

Associated measuring instruments shall be fitted with checking devices, as specified in B.6.

Correction devices shall not be used for adjusting the errors (of indication) of a water meter to values other than as close as practical to zero, even when these values are within the maximum permissible errors.

Any adjustment shall be performed in such a way as to adjust the errors (of indication) of a water meter to values as close as practical to zero so that the meter may not exploit the mpe or systematically favour any party.

Conditioning of the water at flow rates below Q_1 by means of a moving device, e.g. spring-loaded flow accelerator, shall not be permitted.

3.3.4 Calculator

All parameters necessary for the elaboration of indications that are subject to legal metrological control, such as a calculation table or correction polynomial, shall be present in the calculator at the beginning of the measurement operation.

The calculator may be provided with interfaces permitting the coupling of peripheral equipment. When these interfaces are used, the water meter's hardware and software shall continue to function correctly and its metrological functions shall not be capable of being affected.

3.3.5 Indicating device

The indicating device shall display the volume either continuously, periodically or on demand. It shall be readily available to read.

3.3.6 Ancillary devices

In addition to the indicating devices described in 5.7.2, a water meter may include the ancillary devices described in 2.1.8.

Where national regulations permit, a remote reading device may be used for testing and verification and for remote reading of the water meter, provided that other means guarantee the satisfactory operation of the water meter.

The addition of these devices, either temporary or permanent, shall not alter the metrological characteristics of the meter.

Do we want a clause about detecting activity of the flow sensor (CEN 4.4.5/ISO 5.6.5)?

4 Water meters equipped with electronic devices

4.1 General requirements

4.1.1 Water meters with electronic devices shall be designed and manufactured in such a way that significant faults do not occur when they are exposed to the disturbances specified in A.5.

These requirements shall be met durably.

4.1.2 Water meters with electronic devices shall be provided with the checking facilities specified in Annex B, except in the case of non-resettable measurements between two constant partners.

All water meters equipped with checking facilities shall prevent or detect reverse flow, as specified in 3.2.6.

4.1.3 Water meters equipped with checking facilities are presumed to comply with the requirements in 3.2 and 4.1.1 if they pass the design inspection and performance tests specified in 6.2.14.1 and 6.2.14.2.

4.1.4 Water meters not equipped with checking facilities are presumed to comply with the requirements in 3.2 and 4.1.1 if they pass the design inspection and performance tests specified in 6.2.14.1 and 6.2.14.2 in the following conditions:

- five identical meters are submitted at pattern approval;
- at least one of these five meters is submitted to the whole set of tests; and

- no meter fails any test.

4.1.5 The meter shall also provide visual checking of the entire display which shall have the following sequence:

- displaying all the elements (e.g. an “eights” test); and
- blanking all the elements (a “blanks” test).

Each step of the sequence shall last at least one second.

4.2 Power supply

Three different kinds of basic power supplies for water meters with electronic devices are covered by this Standard/Recommendation:

- external power supply;
- non-replaceable battery; and
- replaceable battery.

These three types of power supplies may be used alone or in combination. The requirements for each type of power supply are covered by the following paragraphs.

4.2.1 External power supply

4.2.1.1 Water meters with electronic devices shall be designed such that in the event of an external power supply failure (AC or DC), the meter indication of volume just before failure is not lost, and remains accessible for a minimum of one year.

The corresponding memorization shall occur at least either once per day or for every volume equivalent to 10 minutes of flow at Q_3 .

4.2.1.2 Any other properties or parameters of the meter shall not be affected by an interruption of the electrical supply.

NOTE Compliance with this clause will not necessarily ensure that the water meter will continue to register the volume consumed during a power supply failure.

4.2.1.3 The power supply shall be capable of being secured from tampering.

4.2.2 Non-replaceable battery

The manufacturer shall ensure that the indicated lifetime of the battery guarantees that the meter functions correctly for at least one year longer than the operational lifetime of the meter.

NOTE It is anticipated that a combination of specified maximum allowable total volume registered, displayed volume, indicated operational lifetime, remote reading and extreme temperatures will be considered when specifying a battery and during type approval.

4.2.3 Replaceable battery

4.2.3.1 Where the electrical power supply is a replaceable battery, the manufacturer shall give precise rules for the replacement of the battery.

4.2.3.2 The replacement date of the battery shall be indicated on the meter.

4.2.3.3 The properties and parameters of the meter shall not be affected by the interruption of the electrical supply when the battery is replaced.

NOTE It is anticipated that a combination of specified maximum allowable total volume registered, displayed volume, indicated operational lifetime, remote reading and extreme temperatures will be considered when specifying a battery and during type approval.

4.2.3.4 The operation of replacing the battery shall be carried out in a way that does not necessitate breaking the seal required for statutory metrological inspections.

4.2.3.5 The battery compartment shall be capable of being secured from tampering.

5 Technical requirements

5.1 Materials and construction of water meters

5.1.1 The water meter shall be manufactured from materials of adequate strength and durability for the purpose for which the water meter is to be used.

5.1.2 The water meter shall be manufactured from materials which shall not be adversely affected by the water temperature variations, within the working temperature range (see 5.4).

5.1.3 All parts of the water meter in contact with the water flowing through it shall be manufactured from materials which are conventionally known to be non-toxic, non-contaminating and biologically inert¹⁾.

5.1.4 The complete water meter shall be manufactured from materials which are resistant to internal and external corrosion, or which are protected by a suitable surface treatment.

5.1.5 The water meter indicating device shall be protected by a transparent window. A cover of a suitable type may also be provided as additional protection.

5.1.6 The water meter shall incorporate devices for elimination of condensation, where there is a risk of condensation forming on the underside of the window of the water meter indicating device.

5.1.7 A water meter shall be of such design, composition and construction that, under normal conditions of use, it is able to measure accurately and does not facilitate the perpetration of fraud.

5.1.8 A water meter shall be fitted with a metrologically controlled display. The display shall be readily accessible to the customer. The water utility or water provider shall make available to the customer any special tool that is required to access the meter.

5.2 Adjustment and correction

5.2.1 The water meter may be fitted with an adjustment device, and/or a correction device.

5.2.2 If these devices are mounted on the outside of the water meter, provision for sealing shall be made (see 5.8.2).

1) National regulations shall apply.

5.3 Installation conditions

Renumber footnotes

5.3.1 A water meter shall be installed such that it is completely filled with water under normal conditions.

5.3.2 If the accuracy of the water meter is likely to be affected by the presence of solid particles in the water (turbine and displacement type water meters, for example), it shall be provided with a strainer or filter, fitted at its inlet or in the upstream pipeline²⁾.

5.3.3 Provision may be made on the water meter to allow the water meter to be correctly leveled during installation³⁾.

5.3.4 If the accuracy of the water meter is affected by disturbances in the upstream or downstream pipeline (for example due to the presence of bends, valves or pumps), the water meter shall be provided with a sufficient number of straight pipe lengths, with or without a flow straightener, as specified by the manufacturer, that the indications of the installed water meter meet the requirements of 3.2.1 or 3.2.2 with respect to the maximum permissible errors and according to the accuracy class of the meter.

5.3.5 Flow profile sensitivity classes

The water meter shall be able to withstand the influence of disturbed velocity fields as defined in the test procedures in Part 2. During the application of these flow disturbances the error (of indication) shall meet the requirements of 3.2.1 or 3.2.2.

The meter manufacturer shall specify the flow profile sensitivity class in accordance with Tables 2 and 3.

Any specific flow conditioning section, including straightener and/or straight lengths, to be used shall be prescribed by the manufacturer.

2) Installation engineers should note that solid particles will collect in the water meter, for example, following work on the pipework upstream from the meter.

3) This can be a flat vertical or horizontal surface against which a temporary, or permanent, level indicating device e.g. spirit level, can be placed.

Table 2 — Sensitivity to the irregularity in the upstream velocity field classes (U)

Class	Required straight lengths (x DN)	Straightener needed
U0	0	No
U3	3	No
U5	5	No
U10	10	No
U15	15	No
U0S	0	Yes
U3S	3	Yes
U5S	5	Yes
U10S	10	Yes

Table 3 — Sensitivity to the irregularity in the downstream velocity fields classes (D)

Class	Required straight lengths (x DN)	Straightener needed
D0	0	No
D3	3	No
D5	5	No
D0S	0	Yes
D3S	3	Yes

5.4 Rated operating conditions

The rated operating conditions for a water meter shall be as follows:

Flowrate range:	Q_1 to Q_3 inclusive;
Ambient temperature range:	+ 5 °C to + 55 °C;
Water temperature range:	Refer to Table 1 - Meter temperature classes - clause 3.2.3
Ambient relative humidity range:	0 % to 100 %, except for remote indicating devices where the range shall be 0 % to 93 %;
Working pressure range:	0.03 MPa (0.3 bar) ⁴⁾ to at least 1 MPa (10 bar), except for meters of DN ≥ 300, where the maximum admissible pressure (MAP) shall be at least 0.6 MPa (6 bar).

5.5 Pressure loss

The pressure loss through the water meter, including its filter where the latter forms an integral part of the water meter, shall not be greater than 0.063 MPa (0.63 bar)⁵⁾ between Q_1 and Q_3 .

4) The unit bar may be used where national regulations permit.

NOTE The maximum pressure loss can differ from, and may exceed, the pressure loss at the permanent flowrate Q_3 .

5.6 Marks and inscriptions

A place shall be provided for affixing the main verification mark, which shall be visible without dismantling the water meter.

The water meter shall be clearly and indelibly marked with the following information, either grouped or distributed, on the casing, the indicating device dial, an identification plate, or the meter cover if it is not detachable.

NOTE 1 In the case of a combination meter, the markings below refer to the combination meter.

NOTE 2 An example of the required marks and inscriptions is given in Part 2.

- a) Unit of measurement;
- b) Accuracy class, where it differs from accuracy class 2;
- c) Numerical value of Q_3 and the ratio Q_3/Q_1 (preceded by "R", e.g. "R160"): if the meter measures reverse flow and Q_3 and the ratio Q_3/Q_1 are different in the two directions, both values of Q_3 and Q_3/Q_1 shall be inscribed; the direction of flow to which each pair of values refers shall be clear;
- d) Type approval sign according to national regulations;
- e) Name or trademark of the manufacturer;
- f) Year of manufacture (or the last 2 digits of the year of manufacture) and serial number (as near as possible to the indicating device);
- g) Direction of flow (shown on both sides of the body; or on one side only provided the direction of flow arrow will be easily visible under all circumstances);
- h) Maximum admissible pressure (MAP) if it exceeds 1 MPa (10 bar)⁵⁾ or 0.6 MPa (6 bar) for $DN \geq 500$;
- i) Letter V or H, if the meter can only be operated in the vertical or horizontal position;
- j) The temperature class as specified in Table 1 where it differs from T30;
- k) The pressure loss class where it differs from $\Delta P 63$ (see Part 4), and
- l) The installation sensitivity class where it differs from U0/D0.

For water meters with electronic devices, the following additional inscriptions shall be applied where appropriate:

- m) For an external power supply: the voltage and frequency;
- n) For a replaceable battery: the latest date that the battery is to be replaced; and
- o) For a non-replaceable battery: the latest date by which the meter is to be replaced.

5) The unit bar may be used where national regulations permit.

p) Climatic and mechanical environmental severity level

q) EMC class

NOTE 3 The climatic and environmental severity level and EMC class may be given on a separate datasheet, unambiguously related to the meter by a unique identification, and not on the meter itself.

5.7 Indicating device

5.7.1 General requirements

5.7.1.1 Function

The indicating device of the water meter shall provide an easily read, reliable and unambiguous visual indication of the indicated volume. A combination meter may have two indicating devices, the sum of which provides the indicated volume.

The indicating device shall include visual means for testing and calibration.

The indicating device may include additional elements for testing and calibration by other methods, e.g. for automatic testing and calibration.

5.7.1.2 Unit of measurement, symbol and its placement

The indicated volume of water shall be expressed in cubic metres. The symbol m^3 shall appear on the dial or immediately adjacent to the numbered display.

If units of measurement outside the SI are required by a country's national regulations, these units of measurement shall be considered acceptable for indications in that country. In international trade, the officially agreed equivalents between these units of measurement and those of the SI shall be applied.

5.7.1.3 Indicating range

The indicating device shall be able to record the indicated volume in cubic metres corresponding to at least 1 580 hours of operation at the permanent flowrate Q_3 , without passing through zero. This provision is formulated in Table 4.

Table 4 — Indicating range of a water meter

Q_3 m^3/h	Indicating range (minimum values) m^3
$Q_3 \leq 0.3$	9 999
$0.3 < Q_3 \leq 3$	99 999
$3 < Q_3 \leq 30$	999 999
$30 < Q_3 \leq 300$	9 999 999

5.7.1.4 Colour coding for indicating devices

The colour black should be used to indicate the cubic metre and its multiples.

The colour red should be used to indicate sub-multiples of a cubic metre.

These colours shall be applied to either pointers, indexes, numbers, wheels, discs, dials or to the aperture frames.

Other means of indicating the cubic metre, its multiples and its sub-multiples may be used for water meters, provided there is no ambiguity in distinguishing between the primary indication and alternative displays, e.g. sub-multiples for verification and testing.

5.7.2 Types of indicating device

Any of the following types shall be used.

5.7.2.1 Type 1 - Analogue device

The indicated volume is indicated by continuous movement of:

- a) one or more pointers moving relative to graduated scales;
- b) one or more circular scales or drums each passing an index.

The value expressed in cubic metres for each scale division shall be of the form 10^n , where n is a positive or negative whole number or zero, thereby establishing a system of consecutive decades. Each scale shall either be graduated in values expressed in cubic metres or accompanied by a multiplying factor (x 0.001; x 0,01; x 0,1; x 1; x 10; x 100; x 1000, etc.)

Rotational movement of the pointers or circular scales shall be clockwise.

Linear movement of pointers or scales shall be left to right.

Movement of numbered roller indicators (drums) shall be upwards.

5.7.2.2 Type 2 - Digital device

The indicated volume shall be given by a line of adjacent digits appearing in one or more apertures. These digits may be shown from a mechanical or electronic display. The advance of a given digit shall be completed while the digit of the next immediately lower decade changes from 9 to 0.

Movement of numbered roller indicators (drums) shall be upwards.

The lowest value decade may have a continuous movement, the aperture being large enough to permit a digit to be read unambiguously.

The apparent height of the digits shall be at least 4 mm.

5.7.2.3 Type 3 - Combination of analogue and digital devices

The indicated volume is given by a combination of type 1 and type 2 devices and the respective requirements of each shall apply.

5.7.3 Verification devices - First element of an indicating device - Verification scale interval

5.7.3.1 General requirements

Every indicating device shall provide means for visual, non-ambiguous verification testing and calibration.

The visual verification display may have either a continuous or a discontinuous movement.

In addition to the visual verification display, an indicating device may include provisions for rapid testing by the inclusion of complementary elements (e.g. star wheels or discs), providing signals through externally attached sensors.

5.7.3.2 Visual verification displays

5.7.3.2.1 Value of the verification scale interval

The value of the verification scale interval expressed in cubic metres shall be of the form: 1×10^n , or 2×10^n or 5×10^n , where n is a positive or negative whole number, or zero.

For analogue and digital indicating devices with continuous movement of the first element, the verification scale may be formed from the division into 2, 5 or 10 equal parts of the interval between two consecutive digits of the first element. Numbering shall not be applied to these divisions.

For digital indicating devices with discontinuous movement of the first element, the verification scale interval is the interval between two consecutive digits or incremental movements of the first element.

5.7.3.2.2 Form of the verification scale

On indicating devices with continuous movement of the first element, the apparent scale spacing shall not be less than 1 mm and not more than 5 mm. The scale shall consist of:

- either lines of equal thickness not exceeding one-quarter of the scale spacing and differing only in length; or
- contrasting bands of a constant width equal to the scale spacing.

The apparent width of the pointer at its tip shall not exceed one-quarter of the scale spacing and in no case shall it be greater than 0.5 mm.

5.7.3.2.3 Resolution of the indicating device

The sub-divisions of the verification scale shall be small enough to ensure that the resolution error of the indicating device does not exceed 0.25 % for accuracy class 1 meters, and 0.5 % for accuracy class 2 meters, of the volume passed during 1 hour 30 minutes at the minimum flowrate Q_1 .

Additional verification elements may be used provided that the uncertainty of reading is not greater than 0.25 % of the test volume for accuracy class 1 meters and 0.5 % of the test volume for accuracy class 2 meters and that the correct functioning of the register is checked.

When the display of the first element is continuous, an allowance shall be made for a maximum error in each reading of not more than half the verification scale interval.

When the display of the first element is discontinuous, an allowance shall be made for a maximum error in each reading of not more than one digit of the verification scale.

Delete these last two paragraphs, because they are both in Part 2?

5.7.3.3 Combination meters

For combination meters with two indicating devices, clauses 5.7.3.1 and 5.7.3.2 apply to both indicating devices.

5.8 Verification marks and protection devices

5.8.1 A place shall be provided on water meters for affixing the main verification mark, which shall be visible without dismantling the water meter.

5.8.2 Water meters shall include protection devices which can be sealed so as to prevent, both before and after correct installation of the water meter, dismantling or modification of the meter, its adjustment device or its correction device, without damaging these devices. In the case of combination meters, this requirement applies to both meters.

The display of the total quantity supplied or the displays from which the total quantity supplied can be derived shall not be resettable while the meter is in service to a single customer.

5.8.3 Electronic sealing devices

5.8.3.1 When access to parameters that influence the determination of the results of measurements is not protected by mechanical sealing devices, the protection shall fulfil the following provisions:

- a) Access shall only be allowed to authorized people, e.g. by means of a code (key-word) or of a special device (e.g. a hard key). The code shall be capable of being changed; and
- b) It shall be possible for at least the last intervention to be memorized. The record shall include the date and a characteristic element identifying the authorized person making the intervention (see (a) above). The traceability of the last intervention shall be assured for at least two years, if it is not overwritten on the occasion of a further intervention. If it is possible to memorize more than one intervention and if deletion of a previous intervention must occur to permit a new record, the oldest record shall be deleted.

5.8.3.2 For meters with parts which may be disconnected one from another by the user and which are inter-changeable, the following provisions shall be fulfilled:

- a) It shall not be possible to access parameters that participate in the determination of results of measurements through disconnected points unless the provisions in 5.8.3.1 are fulfilled; and
- b) Interposing any device which may influence the accuracy shall be prevented by means of electronic and data processing securities or, if this is not possible, by mechanical means.

5.8.3.3 For meters with parts which may be disconnected one from another by the user and which are not interchangeable, the provisions in 5.8.3.2 shall apply. Moreover, these meters shall be provided with devices/means which do not allow them to operate if the various parts are not connected according to the approved type.

NOTE Disconnections which are not allowed to the user may be prevented, for example, by means of a device that prevents any measurement after disconnecting and reconnecting.

6 Metrological controls

6.1 Reference conditions

All influence quantities, except for the influence quantity being tested, shall be held to their reference conditions. The reference conditions (including their tolerances) are given in ISO 4064-2/R 49-2, 3. Values are specified for flowrate, water temperature, water pressure, ambient temperature, ambient relative humidity, and ambient atmospheric pressure.

6.2 Type approval

6.2.1 Before undergoing type evaluation tests, each type of water meter submitted shall be examined externally to ensure that it complies with the provisions of the relevant preceding clauses of this Standard/Recommendation.

6.2.2 The evaluation tests shall be made on the minimum number of samples of each type shown in Table 5 as a function of the water meter designation Q_3 of the type presented.

The service responsible for type evaluation may request further specimens.

Table 5 — Number of water meters to be tested

Meter designation Q_3 (m ³ /h)	Minimum number of meters
$Q_3 \leq 160$	3
$160 < Q_3 \leq 1\,600$	2
$1\,600 < Q_3$	1

Additional samples are required for meters equipped with electronic devices but not equipped with checking facilities (see 4.1.4).

The requirements of 3.2.1 or 3.2.2 shall apply to all the meters tested, according to the accuracy class of the meter.

6.2.3 Errors (of indication)

6.2.3.1 The errors (of indication) of the water meter (in the measurement of the reference volume) shall be determined at least at the following flowrates (ISO 4064-2/OIML R49-2, 6.3.4):

- a) $1.05Q_1$;
- b) $1.05Q_2$;
- c) $0.35 (Q_2 + Q_3)$;
- d) $0.705 (Q_2 + Q_3)$;
- e) $0.95 Q_3$; and
- f) $0.975 Q_4$;

and for combination meters:

- g) $0.9 Q_{x1}$
- h) $1.1 Q_{x2}$

I have omitted old 6.2.4.3. Is this right?

6.2.3.2 The meter shall be repeatable: the standard deviation of three measurements at the same flowrate shall not exceed one third of the maximum permissible errors given in 3.2.1 or 3.2.2.

6.2.4 The water meter shall be capable of withstanding the following test pressures without leakage or damage:

- 1.6 times the maximum admissible pressure applied for 15 minutes; and
- twice the maximum admissible pressure applied for 1 minute.

6.2.5 Overload temperature tests

Water meters with $MAT \geq 50\text{ }^{\circ}\text{C}$ shall be capable of withstanding a water temperature of $MAT+10\text{ }^{\circ}\text{C}$ for one hour.

6.2.6 The water meter shall undergo the endurance tests detailed in Table 6, according to the permanent flowrate Q_3 and the overload flowrate Q_4 of the meter, simulating service conditions.

After each of these tests the errors of the water meter shall again be measured at the flowrates given in 6.2.3.1 and the criteria given in 6.2.6.1 or 6.2.6.2 shall be applied.

The orientation(s) of the meters on test shall be set with reference to the meter orientation(s) claimed by the manufacturer.

Does this sentence relate to the whole of 6.2?

6.2.6.1 Accuracy class 1 water meters

For accuracy class 1 water meters, the variation in the error (of indication) curve shall not exceed 2 % for flowrates in the lower flowrate zone ($Q_1 \leq Q < Q_2$), and 1 % for flowrates in the upper flowrate zone ($Q_2 \leq Q \leq Q_4$).

For flowrates in the lower flowrate zone ($Q_1 \leq Q < Q_2$), the error (of indication) curve shall not exceed a maximum error limit of $\pm 4\text{ %}$ for all temperature classes. For flowrates in the upper flowrate zone ($Q_2 \leq Q \leq Q_4$), the error (of indication) curve shall not exceed a maximum error limit of $\pm 1.5\text{ %}$ for meters of temperature class T30 and $\pm 2.5\text{ %}$ for all other temperature classes.

For the purpose of these requirements the mean values of the errors (of indication) shall apply.

6.2.6.2 Accuracy class 2 water meters

For accuracy class 2 water meters, the variation in the error (of indication) curve shall not exceed 3 % for flowrates in the lower flowrate zone ($Q_1 \leq Q < Q_2$), and 1.5 % for flowrates in the upper flowrate zone ($Q_2 \leq Q \leq Q_4$).

For flowrates in the lower flowrate zone ($Q_1 \leq Q < Q_2$), the error (of indication) curve shall not exceed a maximum error limit of $\pm 6\text{ %}$ for all temperature classes. For flowrates in the upper flowrate zone ($Q_2 \leq Q \leq Q_4$), the error (of indication) curve shall not exceed a maximum error limit of $\pm 2.5\text{ %}$ for meters of temperature class T30 and $\pm 3.5\text{ %}$ for all other temperature classes.

For the purpose of these requirements the mean values of the errors (of indication) shall apply.

Table 6 Endurance tests

Temperature Class	Permanent flowrate Q_3	Test flow-rate	Test water temperature $\pm 5\text{ }^{\circ}\text{C}$	Type of test	Number of interrupts	Time of pauses	Time of test at test flowrate	Duration of start-up and rundown
T30 and T50	$Q_3 \leq 16\text{ m}^3/\text{h}$	Q_3	20 °C	Dis-continuous	100 000	15 s	15 s	0.15 [Q_3] ^{a)} s with a minimum of 1 s
		Q_4	20 °C	Continuous	-	-	100 h	-
	$Q_3 > 16\text{ m}^3/\text{h}$	Q_3	20 °C	Continuous	-	-	800 h	-
		Q_4	20 °C	Continuous	-	-	200 h	-
All other temperature classes	$Q_3 \leq 16\text{ m}^3/\text{h}$	Q_3	50 °C	Dis-continuous	100 000	15 s	15 s	0.15 [Q_3] ^{a)} s with a minimum of 1 s
		Q_4	0.9 × MAT	Continuous	-	-	100 h	-
	$Q_3 > 16\text{ m}^3/\text{h}$	Q_3	50 °C	Continuous	-	-	800 h	-
		Q_4	0.9 × MAT	Continuous	-	-	200 h	-
Combination meters (additional test)	$Q_3 > 16\text{ m}^3/\text{h}$	$Q \geq 2 \cdot Q_{x2}$	20 °C	Dis-continuous	50 000	15 s	15 s	3 to 6 s
Combination meters (where small meter has not been pre-approved)	$Q_3 > 16\text{ m}^3/\text{h}$	0.9 Q_{x1}	20 °C	Continuous	-	-	200 h	-

a) [Q_3] is the number equal to the value of Q_3 expressed in m^3/h .

NOTE Where a combination meter consists of meters that have been previously approved, only the *Combination meters (additional test)* is required.

6.2.7 Interchange error tests

It shall be demonstrated that cartridge meters and measuring inserts for water meters with interchangeable inserts are independent of the connection interfaces for which they are made as far as their metrological performance is concerned.

6.2.8 Static magnetic field test

The water meter shall undergo a test for the influence of a static magnetic field. This test shall apply to all water meters where the mechanical components may be influenced by a magnetic field, and for all meters with electronic components. The test is specified in ISO 4064-2/OIML R 49-2 section 6.12. The purpose of the test is to ensure compliance with the provisions of 3.2 and 4.1.1 in the presence of static magnetic fields.

6.2.9 Documentation

6.2.9.1 The application for type approval of a water meter or a calculator (including indicating device) or a measurement transducer shall include the following documents:

- a description giving the technical characteristics and the principle of operation;
- a drawing or photograph of the complete water meter or calculator or measurement transducer;
- a list of the parts with a description of their constituent materials when these parts have a metrological influence;
- an assembly drawing with identification of the different parts;
- for meters fitted with correction devices, a description of how the correction parameters are determined;
- a drawing showing the location of seals and verification marks; and
- a drawing of regulatory markings.
- for combination meters that comprise approved meters, the test reports for those meters.

6.2.9.2 In addition, the application for type approval of a water meter with electronic devices shall include:

- a functional description of the various electronic devices;
- a flow diagram of the logic, showing the functions of the electronic devices; and
- any document or evidence which shows that the design and construction of the water meter with electronic devices comply with the requirements of this Standard/Recommendation, in particular sections 4.1 and Annex B.

6.2.9.3 The applicant seeking type approval shall provide the body responsible for the evaluation with a meter or a calculator (including indicating device) or a measurement transducer which is representative of the final type.

Additional specimens of the type may be considered necessary by the body responsible for the type evaluation to estimate the reproducibility of the measurements.

All of 6.2.9 and 6.2.10 could be moved to Part 2, but then we would, I think, need to provide tests.

6.2.10 Type approval certificate

The following information shall appear on the type approval certificate:

- name and address of the recipient of the certificate;
- name and address of the manufacturer, if it is not the recipient;
- type and/or commercial designation;
- principal metrological and technical characteristics;
- type approval mark;

- period of validity;
- environmental classification, if applicable (see A.2);
- information on the location of marks for type approval, initial verification and sealing (e.g. a picture or drawing);
- list of documents accompanying the type approval certificate; and
- specific remarks.

When applicable, the version of the metrological part of the evaluated software shall be indicated in the type approval certificate or in its annexes (technical file).

6.2.11 Modification of an approved type

6.2.11.1 The recipient of the type approval shall inform the body responsible for the approval of any modification or addition which concerns an approved type.

6.2.11.2 Modifications and additions shall be subject to a supplementary type approval when they influence, or are likely to influence, the measurement results or the meter's regulatory conditions of use. The body that approved the initial type shall decide to what extent the examinations and tests described below shall be carried out on the modified type in relation to the nature of the modification.

6.2.11.3 If the body that approved the initial type judges that the modifications or additions are not likely to influence the measurement results, this body shall allow, in writing, the modified meters to be presented for initial verification without granting a supplementary type approval.

A new or supplementary type approval must (*shall?*) be issued whenever the modified type no longer fulfils the provisions of the initial type approval.

6.2.12 Type approval of a water meter with electronic devices

6.2.12.1 Design inspection

In addition to the requirements described in the preceding paragraphs, a water meter with electronic devices shall be subject to design inspection. This examination of documents aims at verifying that the design of electronic devices and their checking facilities, if applicable, comply with the provisions of this Standard/Recommendation, clause 4 in particular. It includes:

- a) An examination of the mode of construction and of the electronic sub-systems and components used, to verify their appropriateness for their intended use;
- b) Consideration of faults likely to occur, to verify that in all considered cases these devices comply with the provisions of 4.1 and Annex B; and
- c) Verification of the presence and effectiveness of the test device(s) for the checking facilities, if required.

This might be better in Part 2, but then we would need proper tests.

6.2.12.2 Performance tests

The water meter shall comply with the provisions of 3.2 and 4.1.1 with regard to influence quantities.

a) Performance under the effect of influence factors:

When subjected to the effect of influence factors as provided for in Annex A, the equipment shall continue to operate correctly and the errors (of indication) shall not exceed the applicable maximum permissible errors.

b) Performance under the effect of disturbances:

When subjected to external disturbances as provided for in Annex A, the equipment shall continue to operate correctly, or significant faults shall be detected and acted upon by means of a checking facility.

6.2.12.3 Equipment under test

Where the electronic devices form an integral part of the water meter, tests shall be carried out on the complete water meter.

If the electronic devices of a water meter are in a separate housing, their electronic functions may be tested independently of the measurement transducer of the water meter by simulated signals representative of the normal operation of the meter, in which case the electronic devices shall be tested in their final housing.

In all cases, ancillary equipment may be tested separately.

6.3 Initial verification

6.3.1 Water meters shall undergo the initial verification tests indicated below. This verification shall be carried out after type approval has been granted.

6.3.2 Water meters of the same size and the same type may be tested in series; however in this case the requirements of ISO 4064-2/R 49-2 9.1.3 4) (concerning water meter outlet pressure) shall be met for each water meter, and there shall be no significant interaction between water meters.

6.3.3 The errors (of indication) of the water meters in the measurement of reference volume shall be determined for at least the following flowrates:

- a) $1.05 Q_1$;
- b) $1.05 Q_2$; and
- c) $0.95 Q_3$.
- d) For combination meters, $1.1 Q_{x2}$

However, depending on the shape of the error curve, additional flowrates may be specified in the type approval certificate.

During a test, the water temperature shall be as given in ISO 4064-2/R 49-2 9.1.3 5).

All other influence factors shall be held within the rated operating conditions.

6.3.4 The errors (of indication) determined at each of the above flowrates shall not exceed the maximum permissible errors given in 3.2.1 or 3.2.2.

6.3.5 If all the errors (of indication) of the water meter have the same sign, at least one of the errors shall not exceed one half of the maximum permissible error.

When a test is conducted, the error arising from the resolution of the meter under test shall not exceed the values given in 5.7.3.2.3.

What exactly are we trying to ensure?

Annex A (normative)

Performance tests for water meters with electronic devices

A.1 General

This Annex defines the program of performance tests intended to verify that water meters with electronic devices may perform and function as intended in a specified environment and under specified conditions. Each test indicates, where appropriate, the reference conditions for determining the intrinsic error.

These tests supplement any other prescribed test.

When the effect of one influence quantity is being evaluated, all other influence quantities are to be held relatively constant, at values close to reference conditions (see 6.1 and ISO 4064-2/OIML R49-2, 3).

A.2 Environmental classification (see [3])

For each performance test, typical test conditions are indicated which correspond to the climatic and mechanical environmental conditions to which water meters are usually exposed.

Water meters with electronic devices are divided into three classes according to climatic and mechanical environmental conditions:

- class B for fixed meters installed in a **b**uilding;
- class O for fixed meters installed **o**utdoors; and
- class M for **m**obile meters.

However, the applicant for type approval may indicate specific environmental conditions in the documentation supplied to the metrology service, based on the intended use of the instrument. In this case, the metrology service shall carry out performance tests at severity levels corresponding to these environmental conditions. If type approval is granted, the data plate shall indicate the corresponding limits of use. Manufacturers shall inform potential users of the conditions of use for which the meter is approved. The metrology service shall verify that the conditions of use are met.

A.3 Electromagnetic environments

Water meters with electronic devices are divided into two electromagnetic environments:

- E1 Residential, commercial and light industrial; and
- E2 Industrial.

A.4 Type approval of a calculator

When an electronic calculator (including indicating device) is submitted for separate type approval, type evaluation tests shall be conducted on the calculator (including indicating device) alone, simulating different inputs generated by appropriate standards (e.g. calibrators).

A.4.1 Accuracy tests on the indications of measurement results are required. For this purpose, the error obtained on the indication of the result is calculated considering that the true value is the one which takes into account the value of the simulated quantities applied to inputs of the calculator and using standard methods for calculation. The maximum permissible errors are those given in 3.2.

NOTE An appropriate MPE for a calculator is 1/10 of the MPE of a complete meter. However, this is not a requirement. The requirement is given in 3.2.4.

A.4.2 The examinations and tests for electronic instruments described in 6.2.12 shall be performed.

A.5 Performance tests

The tests indicated in Table A.1 involve the electronic part of the water meter or its devices and may be carried out in any order.

Table A.1 — Tests involving the electronic part of the water meter or its devices

Test		Nature of the influence quantity (by ref. to OIML D 11: 2004)	Severity level for the class			
			B	O	M	D11 clause
A.5.1	Dry heat	Influence factor	3	3	3	10.1.1
A.5.2	Cold	Influence factor	1	3	3	10.1.2
A.5.3	Damp heat, cyclic	Disturbance	1	2	2	10.2.2
A.5.4.a	Mains voltage variation	Influence factor	1	1	1	13.1&13.2
A.5.4.b	Mains frequency variation	Influence factor	1	1	1	13.3
A.5.4.c	Low voltage of internal battery (not connected to the mains power)	Influence factor	-	-	-	14.1
A.5.5	Vibration (random)	Disturbance	-	-	2	11.1.1
A.5.6	Mechanical shock	Disturbance	-	-	2	11.2
A.5.7	AC mains voltage dips, short interruption voltage variations	Disturbance	2 or 3	2 or 3	2 or 3	13.4
A.5.8.a	Bursts on signal, data and control lines	Disturbance	2 or 3	2 or 3	2 or 3	12.4
A.5.8.b	Bursts (transients) on AC and DC mains	Disturbance	2 or 3	2 or 3	2 or 3	13.5
A.5.9	Electrostatic discharge	Disturbance	3	3	3	12.2
A.5.10	Radiated, radio-frequency, electromagnetic fields					
	Electromagnetic fields of general origin	Disturbance	2 or 3	2 or 3	2 or 3	12.1.1/1
	Electromagnetic fields specifically caused by digital radio telephones	Disturbance	3 or 4	3 or 4	3 or 4	12.1.1/2
A.5.11.a	Surges on signal, data and control lines	Disturbance	3	3	3	12.5
A.5.11.b	Surges on AC and DC mains power lines	Disturbance	3	3	3	13.8

A.5.1 Dry heat

Test method:	Dry heat (non condensing) (see ISO 4064-2/OIML R49-2, 7.2)
Object of the test:	To verify compliance with the provisions in 3.2 under conditions of high temperature

A.5.2 Cold

Test method:	Cold (see ISO 4064-2/OIML R49-2, 7.3)
Object of the test:	To verify compliance with the provisions in 3.2 under conditions of low temperature

A.5.3 Damp heat cyclic (condensing)

Test method:	Damp heat, cyclic (see ISO 4064-2/OIML R49-2, 7.4)
Object of the test:	<p>To verify compliance with the provisions in 4.1.1 under conditions of high humidity when combined with cyclic temperature changes.</p> <p><i>For consistency with Part 2 '4.1.1' should be '3.2'.</i></p> <p>Cyclic tests shall be applied in all the cases where condensation is important or when the penetration of vapour will be accelerated by the breathing effect.</p>

A.5.4.a.1 DC mains voltage variation (if relevant)

Test method:	Variation in DC mains power voltage (see ISO 4064-2/OIML R49-2, 7.5)
Object of the test:	To verify compliance with the provisions in 3.2 under conditions of varying DC mains power voltage (if relevant).

A.5.4.a.2 AC mains voltage variation

Test method:	Variation in AC mains power voltage (single phase) (see ISO 4064-2/OIML R49-2, 7.5)
Object of the test:	To verify compliance with the provisions in 3.2 under conditions of varying AC mains power voltage (if relevant).

A.5.4.b AC mains frequency variation

Test method	Variation in AC mains power frequency (see ISO 4064-2/OIML R49-2, 7.5)
Object of the test	To verify compliance with the provisions in 3.2 under conditions of varying AC mains power frequency (if relevant).

A.5.4.c Voltage of internal battery (if relevant)

Test method	Variation in battery voltage (see ISO 4064-2/OIML R49-2, 7.5)
Object of the test	To verify compliance with the provisions in 3.2 under conditions of varying battery voltage (if relevant).

A.5.5 Vibration (random)

Test method:	Random vibration (see ISO 4064-2/OIML R49-2, 7.6)
Object of the test:	To verify compliance with the provisions in 3.2 under conditions of random vibration.

A.5.6 Mechanical shock

Test method:	Mechanical shock (see ISO 4064-2/OIML R49-2, 7.7)
Object of the test:	To verify compliance with the provisions in 3.2 under conditions of mechanical shocks. This test should normally apply to mobile installations only.

A.5.7 AC mains voltage dips, short interruptions, and voltage variations

Test method:	Short-time reductions in mains voltage (see ISO 4064-2/OIML R49-2, 7.8)
Object of the test:	To verify compliance with the provisions in 4.1.1 under conditions of short time mains voltage reductions.

A.5.8.a Bursts on signal lines

Test method:	Electrical bursts (see ISO 4064-2/OIML R49-2, 7.9)
Object of the test:	To verify compliance with the provisions in 4.1.1 under conditions where electrical bursts are superimposed on the mains voltage and if applicable on input/output and communication ports.

A.5.8.b Bursts (transients) on AC and DC mains

Test method:	Electrical bursts (see ISO 4064-2/OIML R49-2, 7.10)
Object of the test:	To verify compliance with the provisions in 4.1.1 under conditions where electrical bursts are superimposed on the mains voltage and if applicable on input/output and communication ports.

A.5.9 Electrostatic discharge

Test method:	Electrostatic discharge (ESD) (see ISO 4064-2/OIML R49-2, 7.11)
Object of the test:	To verify compliance with the provisions in 4.1.1 under conditions of direct and indirect electrostatic discharges.

A.5.10 Radio frequency immunity

Test method:	Radiated electromagnetic fields (see ISO 4064-2/OIML R49-2, 7.12)
Object of the test:	<p>To verify compliance with the provisions in 4.1.1 under conditions of electromagnetic fields:</p> <p>Radiated, radio frequency, electromagnetic fields of general origin</p> <p>Radiated, radio frequency, electromagnetic fields caused by digital radio telephones</p>

A.5.11.a Surges on signal, data and control lines

Test method:	Electrical surges (see ISO 4064-2/OIML R49-2, 7.13)
Object of the test:	To verify compliance with the provisions in 4.1.1 under conditions where electrical surges are superimposed on I/O and communication ports.

A.5.11.b Surges on AC and DC mains power lines

Test method:	Electrical surges (see ISO 4064-2/OIML R49-2, 7.14)
Object of the test:	To verify compliance with the provisions in 4.1.1 under conditions where electrical surges are superimposed on the mains voltage.

Annex B (normative)

Checking facilities

B.1 Action of checking facilities

The detection by the checking facilities of significant faults shall result in the following actions, according to the type:

For checking facilities of type P or I:

- automatic correction of the fault; or
- stopping only the faulty device when the water meter without that device continues to comply with the regulations; or
- a visible or audible alarm; this alarm shall continue until the cause of the alarm is suppressed.

In addition, when the water meter transmits data to peripheral equipment, the transmission shall be accompanied by a message indicating the presence of a fault. (This requirement is not applicable to the application of disturbances specified in A.5).

The instrument may also be provided with devices to estimate the volume of water having passed through the installation during the occurrence of the fault. The result of this estimate shall not be capable of being mistaken for a valid indication.

The visible or audible alarm is not allowed in the case of two constant partners, non-resettable and non-prepaid measurements, where checking facilities are used, unless this alarm is transferred to a remote station.

NOTE The transmission of the alarm and repeated measured values from the meter to the remote station need not be secured if the measured values are repeated at that station.

B.2 Checking facilities for the measurement transducer

The objective of these checking facilities is to verify the presence of the measurement transducer, its correct operation and the correctness of data transmission.

The verification of correct operation includes detection or prevention of reverse flow. However, it is not necessary for the detection or prevention of reverse flow to be operated electronically.

B.2.1 When the signals generated by the flow sensor are in the form of pulses, each pulse representing an elementary volume, the pulse generation, transmission and counting shall fulfil the following tasks:

- correct counting of pulses;
- detection of reverse flow, if necessary; and
- checking of correct function.

This may be done by means of:

- three-pulse system with use of either pulse edges or pulse status;
- double-pulse line system with use of pulse edges plus pulse status; and
- double-pulse system with positive and negative pulses depending on the flow direction.

These checking facilities shall be of type P.

It shall be possible during type approval to verify that these checking facilities function correctly:

- by disconnecting the transducer; or
- by interrupting one of the sensor's pulse generators; or
- by interrupting the electrical supply of the transducer.

B.2.2 For electromagnetic meters only, where the amplitude of the signals generated by the measurement transducer is proportional to the flowrate, the following procedure may be used:

A simulated signal with a shape similar to that of the measurement signal is fed into the input of the secondary device, representing a flowrate between the minimum and maximum flowrates of the meter. The checking facility shall check the primary and the secondary device. The equivalent digital value is checked to verify that it is within predetermined limits given by the manufacturer and consistent with the maximum permissible errors. This checking facility shall be of type P or I. For type I facilities, checking shall occur at least every five minutes.

NOTE Following this procedure, additional checking facilities (more than two electrodes, double signal transmission, etc.) are not required.

B.2.3 The maximum permissible cable length between primary and secondary devices of an electromagnetic meter, as defined in ISO 6817:1992 [6], shall be not more than 100 metres or not more than the value L expressed in metres according to the following formula, whichever is smaller:

$$L = (k \times c) / (f \times C)$$

where:

$$k = 2 \times 10^{-5} \text{ m};$$

c is the conductivity of the water, in S/m;

f is the field frequency during the measuring cycle, in Hz; and

C is the effective cable capacitance per metre, in F/m.

It is not necessary to fulfil these requirements if the manufacturer's solutions ensure equivalent results.

B.2.4 For other technologies, checking facilities providing equivalent levels of security remain to be developed.

B.3 Checking facilities for the calculator

The objective of these checking facilities is to verify that the calculator system functions correctly and to ensure the validity of the calculations made.

No special means are required for indicating that these checking facilities function correctly.

B.3.1 The checking facilities for the functioning of the calculation system shall be of type P or I. For type I the checking must occur at least either once per day or for every volume equivalent to 10 minutes of flow at Q_3 . The objective of this checking facility is to verify that:

- a) the values of all permanently memorized instructions and data are correct, by such means as:
 - summing up all instruction and data codes and comparing the sum with a fixed value;
 - line and column parity bits (longitudinal redundancy check and vertical redundancy check);
 - cyclic redundancy check (CRC 16);
 - double independent storage of data; and
 - storage of data in “safe coding”, for example protected by checksum, line and column parity bits.
- b) all procedures of internal transfer and storage of data relevant to the measurement result are performed correctly, by such means as:
 - write-read routine;
 - conversion and re-conversion of codes;
 - use of “safe coding” (checksum, parity bit); and
 - double storage.

B.3.2 The checking facilities for the validity of calculations shall be of type P or I. For type I the checking must either occur at least once per day, or for every volume equivalent to 10 minutes of flow at Q_3 .

This consists of checking the correct value of all data related to the measurement whenever these data are internally stored or transmitted to peripheral equipment through an interface. This check may be carried out by such means as parity bit, check sum or double storage. In addition, the calculation system shall be provided with a means of controlling the continuity of the calculation program.

B.4 Checking facility for the indicating device

The objective of this checking facility is to verify that the primary indications are displayed and that they correspond to the data provided by the calculator. In addition, it aims at verifying the presence of the indicating devices when they are removable. These checking facilities shall either have the form as defined in B.4.1 or that as defined in B.4.2.

B.4.1 The checking facility of the indicating device is of type P; however, it may be of type I if a primary indication is provided by another device.

Means may include, for example:

- for indicating devices using incandescent filaments or light emitting diodes, measuring the current in the filaments;
- for indicating devices using fluorescent tubes, measuring the grid voltage; and
- for indicating devices using multiplexed liquid crystals, output checking of the control voltage of segment lines and of common electrodes, so as to detect any disconnection or short circuit between control circuits.

The checks mentioned in 4.1.5 are not necessary.

B.4.2 The checking facility for the indicating device shall include type P or type I checking of the electronic circuits used for the indicating device (except the driving circuits of the display itself); this checking facility shall meet the requirements of B.3.2.

B.4.3 It shall be possible during type approval to determine that the checking facility of the indicating device is working, either:

- by disconnecting all or part of the indicating device; or
- by an action which simulates a failure in the display, such as using a test button.

B.4.4 Although the continuous display of volume is not mandatory (see 3.3.5), interruption of the display shall not interrupt the action of checking facilities.

B.5 Checking facilities for ancillary devices

An ancillary device (repeating device, printing device, memory device, etc.) with primary indications shall include a checking facility of type P or I. The aim of this checking facility is to verify the presence of the ancillary device, when it is a necessary device, and to verify correct functioning and correct transmission.

B.6 Checking facilities for the associated measuring instruments

Associated measuring instruments shall include a checking facility of type P or I. The aim of this checking facility is to ensure that the signal given by these associated instruments is inside a predetermined measuring range.

Examples:

- four wire transmission for resistance type temperature sensors; and
- control of the driving current for 4–20 mA pressure sensors.

Annex C (informative)

Subsequent verification

The maximum permissible errors of a water meter while in service should be twice the maximum permissible errors given in 3.2.1 or 3.2.2 according to the accuracy class of the meter. Although subsequent verification is not covered in the scope of this document, historically this has been found reasonable.

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