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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 4064-1 was prepared jointly by Technical Committee ISO/TC 30, *Measurement of fluid flow in closed conduits*, Subcommittee SC 7, *Volume methods including water meters* and OIML Technical Subcommittee TC 8/SC 5 *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.

This edition of ISO 4064-1 is identical with the corresponding edition of OIML R 49-1, which has been issued concurrently.

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*

The International Organization of Legal Metrology (OIML) is a worldwide, intergovernmental organization whose primary aim is to harmonize the regulations and metrological controls applied by the national metrological services, or related organizations, of its Member States. The two main categories of OIML publications are:

- **International Recommendations (OIML R)**, which are model regulations that establish the metrological characteristics required of certain measuring instruments and which specify methods and equipment for checking their conformity; the OIML Member States shall implement these Recommendations to the greatest possible extent;

- **International Documents (OIML D)**, which are informative in nature and which are intended to harmonize and improve work in the field of legal metrology;

- **International Guides (OIML G)**, which are also informative in nature and intended to give guidelines for the application of certain requirements to legal metrology; and

- **International Basic Publications (OIML B)**, which define the operating rules of the various OIML structures and systems.

OIML Draft Recommendations, Documents and Guides are developed by Technical Committees or Subcommittees which comprise representatives from the Member States. Certain international and regional institutions also participate on a consultation basis. Cooperative agreements have been established between OIML and certain institutions, such as ISO and the IEC, with the objective of avoiding contradictory requirements. Consequently, manufacturers and users of measuring instruments, test laboratories, etc. may simultaneously apply OIML publications and those of other institutions.

International Recommendations, Documents, Guides and Basic Publications are published in English (E) and translated into French (F) and are subject to periodic revision.

Additionally, the OIML publishes or participates in the publication of **Vocabularies (OIML V)** and periodically commissions legal metrology experts to write **Expert Reports (OIML E)**. Expert Reports are intended to provide information and advice, and are written solely from the viewpoint of their author, without the involvement of a Technical Committee or Subcommittee, nor that of the CIML. Thus, they do not necessarily represent the views of the OIML.

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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OIML R49-1 Water meters intended for the metering of cold potable water and hot water — Part 1: Metrological and technical requirements

1 Scope

1.1 This Part of ISO 4064/OIML R 49 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 Part of ISO 4064/OIML R 49 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 Part of ISO 4064/OIML R 49 also applies to water meters based on electrical or electronic principles, and to water meters based on mechanical principles incorporating electronic devices, used to measure the volume flow of hot water and cold potable water. It also applies to electronic ancillary devices. Ancillary devices are optional. However, national or regional regulations may make some ancillary devices mandatory in relation to the utilization of the water meter.

1.4 In addition to the requirements set out in this Part, the methods of examination and testing are included in Part 2, a test report format is given in Part 3, and there are additional technical requirements in Part 4 and installation requirements in Part 5.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4064-2:201x, Water meters intended for the metering of cold potable water and hot water — Part 2: Test methods [≡OIML R 49-2:201x]

3 Terminology

The terminology used in this Part of ISO 4064/OIML R 49 conforms to the *International Vocabulary of Metrology – Basic and General Concepts and Associated Terms (VIM)* [1], the *International Vocabulary of Terms in Legal Metrology (VIML)* [2] and OIML International Document D 11. For clarification, some terms defined in [1-3] have been repeated here, replacing the term “measuring instrument” by the term “meter”.

For the purposes of this Part of ISO 4064/OIML R 49 the following definitions shall apply.

3.1 Water meter and its constituents

3.1.1
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 (see 3.1.16).

NOTE 3 In this Part of ISO 4064/OIML R 49 a water meter is also referred to as a “meter”.

3.1.2
measurement transducer
part of the meter that transforms the flowrate or volume of water to be measured into signals which are passed to the calculator and includes the sensor

NOTE The measurement transducer may function autonomously or use an external power source and may be based on a mechanical, electrical or electronic principle.

3.1.3
sensor
element of a measuring system that is directly affected by a phenomenon, body or substance carrying a quantity to be measured

[VIM:2007, 3.8]

NOTE For a water meter, the sensor may be a disc, piston, wheel, turbine element, electromagnetic coil or other element. It senses the flowrate or volume of water passing through the meter and is referred to as flow sensor or volume sensor.

3.1.4
calculator
part of the meter that transforms the output signals from the measurement transducer(s) and, possibly, from associated measuring instruments and, if appropriate, stores the results in memory until they are used

NOTE The calculator may be capable of communicating both ways with ancillary devices.

3.1.5
indicating device
part of the meter that provides an indication corresponding to the volume of water passing through the meter

NOTE For the definition of the term “indication”, see VIM:2007, 4.1.

3.1.6
adjustment device
part of the meter that allows an adjustment of the meter such that the error curve of the meter is generally shifted parallel to itself to fit in the envelope of the maximum permissible errors

NOTE For the definition of the term “adjustment”, see VIM:2007, 3.11.

3.1.7
correction device
device connected to or incorporated in the meter for automatic correction of the volume of water at metering conditions, by taking into account the flowrate and/or the characteristics of the water to be measured and the pre-established calibration curves

NOTE 1 The characteristics of the water (such as: temperature and pressure) may either be measured using associated measuring instruments, or be stored in a memory in the instrument.

NOTE 2 For the definition of the term “correction”, see VIM:2007, 2.53.

3.1.8
ancillary device
device intended to perform a specific function, directly involved in elaborating, transmitting or displaying measured values

NOTE 1 For the definition of “measured value”, see VIM:2007, 2.10.

NOTE 2 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 incorporated permanently or added temporarily).

NOTE 3 Depending on national legislation, ancillary devices may, or may not be, subject to legal metrological control.

3.1.9
tariff control device
device that allocates measured values into different registers depending on tariff or other criteria, each register having the possibility to be read individually

3.1.10
pre-setting device
device that permits the selection of the quantity of water to be measured and which automatically stops the flow of water after the selected quantity has been measured

3.1.11
associated measuring instrument
instrument connected to the calculator or the correction device for measuring a quantity, characteristic of water, with a view to making a correction and/or a conversion

3.1.12
meter for two constant partners
meter that is permanently installed and only used for deliveries from one supplier to one customer

3.1.13
in-line meter
type of meter that is fitted into a closed conduit by means of the meter end connections provided

NOTE The end connections may be flanged or threaded.

3.1.14
complete meter
meter whose measurement transducer, calculator and indicating device are not separable

3.1.15
combined meter
meter whose measurement transducer, calculator and indicating device are separable.

3.1.16
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

NOTE Meter reading is obtained from two independent totalizers or one totalizer, which adds up the values from both water meters.

3.1.17
equipment under test
EUT
complete meter, sub-assembly or ancillary device that is subjected to a test

3.1.18
concentric meter
type of meter that is fitted into a closed conduit by means of a manifold

NOTE The inlet and outlet passages of the meter and the manifold, at the interface between them, are coaxial.

3.1.19
(concentric meter) manifold
pipe fitting, specific to the connection of a concentric meter

3.1.20
cartridge meter
type of meter that is fitted into a closed conduit by means of an intermediate fitting called a connection interface

NOTE The inlet and outlet passages of the meter and the connection interface are either concentric or axial as detailed in Part 4 of this standard.

3.1.21
cartridge meter connection interface
pipe fitting specific to the connection of an axial or concentric cartridge meter

3.1.22
meter with exchangeable metrological unit
meter with $Q_3 \geq 16$ m^3/h, comprising a connection interface and an exchangeable measuring unit from the same type approval, i.e. from the same manufacturer as a matter of principle

3.1.23
exchangeable metrological unit
self-contained unit comprising a measurement transducer and either an indicating device or a calculator and indicating device

3.1.24
connection interface for meters with exchangeable metrological units
pipe fitting specific to the connection of exchangeable metrological units

3.2 Metrological characteristics

3.2.1
actual volume
V_a
total volume of water passing through the meter, disregarding the time taken

NOTE 1 This is the measurand.

NOTE 2 The actual volume is calculated from a reference volume as determined by a suitable measurement standard, taking into account differences in metering conditions, as appropriate.

3.2.2
indicated volume
V_i
volume of water indicated by the meter, corresponding to the actual volume

3.2.3
primary indication
indication which is subject to legal metrological control

NOTE An indication may be a displayed, printed or memorized value.

3.2.4
error
measured quantity value minus a reference quantity value

[VIM:2007, 2.16]

NOTE 1 For the application of this Part of ISO 4064/OIML R 49 the indicated volume is considered as the measured quantity value and the actual volume as the reference quantity value. The difference between indicated volume and actual volume is referred to as: error (of indication).

NOTE 2 In this Part of ISO 4064/OIML R 49 the error (of indication) is generally expressed as a percentage, and is equal to

$$\frac{V_i - V_a}{V_a} \times 100\,\%$$

3.2.5
maximum permissible error (of indication)
MPE
extreme value of error (of indication) permitted by this Part of ISO 4064/OIML R 49

3.2.6
intrinsic error
error of a meter determined under reference conditions

[OIML D 11:2004, 3.7]

3.2.7
initial intrinsic error
intrinsic error of a meter as determined prior to performance tests and durability evaluations

[OIML D 11:2004, 3.8]

3.2.8
fault
difference between the error (of indication) and the intrinsic error of a meter

[OIML D 11:2004, 3.9]

3.2.9
significant fault
fault greater than the value specified in this Part of ISO 4064/OIML R 49

[OIML D 11:2004, 3.10]

NOTE See 4.1.2.

3.2.10
durability
ability of a meter to maintain its performance characteristics over a period of use

[OIML D 11:2004, 3.17]

3.2.11
metering conditions
conditions of the water, the volume of which is to be measured, at the point of measurement

NOTE Examples: temperature and pressure of the water.

3.2.12
first element of an indicating device
element which, in an indicating device comprising several elements, carries the graduated scale with the verification scale interval

3.2.13
verification scale interval
lowest value scale division of the first element of an indicating device

3.2.14
resolution of a displaying device
smallest difference between displayed indications that can be meaningfully distinguished

[VIM:2007, 4.15]

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

3.3 Operating conditions

3.3.1
flowrate
Q
quotient of the actual volume and the time taken for this volume to pass through the meter

3.3.2
permanent flowrate
Q_3
highest flowrate within the rated operating conditions at which the meter is to operate in a satisfactory manner within the maximum permissible errors

NOTE In this Part of ISO 4064/OIML R 49, flowrate is expressed in m^3/h.

3.3.3
overload flowrate
Q_4
highest flowrate at which the meter is to operate for a short period of time within the maximum permissible errors, whilst maintaining its metrological performance when it is subsequently operating within the rated operating conditions

3.3.4
transitional flowrate
***Q*$_2$**
flowrate between the the permanent flowrate and the minimum flowrate that divides the flowrate range into two zones, the upper flowrate zone and the lower flowrate zone, each characterized by its own maximum permissible errors

3.3.5
minimum flowrate
***Q*$_1$**
lowest flowrate at which the meter is to operate within the maximum permissible errors

3.3.6
combination meter changeover flowrate
***Q*$_x$**
flowrate at which the flow in the larger meter stops with decreasing flowrate (Q_{x1}) or starts with increasing flowrate (Q_{x2})

3.3.7
minimum and maximum admissible temperature
mAT and MAT
minimum and maximum water temperatures that a meter can withstand permanently, within its rated operating conditions, without deterioration of its metrological performance

NOTE mAT and MAT are the lower and upper of the rated operating conditions for temperature respectively.

3.3.8
maximum admissible pressure
MAP
maximum internal pressure that a meter can withstand permanently, within its rated operating conditions, without deterioration of its metrological performance

3.3.9
working temperature
***T*$_w$**
water temperature in the pipe measured upstream of the meter

3.3.10
working pressure
***P*$_w$**
average water pressure in the pipe measured upstream and downstream of the meter

3.3.11
pressure loss
Δp
pressure loss, at a given flowrate, caused by the presence of the meter in the pipeline

3.3.12
test flowrate
mean flowrate during a test, calculated from the indications of a calibrated reference device

3.3.13
nominal diameter
DN
alphanumeric designation of size for components of a pipework system, which is used for reference purposes. It comprises the letters DN followed by a dimensionless whole number which is indirectly related to the physical size, in millimetres, of the bore or outside diameter of the end connections

NOTE 1 The number following the letters DN does not represent a measurable value and should not be used for calculation purposes except where specified in the relevant standard.

NOTE 2 In those standards which use the DN designation system, any relationship between DN and component dimensions should be given, e.g. DN/OD or DN/ID.

3.4 Test conditions

3.4.1
influence quantity
quantity that, in a direct measurement, does not affect the quantity that is actually measured, but affects the relation between the indication and the measurement result

[VIM:2007, 2.52]

NOTE Example: The ambient temperature of the meter is an influence quantity, whereas the temperature of the water passing through the meter affects the measurand.

3.4.2
influence factor
influence quantity having a value within the rated operating conditions specified in this Part of ISO 4064/OIML R 49

[OIML D 11:2004, 3.13.1]

3.4.3
disturbance
influence quantity having a value within the limits specified in this Part of ISO 4064/OIML R 49, but outside the specified rated operating conditions of the meter

[OIML D 11:2004, 3.13.2]

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

3.4.4
rated operating condition
ROC
operating condition that shall be fulfilled during measurement in order that a meter performs as designed

[VIM:2007, 4.9]

NOTE The rated operating conditions specify intervals for the flowrate and for the influence quantities for which the errors (of indication) are required to be within the maximum permissible errors.

3.4.5
reference condition
operating condition prescribed for evaluating the performance of a meter or for comparison of measurement results

[VIM:2007, 4.11]

3.4.6
limiting condition
extreme condition that a meter is required to withstand without damage, and without degradation of specified metrological properties, when it is subsequently operated under its rated operating conditions

[VIM:2007, 4.10]

NOTE Such conditions include: flowrate, temperature, pressure, humidity and electromagnetic interference.

3.4.7
performance test
test intended to verify whether the EUT is able to accomplish its intended functions

[OIML D 11:2004, 3.20.3]

3.4.8
durability test
test intended to verify whether the EUT is able to maintain its performance characteristics over a period of use

[OIML D 11:2004, 3.20.4]

3.4.9
temperature stability
condition in which all parts of the EUT have a temperature within 3 ○C of each other, or as otherwise specified in the relevant specification of its final temperature

3.4.10
preconditioning
treatment of the EUT with the objective of eliminating or partially counteracting the effects of its previous history

NOTE Where called for, this is the first process in a test procedure.

3.4.11
conditioning
exposure of the EUT to an environmental condition (influence factor or disturbance) in order to determine the effect of such a condition on it

3.4.12
recovery
treatment of the EUT, after conditioning, in order that its properties may be stabilized before measurement.

3.5 Electronic and electrical equipment

3.5.1
electronic device
device employing electronic sub-assemblies and performing a specific function, usually manufactured as a separate unit and capable of being independently tested

[OIML D 11:2004, 3.2]

NOTE An electronic device may be a complete meter or a part of a meter, for example as defined in 3.1.1-3.1.5 and 3.1.8.

3.5.2
electronic sub-assembly
part of an electronic device, employing electronic components and having a recognizable function of its own

[OIML D 11:2004, 3.3]

3.5.3
electronic component
smallest physical entity that uses electron or hole conduction in semi-conductors, gases or in a vacuum

[OIML D 11:2004, 3.4]

3.5.4
checking facility
facility that is incorporated in a meter and which enables significant faults to be detected and acted upon

[OIML D 11:2004, 3.18]

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.

3.5.5
automatic checking facility
checking facility that operates without the intervention of an operator

[OIML D 11:2004, 3.18.1]

3.5.6
permanent automatic checking facility (type P)
automatic checking facility that operates at each measurement cycle

[OIML D 11:2004, 3.18.1.1]

3.5.7
intermittent automatic checking facility (type I)
automatic checking facility that operates at certain time intervals or per fixed number of measurement cycles

[OIML D 11:2004, 3.18.1.2]

3.5.8
non-automatic checking facility (type N)
checking facility which requires the intervention of an operator

[OIML D 11:2004, 3.18.2]

3.5.9
power supply device
sub-assembly converting the voltage from the mains power to a voltage suitable for other sub-assemblies

[OIML D 11:2004, 3.22]

NOTE The power supply device provides electrical energy to the electronic devices of a meter, using one or more sources of AC or DC.

4 Metrological requirements

4.1 Values of Q_1, Q_2, Q_3 and Q_4

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

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

4.1.3 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.

4.1.4 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 4.1.3 and 4.1.4 are taken from the R5 and R10 lines of ISO 3:1973 [4] respectively.

4.1.5 The ratio Q_2 / Q_1 shall be 1.6.

4.1.6 The ratio Q_4 / Q_3 shall be 1.25.

4.2 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 4.2.1 or 4.2.2 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 4.2.1 or 4.2.2.

The meter manufacturer shall specify the accuracy class.

4.2.1 Accuracy class 1 water meters

The maximum permissible error for the upper flowrate zone ($Q_2 \leq Q \leq Q_4$) 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 ($Q_1 \leq Q < Q_2$) is ± 3 % regardless of the temperature range.

4.2.2 Accuracy class 2 water meters

The maximum permissible error for the upper flowrate zone ($Q_2 \leq Q \leq Q_4$) 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 ($Q_1 \leq Q < Q_2$) is ± 5 % regardless of the temperature range.

4.2.3 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

4.2.4 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. The maximum permissible errors of the combined indicating device and measurement transducer shall not exceed the values given in 4.2.1 or 4.2.2 according to the accuracy class of the meter.

4.2.5 The relative error (of indication) is expressed as a percentage, and is equal to:

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

4.2.6 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 4.2.1 or 4.2.2 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 at a flowrate up to Q_3 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.

4.2.7 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.

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

4.2.9 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.

4.3 Requirements for meters and ancillary devices

4.3.1 Connections between electronic parts

The connections between the measurement transducer, the calculator and the indicating device shall be reliable and durable in accordance with 5.1.4 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].

4.3.2 Adjustment device

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

4.3.3 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 4.2, 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 4.2.

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.

4.3.4 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.

4.3.5 Indicating device

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

4.3.6 Ancillary devices

In addition to the indicating devices described in 6.7.2, a water meter may include the ancillary devices described in 3.1.8.

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.

5 Water meters equipped with electronic devices

5.1 General requirements

5.1.1 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.

5.1.2 The significant fault shall have a value equal to one half of the maximum permissible error in the upper flowrate zone.

The following are not considered to be significant faults:

- faults arising from simultaneous and mutually independent cuases in the 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.

5.1.3 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 4.2.6.

5.1.4 Water meters are presumed to comply with the requirements in 4.2 and 5.1.1 if they pass the design inspection and performance tests specified in 7.2.11.1 and 7.2.11.2 in the following conditions:

- the number of meters submitted is defined in 7.2.2;
- at least one of these meters is submitted to the whole set of tests; and
- no meter fails any test.

5.2 Power supply

Three different kinds of basic power supplies for water meters with electronic devices are covered by this Part of ISO 4064/OIML R 49:

— 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.

5.2.1 External power supply

5.2.1.1 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.

5.2.1.2 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.

5.2.1.3 The power supply connections at the meter shall be capable of being secured from tampering.

5.2.2 Non-replaceable battery

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

A low battery or exhausted battery indicator or a meter replacement date shall be indicated on the meter. If the register display gives an indication of “low battery”, there shall be at least 180 days of useful life for the register display from the time “low battery” indication is displayed to end of life.

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

5.2.3 Replaceable battery

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

5.2.3.2 A low battery or exhausted battery indicator or a battery replacement date shall be indicated on the meter. If the register display gives an indication of “low battery”, there shall be at least 180 days of useful life for the register display from the time “low battery” indication is displayed to end of life.

5.2.3.3 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, extreme temperatures and, if necessary, water conductivity, will be considered when specifying a battery and during type approval.

5.2.3.4 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.

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

6 Technical requirements

6.1 Materials and construction of water meters

6.1.1 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.

6.1.2 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 6.4).

6.1.3 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 inert[1)].

6.1.4 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.

6.1.5 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.

6.1.6 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.

6.1.7 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.

6.1.8 A water meter shall be fitted with a metrologically controlled display. The display shall be readily accessible to the customer, without requiring the use of a tool.

6.2 Adjustment and correction

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

6.2.2 If these devices are mounted on the outside of the water meter, provision for sealing shall be made (see 6.8.2).

6.3 Installation conditions

NOTE ISO 4064-5 specifies requirements for meter installation.

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

6.3.2 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 pipeline[2)].

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1) National regulations shall apply.

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.

6.3.3 Provision may be made on the water meter to allow the water meter to be correctly leveled during installation[3)].

6.3.4 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 4.2.1 or 4.2.2 with respect to the maximum permissible errors and according to the accuracy class of the meter.

6.3.5 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 4.2.1 or 4.2.2.

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.

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

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 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

6.4 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 4.2.3

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 ≥ 500, where the maximum admissible pressure (MAP) shall be at least 0.6 MPa (6 bar).

6.5 Pressure loss

The pressure loss through the water meter, including its filter and/or straightener, where either of these 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.

The pressure loss class is selected by the manufacturer from the values of the following R 5 of ISO 3:1973 as indicated in Table 4: for a given pressure loss class the pressure loss through the water meter, including its filter and/or straightener, where either of these forms an integral part of the water meter, shall not be greater than the specified maximum pressure loss between Q_1 and Q_3.

A concentric meter, of any type and measuring principle, shall be tested together with its respective manifold.

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

Table 4 — Pressure-loss classes

Class	Maximum pressure-loss (bar)
ΔP 63	0,63
ΔP 40	0,40
ΔP 25	0,25
ΔP 16	0,16
ΔP 10	0,10

NOTE 1 Straighteners, as described in 6.3, are not considered to be integral parts of the meter.

NOTE 2 The maximum pressure loss can differ from, and may exceed, the pressure loss at the permanent flowrate Q_3.

6.6 Marks and inscriptions

6.6.1 A place shall be provided for affixing the verification mark (see VIML (2000), 3.7), which shall be visible without dismantling the water meter.

6.6.2 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. These markings shall be visible after the instrument has been placed on the market or put into use.

NOTE 1 In the case of a combination meter, the markings below refer to the combination meter considered as a single 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 : 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. The ratio Q_3/Q_1 may be expressed as R, e.g. "R160". If the meter has different values of Q_3/Q_1 in horizontal and vertical positions, both values of Q_3/Q_1 shall be inscribed, and the orientation to which each value 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 ≥ 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 ΔP 63, 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.

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.

NOTE 4 An example of the required marks and inscriptions for a meter without electronic devices is given below:

— Q_3 = 2,5 m^3/h ;

— Q_3/Q_1 = 200 ;

— horizontal mounting;

— temperature Class 30 ;

— pressure loss Class ΔP 63 ;

— maximum admissible pressure : 1 MPa (10 bar);

— flow profile sensitivity Class U0/D0

— serial number : 123456 ;

— year of manufacture : 2 008 ;

— manufacturer ABC,

is : **Q_3 2,5 ; R200 ; H ; → ; 123456 ; 08 ; ABC.**

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

6.7 Indicating device

6.7.1 General requirements

6.7.1.1 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.

6.7.1.2 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 or allowed 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.

6.7.1.3 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 5.

Table 5 — Indicating range of a water meter

Q_3 m^3/h	**Indicating range (minimum values)** m^3
$Q_3 \leq 6.3$	9 999
$6.3 < Q_3 \leq 63$	99 999
$63 < Q_3 \leq 630$	999 999
$630 < Q_3 \leq 6\ 300$	9 999 999

6.7.1.4 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.

6.7.2 Types of indicating device

Any of the following types shall be used.

6.7.2.1 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.

6.7.2.2 Type 2 - Digital device

The indicated volume is given by a line of adjacent digits appearing in one or more apertures. The advance of a given digit shall be completed while the digit of the next immediately lower decade changes from 9 to 0. The apparent height of the digits shall be at least 4 mm.

For non-electronic devices:

1. movement of numbered roller indicators (drums) shall be upwards; and
2. if the lowest value decade has a continuous movement, the aperture shall be large enough to permit a digit to be read unambiguously.

For electronic devices:

1. either permanent or non-permanent displays are permitted; for non-permanent displays the volume shall be able to be displayed at any time for at least 10 s; and
2. The meter shall provide visual checking of the entire display which shall have the following sequence:

   — for seven segment type displaying all the elements (e.g. an “eights” test); and

   — for seven segment type blanking all the elements (a “blanks” test).

   — for graphical displays an equivalent test to demonstrate that display faults cannot result in any digit being misinterpreted.

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

6.7.2.3 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.

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

6.7.3.1 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. Such a provision may also be used for leak detection.

6.7.3.2 Visual verification displays

6.7.3.2.1 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.

6.7.3.2.2 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.

6.7.3.2.3 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.

NOTE See 6.3.2.6.2.3 of ISO 4064-2/OIML R49-2 for the calculation of the resolution error.

6.7.3.3 Combination meters

For combination meters with two indicating devices, 6.7.3.1 and 6.7.3.2 apply to both indicating devices.

6.8 Protection devices

6.8.1 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.

6.8.2 Electronic sealing devices

6.8.2.1 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 evidence of an intervention to be available for a reasonable period of time. The record shall include the date and a characteristic element identifying the authorized person making the intervention (see (a) above). If deletion of a previous intervention is necessary to permit a new record, the oldest record shall be deleted.

6.8.2.2 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 6.8.2.1 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.

6.8.2.3 For meters with parts which may be disconnected one from another by the user and which are not interchangeable, the provisions in 6.8.2.2 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. They shall be provided with a device that prevents any measurement after any unauthorized disconnection and subsequent reconnection by the user.

7 Metrological controls

7.1 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 clause 4 of ISO 4064-2/R 49-2. Values are specified for flowrate, water temperature, water pressure, ambient temperature, ambient relative humidity, and ambient atmospheric pressure.

7.2 Type approval

7.2.1 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 Part of ISO 4064/OIML R 49.

7.2.2 The evaluation tests shall be made on the minimum number of samples of each type shown in Table 6 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 6 — Number of water meters to be tested

	Minimum number of meters		
Meter designation Q_3 (m^3/h)	Non-electronic meters	Electronic meters without checking facilities	Electronic meters with checking facilities
$Q_3 \leq 160$	3	5	3
$160 < Q_3 \leq 1\,600$	2	3	2
$1\,600 < Q_3$	1	2	1

The requirements of 4.2.1 or 4.2.2 shall apply to all the meters tested, according to the accuracy class of the meter.

7.2.3 Errors (of indication)

7.2.3.1 The errors (of indication) of the water meter (in the measurement of the actual volume) shall be determined at least at the following nominal flowrates

NOTE See ISO 4064-2/OIML R49-2, 7.3.4 for the permitted flowrate ranges.

a) Q_1;

b) Q_2;

c) 0.35 (Q_2 + Q_3);

d) 0.7 (Q_2 + Q_3);

e) Q_3;

f) Q_4;

and for combination meters:

g) 0.9 Q_{x1}

h) 1.1 Q_{x2}

If the meter is marked as only operating in certain orientations, then the meter shall be tested in these orientations.

In the absence of such marks the meter shall be tested in at least three orientations.

7.2.3.2 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 4.2.1 or 4.2.2. Tests shall be carried out at nominal flowrates of Q_1, Q_2 and Q_3.

7.2.4 Overload temperature tests

Water meters with MAT $\geq$ 50 °C shall be capable of withstanding a water temperature of MAT+10 °C for one hour. The test is specified in ISO 4064-2/OIML R 49-2, 7.5.

7.2.5 Endurance tests

The water meter shall undergo the endurance tests detailed in Table 7 (and in ISO 4064-2/OIML R 49-2, 7.10), 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 7.2.3.1 and the criteria given in 7.2.5.1 or 7.2.5.2 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.

NOTE For families of meters, only the smallest representative diameter one is to be subjected to the endurance test.

7.2.5.1 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 ± 4 % 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 ± 1.5 % for meters of temperature class T30 and ± 2.5 % for all other temperature classes.

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

7.2.5.2 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 ± 6 % 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 ± 2.5 % for meters of temperature class T30 and ± 3.5 % for all other temperature classes.

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

Table 7 Endurance tests

Temperature Class	Permanent flowrate Q_3	Test flow-rate	Test water temper-ature ± 5 °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	$Q_3 \leq 16\ m^3/h$	Q_3	20 °C	Dis-continuous	100 000	15 s	15 s	0.15 [$\boldsymbol{Q}_3$] a) s with a minimum of 1 s
		Q_4	20 °C	Continuous	-	-	100 h	-
	$Q_3 > 16\ m^3/h$	Q_3	20 °C	Continuous	-	-	800 h	-
		Q_4	20 °C	Continuous	-	-	200 h	-
All other temperature classes	$Q_3 \leq 16\ m^3/h$	Q_3	50 °C	Dis-continuous	100 000	15 s	15 s	0.15 [$\boldsymbol{Q}_3$] a) s with a minimum of 1 s
		Q_4	0.9 × MAT	Continuous	-	-	100 h	-
	$Q_3 > 16\ m^3/h$	Q_3	50 °C	Continuous	-	-	800 h	-
		Q_4	0.9 × MAT	Continuous	-	-	200 h	-
Combination meters (additional test)	$Q_3 > 16\ m^3/h$	$Q \geq 2 \times Q_{x2}$	20 °C	Dis - continuous	50 000	15 s	15 s	3 to 6 s
Combination meters (where small meter has not been pre-approved)	$Q_3 > 16\ m^3/h$	$0.9\ Q_{x1}$	20 °C	Continuous	-	-	200 h	-

a) [$\boldsymbol{Q}_3$] is the number equal to the value of $\boldsymbol{Q}_3$ 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. The specified temperature for tests for combination meters assumes that the meter is of class T30 or T50. If it were of other classes the reference temperature would be 50 °C.

7.2.6 Interchange error tests

It shall be demonstrated that cartridge meters and exchangeable metrological units for water meters with exchangeable metrological units are independent of the connection interfaces they are made for as far as their metrological performance is concerned. The cartridge meters and exchangeable metrological units shall be tested in accordance with the test laid down in ISO 4064-2/OIML R 49-2, 7.3.6.

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

7.2.7 Static magnetic field test

It shall be demonstrated that the water meter is not affected by a static magnetic field. A 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, 7.11. The purpose of the test is to ensure compliance with the provisions of 4.2 in the presence of static magnetic fields.

7.2.8 Documentation

7.2.8.1 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.

— optionally, a user guide and installation manual.

7.2.8.2 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 Part of ISO 4064/OIML R 49, in particular 5.1 and Annex B.

7.2.8.3 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.

7.2.9 Type approval certificate

The following information shall appear on the type approval certificate or in its annexes:

— 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

— sufficient information to identify the meter type, e.g. drawing , photograph or description

— 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).

7.2.10 Modification of an approved type

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

7.2.10.2 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.

7.2.10.3 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 shall be issued whenever the modified type no longer fulfils the provisions of the initial type approval.

7.2.11 Type approval of a water meter with electronic devices

7.2.11.1 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 Part of ISO 4064/OIML R 49, clause 5 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 5.1 and Annex B; and

c) Verification of the presence and effectiveness of the test device(s) for the checking facilities, if required.

7.2.11.2 Performance tests

The water meter shall comply with the provisions of 4.2 and 5.1.1 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.

7.2.11.3 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.

7.3 Initial verification

7.3.1 In general, only water meters which have been approved either as complete meters or as separately approved calculator (including indicating device) and measurement transducer (including flow or volume sensor), subsequently assembled into a combined meter, shall be eligible for initial verification.

However, metrological authorities may allow substitution in service of separately approved calculators (including indicating device) and measurement transducers (including flow or volume sensor), if it has been proven during type evaluation that such substitutions will not result in the combined maximum permissible errors exceeding the respective maximum permissible errors for a complete water meter.

Any special requirements for initial verification testing, detailed in the type approval certificate, shall be applied.

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

The water meter shall be shown to be capable of withstanding the following test pressure without leakage or damage: 1.6 times the maximum admissible pressure applied for 1 minute (ISO 4064-2/R 49-2, 10.1.2).

7.3.3 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, 10.1.3 4) (concerning water meter outlet pressure) shall be met for each water meter, and there shall be no significant interaction between water meters.

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

a) Q_1;

b) Q_2;

c) Q_3. and

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, 10.1.3 5).

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

7.3.5 The errors (of indication) determined at each of the above flowrates shall not exceed the maximum permissible errors given in 4.2.1 or 4.2.2.

7.3.6 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.

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 7.1 and ISO 4064-2/OIML R49-2, clause 4).

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 4.2.

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 4.2.4.

A.4.2 The examinations and tests for electronic instruments described in 7.2.11 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.a	Radiated electromagnetic fields	Disturbance	2 or 3	2 or 3	2 or 3	12.1.1
A.5.10.b	Conducted electromagnetic fields	Disturbance	3 or 4	3 or 4	3 or 4	12.1.2
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, 8.2)
Object of the test:	To verify compliance with the provisions in 4.2 under conditions of high temperature

A.5.2 Cold

Test method:	Cold (see ISO 4064-2/OIML R49-2, 8.3)
Object of the test:	To verify compliance with the provisions in 4.2 under conditions of low temperature

A.5.3 Damp heat cyclic (condensing)

Test method:	Damp heat, cyclic (see ISO 4064-2/OIML R49-2, 8.4)
Object of the test:	To verify compliance with the provisions in 5.1.1 under conditions of high humidity when combined with cyclic temperature changes. 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.

A.5.4.a.1 DC mains voltage variation

Test method:	Variation in DC mains power voltage (see ISO 4064-2/OIML R49-2, 8.5)
Object of the test:	To verify compliance with the provisions in 4.2 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, 8.5)
Object of the test:	To verify compliance with the provisions in 4.2 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, 8.5)
Object of the test	To verify compliance with the provisions in 4.2 under conditions of varying AC mains power frequency (if relevant).

A.5.4.c Voltage of internal battery

Test method	Variation in battery voltage (see ISO 4064-2/OIML R49-2, 8.5)
Object of the test	To verify compliance with the provisions in 4.2 under conditions of varying battery voltage (if relevant).

A.5.5 Vibration (random)

Test method:	Random vibration (see ISO 4064-2/OIML R49-2, 8.6)
Object of the test:	To verify compliance with the provisions in 5.1.1 under conditions of random vibration.

A.5.6 Mechanical shock

Test method:	Mechanical shock (see ISO 4064-2/OIML R49-2, 8.7)
Object of the test:	To verify compliance with the provisions in 5.1.1 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, 8.8)
Object of the test:	To verify compliance with the provisions in 5.1.1 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, 8.9)
Object of the test:	To verify compliance with the provisions in 5.1.1 under conditions where electrical bursts are superimposed 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, 8.10)
Object of the test:	To verify compliance with the provisions in 5.1.1 under conditions where electrical bursts are superimposed on the mains voltage.

A.5.9 Electrostatic discharge

Test method:	Electrostatic discharge (ESD) (see ISO 4064-2/OIML R49-2, 8.11)
Object of the test:	To verify compliance with the provisions in 5.1.1 under conditions of direct and indirect electrostatic discharges.

A.5.10.a Radiated electromagnetic fields

Test method:	Radiated electromagnetic fields (see ISO 4064-2/OIML R49-2, 8.12)
Object of the test:	To verify compliance with the provisions in 5.1.1 under conditions of radiated electromagnetic fields.

A.5.10.b Conducted electromagnetic fields

Test method:	Conducted electromagnetic fields (see ISO 4064-2/OIML R49-2, 8.13)
Object of the test:	To verify compliance with the provisions in 5.1.1 under conditions of conducted electromagnetic fields.

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

Test method:	Electrical surges (see ISO 4064-2/OIML R49-2, 8.14)
Object of the test:	To verify compliance with the provisions in 5.1.1 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, 8.15)
Object of the test:	To verify compliance with the provisions in 5.1.1 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:

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

where:

$k = 2 \times 10^{-5}$ 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 shall 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 shall occur either 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 6.7.2.2 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 4.3.5), 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 4.2.1 or 4.2.2 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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