



Australian Government
Department of Industry,
Innovation and Science

National
Measurement
Institute

NMI R 49-1 Water meters for cold potable water and hot water

Part 1: Metrological and technical
requirements

May 2022

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(OIML R 49-1:2013(E), MOD)

The English version of international standard OIML R 49-1 Water meters for cold potable water and hot water. Part 1: Metrological and technical requirements is adopted as the modified national standard with the reference number NMI R 49-1.

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SCOPE

NMI R 49-1 specifies the metrological and technical requirements for the pattern approval of water meters used to measure the volume of cold potable and hot water flowing through fully charged, closed conduits. The corresponding parts of this document are:

- Part 2: NMI R 49-2 Test Methods
- Part 3: NMI R 49-3 Test Report Format

CONTENTS

NMI R 49-1 (2022) is a modified version of OIML R 49-1 (2013) *Water meters for cold potable water and hot water. Part 1: Metrological and technical requirements* published by the International Organisation of Legal Metrology (OIML). These modifications are listed below.

INTERPRETATIONS

The following interpretations shall apply to NMI R 49-1:

- The national authority for the pattern approval of water meters is the National Measurement Institute (NMI).
- The 'body responsible for the approval' or 'body that approved the pattern' is NMI.
- NMI is solely responsible for issuing pattern approval certificates for water meters in Australia.
- The 'body responsible for pattern evaluation' or 'body responsible for meter evaluation' is the Chief Metrologist, or a person or organisation appointed as an **approving authority** by the Chief Metrologist, in accordance with Regulation 76 of the *National Measurement Regulations 1999*.
- For references to 'national regulations' or 'national legislation' refer to the *National Measurement Act 1960*, *National Measurement Regulations 1999* and the *National Trade Measurement Regulations 2009*.
- References to 'this Recommendation' or 'the Recommendation' are taken as being NMI R 49-1.
- Previous restrictions on the approval of water meters with a temperature class greater than T30 no longer apply. Water meters may be approved with any temperature class specified in Table 1, on page 20 of this document.

MODIFICATIONS

NMI R 49-1 has been modified from the 2013 edition of OIML R 49-1 such that deletions are indicated with a '~~red strikethrough~~' and additions are indicated in '**blue text**' (unless otherwise indicated below). All the modifications to OIML R 49-1 that appear in NMI R 49-1 are described below:

- References to "OIML R 49-1" have been replaced with "NMI R 49-1". These amendments have not been indicated with red or blue text.
- In all instances, the term "type approval" and all associated references concerning the testing, evaluation and certification of water meters, have been changed to the equivalent term "**pattern approval**". In this case, for ease of readability, the deleted "type" has not been indicated with a '~~red strikethrough~~'.
- The unit 'kilolitre' (kL) is included as an acceptable unit of measurement of volume throughout the Recommendation. The measurement of the volume of water may be made and displayed in units of cubic metres or kilolitres.
- The unit 'kilolitres per hour' (kL/h) is included as an acceptable unit of measurement of flowrate throughout the Recommendation. The measurement of flowrate may be made and displayed in units of cubic metres per hour or kilolitres per hour.

- Advice regarding the application of the *National Measurement Act 1960*, *National Measurement Regulations 1999* and the *National Trade Measurement Regulations 2009*, has been provided throughout the document where reference is made to 'national regulations' or national legislation'.
- The following definition has been included as clause 3.4.14:

3.4.14

limiting condition

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

- The following additional requirement for T30 water meters has been included in clause 4.2.8:
Water meters approved with a T30 temperature class shall also comply with a limiting condition of 50 °C.

To demonstrate compliance with this requirement, an additional water temperature test has been included for all T30 water meters in Part 2 of the Recommendation.

- The following requirement has been included in clause 4.1.3:
From the values given, for DN20 sized water meters the value of Q_3 shall be 4.
- The following requirement has been included in clause 4.1.4:
From the values given, for DN20 sized water meters, the minimum value of Q_3/Q_1 shall be 200.
- The following Note has been included in clause 6.1:
Note: The following standards are of relevance to the design and construction of water meters in Australia; AS 2845.1, AS 3565.1 and AS 4020. The requirements of these standards are not part of the pattern approval process, but are referenced here for guidance only.
- The following amendment has been made to clause 6.4:

Pressure range:	0.03 MPa (0.3 bar) to at least 1.4 MPa (14 bar) 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).
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- The following sentence has been added to clause 6.5:
Meters with dual check valves or any other type of non-return device may be tested for pressure loss without such devices being fitted where they do not form an integral part of the meter.
- The following amendment has been made to clause 6.6 (f):
Year of manufacture, the last two digits of the year of manufacture, or the month and year of manufacture. This marking is optional.
- The following amendment has been made to clause 6.6 (i):
Maximum admissible pressure (MAP) if it exceeds 1.4 MPa (14 bar) ~~1 MPa (10 bar)~~ or 0.6 MPa (6 bar) for DN ≥ 500.
A similar amendment has been made to the example provided.
- The following statement has been inserted into clause 7.3:
In Australia, water meters are verified in accordance with the National Instrument Test Procedure for Utility Meters (NITP 14) and/or test procedures specified in Certificates of Approval. The following clauses (7.3.1 to 7.3.6) are retained for guidance only.

Water meters for 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

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 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. 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 which are intended to give guidelines for the application of certain requirements to legal metrology;
- **International Basic Publications (OIML B)**, which define the operating rules of the various OIML structures and systems; and

OIML Draft Recommendations, Documents and Guides are developed by Project Groups linked to Technical Committees or Subcommittees which comprise representatives from OIML Member States. Certain international and regional institutions also participate on a consultation basis. Cooperative agreements have been established between the 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 49-1:2013 (E) – was developed by a joint OIML/ISO/CEN working group comprising OIML TC 8/SC 5 *Water meters*, ISO/TC 30/SC 7 *Volume methods including water meters* and CEN/TC92 *Water meters*. The content is the same in substance as that of ISO 4064-1:2014 *Water meters for cold potable water and hot water*. This edition supersedes OIML R 49-1:2006 and was approved for final publication by the International Committee of Legal Metrology at its 48th meeting in Ho Chi Minh City, Viet Nam in October 2013. It will be submitted to the International Conference on Legal Metrology in 2016 for formal sanction.

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Water meters for cold potable water and hot water.

Part 1: Metrological and technical requirements

1 Scope

This part of NMI R 49 specifies the metrological and technical requirements for water meters for cold potable water and hot water flowing through a fully charged, closed conduit. These water meters incorporate devices which indicate the integrated volume.

In addition to water meters based on mechanical principles, this part of NMI R 49 applies to devices based on electrical or electronic principles, and mechanical principles incorporating electronic devices, used to measure the volume of cold potable water and hot water.

This part of NMI R 49 also applies to electronic ancillary devices. Ancillary devices are optional. However, it is possible for national or regional regulations to render some ancillary devices mandatory in relation to the utilization of water meters.

Note: Any national regulations apply in the country of use. [The use of ancillary devices for water meters is optional under the National Measurement Act 1960. Ancillary devices may be approved in accordance with this document.](#)

2 Normative references

The following documents, in whole or in part, are normatively referenced in this Recommendation and are indispensable for its application. The latest edition of the referenced document (including any amendments) applies.

- | | |
|-----------------|---|
| NMI R 49-2:2015 | <i>Water meters for cold potable water and hot water.
Part 2: Test methods.</i> |
| NMI R 49-3:2015 | <i>Water meters for cold potable water and hot water.
Part 3: Test report format.</i> |

3 Terms and definitions

For the purposes of this Recommendation, the following definitions apply.

This terminology conforms to that used in OIML V 2-200:2012 (VIM) [1], OIML V 1:2013 [2], and OIML D 11 [3]. Modified versions of some terms defined in References [1]–[3] are listed here.

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 can be in different housings.

Note 2: A water meter may be a combination meter (see 3.1.16).

Note 3: In this Recommendation, a water meter is also referred to as a “meter”.

3.1.2

measurement transducer

part of the meter that transforms the flow rate 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 meter that is directly affected by a phenomenon, body or substance carrying a quantity to be measured

[Source: OIML V 2-200:2012 (VIM) [1] 3.8, modified — “meter” replaces “measuring system”.]

Note: For a water meter, the sensor may be a disc, piston, wheel or turbine element, the electrodes on an electromagnetic meter, or another element. The element senses the flow rate or volume of water passing through the meter and is referred to as a “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 1: The gearing is considered to be the calculator in a mechanical meter.

Note 2: 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 OIML V 2-200:2012 (VIM) [1], 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 of a measuring system”, see OIML V 2-200:2012 (VIM) [1], 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 flow rate and/or the characteristics of the water to be measured and the pre-established calibration curves

Note 1: The characteristics of the water, e.g. temperature and pressure, may be either measured using associated measuring instruments or stored in a memory in the meter.

Note 2: For the definition of the term “correction”, see OIML V 2-200:2012 (VIM) [1], 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 OIML V 2-200:2012 (VIM) [1], 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);
- j) remote reading device (which may be incorporated permanently or added temporarily).

Note 3: Depending on national legislation, ancillary devices may 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 flow rate passing through the meter, automatically directs the flow through either the small or the large meter, or both

Note: The meter reading is obtained from two independent totalizers, or from 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 are coaxial at the interface between them.

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 specified in ISO 4064-4. [7]

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 module**

meter with a permanent flow rate $\geq 16 \text{ m}^3/\text{h}$ (kL/h), comprising a connection interface and an exchangeable metrological module from the same [pattern](#) approval

3.1.23**exchangeable metrological module**

self-contained module comprising a measurement transducer, a calculator and an indicating device

3.1.24**connection interface for meters with exchangeable metrological modules**

pipe fitting specific to the connection of exchangeable metrological modules

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

3.2.4**error**

measured quantity value minus a reference quantity value

[Source: OIML V 2-200:2012 (VIM) [1], 2.16.]

Note 1: For the application of this part of NMI 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 Recommendation, the error (of indication) is expressed as a percentage of the actual volume, and is equal to:

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

3.2.5**maximum permissible error****MPE**

extreme value of measurement error, with respect to a known reference quantity value, permitted by specifications or regulations for a given meter

[Source: OIML V 2-200:2012 (VIM) [1], 4.26, modified — “meter” replaces “measurement, measuring instrument, or measuring system”.]

3.2.6**intrinsic error**

error of a meter determined under reference conditions

[Source: OIML D 11:2013 [3], 3.8, modified — “meter” replaces “measuring instrument”.]

3.2.7**initial intrinsic error**

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

[Source: OIML D 11:2013 [3], 3.9, modified — “meter” replaces “measuring instrument”.]

3.2.8**fault**

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

[Source: OIML D 11:2013 [3], 3.10, modified — “of indication” placed in parentheses; “meter” replaces “measuring instrument”.]

3.2.9**significant fault**

fault greater than the value specified in this part of NMI R 49

[Source: OIML D 11:2013 [3], 3.12, modified — “this part of NMI R 49” replaces “the relevant Recommendation”.]

Note: See 5.1.2, which specifies the value of a significant fault.

3.2.10**durability**

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

[Source: OIML D 11:2013 [3], 3.18, modified — “meter” replaces “measuring instrument”.]

3.2.11**metering conditions**

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

Examples: Water temperature, water pressure.

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

[Source: OIML V 2-200:2012 (VIM) [1], 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****flow rate**

Q

$Q = dV/dt$ where V is actual volume and t is time taken for this volume to pass through the meter

Note: ISO 4006:1991 [4] 4.1.2 prefers the use of the symbol q_V for this quantity, but Q is used in this Recommendation as it is well established in the industry.

3.3.2**permanent flow rate**

Q_3

highest flow rate within the rated operating conditions at which the meter is to operate within the maximum permissible errors

Note: In this Recommendation, the flow rate is expressed in m³/h or kL/h. See 4.1.3.

3.3.3**overload flow rate**

Q_4

highest flow rate at which the meter is to operate for a short period of time within the maximum permissible errors, while maintaining its metrological performance when it is subsequently operating within the rated operating conditions

3.3.4**transitional flow rate**

Q_2

flow rate between the permanent flow rate and the minimum flow rate that divides the flow rate range into two zones, the upper flow rate zone and the lower flow rate zone, each characterized by its own maximum permissible errors

3.3.5**minimum flow rate**

Q_1

lowest flow rate at which the meter is to operate within the maximum permissible errors

3.3.6**combination meter changeover flow rate** Q_x

flow rate at which the flow in the larger meter stops with decreasing flow rate (Q_{x1}) or starts with increasing flow rate (Q_{x2})

3.3.7**minimum admissible temperature****mAT**

minimum water temperature that a meter can withstand permanently, within its rated operating conditions, without deterioration of its metrological performance

Note: mAT is the lower of the rated operating conditions for temperature.

3.3.8**maximum admissible temperature****MAT**

maximum water temperature that a meter can withstand permanently, within its rated operating conditions, without deterioration of its metrological performance

Note: MAT is the upper of the rated operating conditions for temperature.

3.3.9**maximum admissible pressure****MAP**

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

3.3.10**working temperature** T_w

water temperature in the pipe measured upstream of the meter

3.3.11**working pressure** p_w

average water pressure (gauge) in the pipe measured upstream and downstream of the meter

3.3.12**pressure loss** Δp

irrecoverable decrease in pressure, at a given flow rate, caused by the presence of the meter in the pipeline

3.3.13**test flow rate**

mean flow rate during a test, calculated from the indications of a calibrated reference device

3.3.14**nominal diameter****DN**

alphanumeric designation of size for components of a pipework system, which is used for reference purposes

Note 1: The nominal diameter is expressed by 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 2: 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 Recommendation.

Note 3: In those Recommendations 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

[Source: OIML V 2-200:2012 (VIM) [1], 2.52.]

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 of a meter specified in this part of NMI R 49

[Source: OIML D 11:2013 [3], 3.15.1, modified — “meter” replaces “measuring instrument”; “this part of NMI R 49” replaces “the relevant Recommendation”.]

3.4.3

disturbance

influence quantity having a value within the limits specified in this part of NMI R 49, but outside the specified rated operating conditions of the meter

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

[Source: OIML D 11:2013 [3], 3.15.2, modified — “this part of NMI R 49” replaces “the relevant Recommendation”; “meter” replaces “measuring instrument”.]

3.4.4

rated operating condition

ROC

operating condition requiring fulfilment during measurement in order that a meter perform as designed

[Source: OIML V 2-200:2012 (VIM) [1], 4.9, modified — “requiring fulfillment” replaces “that must be fulfilled”; “meter” replaces “measuring instrument or measuring system”.]

Note: The rated operating conditions specify intervals for the flow rate 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

[Source: OIML V 2-200:2012 (VIM) [1], 4.11, modified — “meter” replaces “measuring instrument or measuring system”.]

3.4.6**performance test**

test intended to verify whether the equipment under test is able to accomplish its intended functions

[Source: OIML D 11:2013 [3], 3.21.4.]

3.4.7**durability test**

test intended to verify whether the equipment under test is able to maintain its performance characteristics over a period of use

[Source: OIML D 11:2013 [3], 3.21.5.]

3.4.8**temperature stability**

condition in which all parts of the equipment under test have a temperature within 3 °C of each other, or as otherwise specified in the relevant specification of its final temperature

3.4.9**preconditioning**

treatment of the equipment under test 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.

3.4.10**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

3.4.11**recovery**

treatment of the equipment under test, after conditioning, in order that its properties can be stabilized before measurement

3.4.12**type evaluation****pattern evaluation**

systematic examination and testing of the performance of one or more specimens of an identified type or pattern of measuring instrument against documented requirements, the results of which are contained in the evaluation report, in order to determine whether the [pattern](#) may be approved

Note: “Pattern” is used in legal metrology with the same meaning as “type”.

[Source: OIML V 1:2013 [2], 2.04, modified — The term synonyms “type evaluation” and “pattern evaluation” replace “type (pattern) evaluation”; “type or pattern” replaces “type (pattern)”.]

3.4.13

pattern approval

decision of legal relevance, based on the evaluation report, that the **pattern** of a measuring instrument complies with the relevant statutory requirements and is suitable for use in the regulated area in such a way that it is expected to provide reliable measurement results over a defined period of time

[Source: OIML V 1:2013 [2], 2.05.]

3.4.14

limiting condition

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

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 tested independently

[Source: OIML D 11:2013 [3], 3.2, modified — “function, usually manufactured as a separate unit and capable” replaces “function. Electronic devices are usually manufactured as separate units and are capable”.]

Note: An electronic device may be a complete meter or a part of a meter, e.g. 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

[Source: OIML D 11:2013 [3], 3.3.]

3.5.3

electronic component

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

[Source: OIML D 11:2013 [3], 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

[Source: OIML D 11:2013 [3], 3.19, modified — “meter” replaces “measuring instrument”.]

Note: The checking of a transmission device aims to verify whether 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

[Source: OIML D 11:2013 [3], 3.19.1.]

3.5.6

permanent automatic checking facility

type P automatic checking facility

automatic checking facility that operates at each measurement cycle

[Source: OIML D 11:2013 [3], 3.19.1.1, modified — Synonym presentation.]

3.5.7

intermittent automatic checking facility

type I automatic checking facility

automatic checking facility that operates at certain time intervals or per fixed number of measurement cycles

[Source: OIML D 11:2013 [3], 3.19.1.2, modified — Synonym presentation.]

3.5.8

non-automatic checking facility

type N checking facility

checking facility that requires the intervention of an operator

[Source: OIML D 11:2013 [3], 3.19.2, modified — Synonym presentation.]

3.6 Use of certain terms within the European Economic Area

Attention is drawn to the fact that the term “verification” or “initial verification” is equivalent to the term “conformity assessment” in the context of application of the European Measuring Instruments Directive.

4 Metrological requirements

4.1 Values of Q_1 , Q_2 , Q_3 , and Q_4

4.1.1 The flow rate 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 m³/h or kL/h and the ratio Q_3/Q_1 .

4.1.3 The value of Q_3 , expressed in m³/h or kL/h, 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

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

From the values given, for DN20 sized water meters the value of Q_3 shall be 4.

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	1 000

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

From the values given, for DN20 sized water meters, the minimum value of Q_3/Q_1 shall be 200.

Note: The values in 4.1.3 and 4.1.4 are taken from ISO 3 [4], R 5 and R 10 lines, 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

4.2.1 General

A water meter shall be designed and manufactured such that its errors (of indication) do not exceed the maximum permissible errors (MPEs) as defined in 4.2.2 or 4.2.3 under rated operating conditions.

A water meter shall be designated as either accuracy class 1 or accuracy class 2, according to the requirements of 4.2.2 or 4.2.3.

The meter manufacturer shall specify the accuracy class.

4.2.2 Accuracy class 1 water meters

The MPE for the upper flow rate 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 MPE for the lower flow rate zone ($Q_1 \leq Q < Q_2$) is ± 3 % regardless of the temperature range.

4.2.3 Accuracy class 2 water meters

The MPE for the upper flow rate 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 MPE for the lower flow rate zone ($Q_1 \leq Q < Q_2$) is ± 5 % regardless of the temperature range.

4.2.4 Meter temperature classes

The meters fall under 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

4.2.5 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 [pattern](#) approvals. The MPEs of the combined indicating device and measurement transducer shall not exceed the values given in 4.2.2 or 4.2.3 according to the accuracy class of the meter.

4.2.6 Relative error of indication

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

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

where V_a is as defined in 3.2.1 and V_i is as defined in 3.2.2.

4.2.7 Reverse flow

The manufacturer shall specify whether or not a 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 MPE of 4.2.2 or 4.2.3 shall be met for both forward and reverse flow. For meters designed to measure reverse flow, the permanent flow rate and the measuring range may be different in each direction.

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 flow rate up to Q_3 without deterioration or change in its metrological properties for forward flow.

4.2.8 Water temperature and water pressure

The requirements relating to the MPEs shall be met for all temperature and pressure variations occurring within the rated operating conditions of a water meter.

Water meters approved with a T30 temperature class shall also comply with a limiting condition of 50 °C.

4.2.9 Absence of flow or of water

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

4.2.10 Static pressure

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

- a) 1.6 times the maximum admissible pressure applied for 15 min;
- b) twice the maximum admissible pressure applied for 1 min.

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

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

4.3.3 Correction device

A meter 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 MPEs specified in 4.2, are therefore applicable to the corrected volume at metering conditions.

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

A water meter 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 [pattern](#) 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, e.g. in relation to time or volume.

Associated measuring instruments, if any, shall comply with the applicable International Standards or OIML 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 facilities, 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 MPEs.

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 hardware and software of a water meter shall continue to function correctly and the metrological functions of the meter 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 specified in 6.7.2, a water meter may include the ancillary devices specified in 3.1.8.

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

Note: Remote reading devices may be used for testing purposes under the National Measurement Act 1960; however the primary indicating device remains the legally traceable indication of volume.

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 A water meter equipped with electronic devices shall be designed and manufactured in such a way that significant faults do not occur when it is exposed to the disturbances specified in A.5.

5.1.2 A significant fault shall have a value equal to one half of the MPE in the upper flow rate zone.

The following faults are not considered to be significant faults:

- a) faults arising from simultaneous and mutually independent causes in the meter itself or in its checking facilities;

- b) transitory faults, i.e. temporary variations in the indication which cannot be interpreted, memorized or transmitted as a measurement result.

5.1.3 A water meter 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 4.2.7.

5.1.4 A water meter is presumed to comply with the requirements in 4.2 and 5.1.1 if it passes the design inspection and performance tests specified in 7.2.12.1 and 7.2.12.2 in the following conditions:

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

5.2 Power supply

5.2.1 General

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

- a) external power supply;
- b) non-replaceable battery;
- c) replaceable battery.

These three types of power supplies may be used alone or in combination. The requirements for each type of power supply are specified in 5.2.2 to 5.2.4.

5.2.2 External power supply

5.2.2.1 A water meter 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 min of flow at Q_3 .

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

Note: Compliance with this requirement does not necessarily ensure that the water meter continues to register the volume consumed during a power supply failure.

5.2.2.3 The power supply connections at a meter shall be capable of being secured from tampering.

5.2.3 Non-replaceable battery

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

5.2.3.2 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 [pattern](#) evaluation.

5.2.4 Replaceable battery

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

5.2.4.2 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.

5.2.4.3 The properties and parameters of a 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 [pattern](#) evaluation.

5.2.4.4 Replacement of the battery shall be carried out in a way that does not necessitate breaking the seal required for statutory metrological inspections.

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

6 Technical requirements

6.1 Materials and construction of water meters

Note: The following standards are of relevance to the design and construction of water meters in Australia; AS 2845.1 [9], AS 3565.1 [10] and AS 4020 [11]. The requirements of these standards are not part of the pattern approval process, but are referenced here for guidance only.

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

6.1.2 A 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 a 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. Attention is drawn to national regulations.

Note: The National Measurement Act 1960 does not specify requirements in relation to health and safety. Please refer to the relevant water supply legislation for health and safety requirements.

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 A 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 Where there is a risk of condensation forming on the underside of the window of a water meter indicating device, the water meter shall incorporate devices for prevention or elimination of condensation.

6.1.7 A water meter shall be of such design, composition, and construction that it 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.

6.1.9 A water meter shall be of such design, composition, and construction that it does not exploit the MPE or favor any party.

6.2 Adjustment and correction

6.2.1 A water meter may be fitted with an adjustment device and/or a correction device. Any adjustment shall be performed in such a way as to adjust the errors (of indication) of the water meter to values as close as practical to zero so that the meter may not exploit the MPE or systematically favor any party.

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 [8] specifies requirements for meter installation.

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

6.3.2 Under specific installation conditions, a strainer or filter, fitted at the inlet of a meter or in the upstream pipeline, may be required.

Installation engineers should note that solid particles collect in a water meter, e.g. following work on the pipework upstream from the meter.

Note: National regulations can apply. [In Australia, the pattern approval certificate may specify any installation conditions.](#) See also ISO 4064-5 [8], 6.3.

6.3.3 Provision may be made on a water meter to allow it to be correctly leveled during installation.

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

6.3.4 If the accuracy of a water meter is affected by disturbances in the upstream or downstream pipeline (e.g. 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, so that the indications of the installed water meter meet the requirements of 4.2.2 or 4.2.3 with respect to MPEs and according to the accuracy class of the meter.

6.3.5 A water meter shall be able to withstand the influence of disturbed velocity fields as defined in the test procedures in NMI R 49-2:2015. During the application of these flow disturbances, the error (of indication) shall meet the requirements of 4.2.2 or 4.2.3.

A 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 irregularity in the upstream velocity field classes (U)

Class	Required straight length ×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 irregularity in the downstream velocity fields classes (D)

Class	Required straight length ×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.

Flow rate range:	Q_1 to Q_3 inclusive.
Ambient temperature range:	+5 °C to +55 °C.
Water temperature range:	refer to Table 1.
Ambient relative humidity range:	0 % to 100 %, except for remote indicating devices where the range shall be 0 % to 93 %.
Pressure range: ¹⁾	0.03 MPa (0.3 bar) to at least 1.4 MPa (14 bar) 1 MPa (10 bar) , except for meters of $DN \geq 500$, where the maximum admissible pressure (MAP) shall be at least 0.6 MPa (6 bar).

6.5 Pressure loss

The pressure loss¹ through a water meter, including its filter or strainer 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) between Q_1 and Q_3 .

The pressure loss class is selected by the manufacturer from the values in Table 4 (which follow ISO 3 [4], R 5): for a given pressure loss class, the pressure loss through a water meter, including its filter or strainer 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.

Meters with dual check valves or any other type of non-return device may be tested for pressure loss without such devices being fitted where they do not form an integral part of the meter.

Table 4 Pressure loss classes

Class	Maximum pressure loss	
	MPa	bar
Δp 63	0.063	0.63
Δp 40	0.040	0.40
Δp 25	0.025	0.25
Δp 16	0.016	0.16
Δp 10	0.010	0.10

Note 1: Straighteners, as specified in 6.3, are not considered to be integral parts of a meter.

Note 2: For some meters, over the flow rate range $Q_1 \leq Q \leq Q_3$, the highest pressure loss does not occur at Q_3 .

¹ The unit bar may be used where national regulations permit. The National Measurement Regulations 1999 (Cth) do not specify the unit bar as an Australian Legal Unit of Measurement for the purposes of measuring water pressure.

6.6 Marks and inscriptions

6.6.1 A place shall be provided for affixing the verification mark(s) (see OIML V 1:2013 [2], 3.04), which shall be visible without dismantling the water meter after it has been placed on the market or put into use.

6.6.2 A 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 without dismantling the water meter after the instrument has been placed on the market or put into use.

Note: In the case of a combination meter, the markings in the following refer to the combination meter considered as a single meter.

- 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 the values of Q_3 and the ratios 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) **Pattern** approval sign according to national regulations.
- e) Name or trademark of the manufacturer.
- f) Year of manufacture, the last two digits of the year of manufacture, or the month and year of manufacture. **This marking is optional.**
- g) Serial number (as near as possible to the indicating device).
- h) Direction of flow, by means of an arrow (shown on both sides of the body or on one side only provided the direction of flow arrow is easily visible under all circumstances).
- i) Maximum admissible pressure (MAP)¹⁾ if it exceeds **1.4 MPa (14 bar)** ~~1 MPa (10 bar)~~ or 0.6 MPa (6 bar) for $DN \geq 500$.
- j) Letter V or H, if the meter can only be operated in the vertical or horizontal position.
- k) The temperature class as specified in Table 1 where it differs from T30.
- l) The pressure loss class where it differs from Δp 63.
- m) The installation sensitivity class where it differs from U0/D0.

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

- n) For an external power supply: the voltage and frequency:
- o) For a replaceable battery: the latest date by which the battery shall be replaced:

- p) For a non-replaceable battery: the latest date by which the meter shall be replaced:
- q) Environmental classification:
- r) Electromagnetic environmental class.

The environmental classification and electromagnetic environmental class may be given on a separate datasheet, unambiguously related to the meter by a unique identification, and not on the meter itself.

An example of the required marks and inscriptions for a meter without electronic devices follows.

Example: A meter with the following characteristics:

- $Q_3 = 2.5 \text{ m}^3/\text{h}$;
- $Q_3/Q_1 = 200$;
- horizontal mounting;
- temperature class 30;
- pressure loss class Δp 63;
- maximum admissible pressure: 1.4 MPa (14 bar) ~~1 MPa (10 bar)~~;
- flow profile sensitivity class U0/D0;
- serial number: 123456;
- year of manufacture: 2008;
- manufacturer ABC,

would be marked as follows:

Q_3 2.5; R200; H; → ; 123456; 08; ABC

6.7 Indicating device

6.7.1 General requirements

6.7.1.1 Function

The indicating device of a 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 or kilolitres. The symbol m^3 or **kL** 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 used.

Note: The National Measurement Regulations 1999 specify the Australian Legal Units of Measurement.

6.7.1.3 Indicating range

The indicating device shall be able to record the indicated volume in cubic metres or kilolitres given in Table 5 without passing through zero.

Table 5 Indicating range of a water meter

Q_3	Indicating range (minimum values)
m^3/h or kL/h	m^3 or kL
$Q_3 \leq 6.3$	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

Table 5 may be expanded to larger values of Q_3 .

6.7.1.4 Color coding for indicating devices

The color black should be used to indicate the cubic metre or kilolitre and its multiples.

The color red should be used to indicate sub-multiples of a cubic metre or kilolitre.

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

Other means of indicating the cubic metre or kilolitre, its multiples and its sub-multiples may be used for a water meter 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

- one or more pointers moving relative to graduated scales, or
- one or more circular scales or drums each passing an index.

The value expressed in cubic metres or kilolitres 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, kilolitres or accompanied by a multiplication factor ($\times 0.001$; $\times 0.01$; $\times 0.1$; $\times 1$; $\times 10$; $\times 100$; $\times 1\,000$, 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:

- a) movement of numbered roller indicators (drums) shall be upwards;
- b) 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:

- c) 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;
- d) the meter shall provide visual checking of the entire display which shall have the following sequence:
 - 1) for seven segment type displaying all the elements (e.g. an “eights” test);
 - 2) for seven segment type blanking all the elements (a “blanks” test);
 - 3) 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 1 s.

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 or kilolitres shall be of the form: 1×10^n , 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 be not less than 1 mm and not more than 5 mm. The scale shall consist of either:

- a) lines of equal thickness not exceeding one-quarter of the scale spacing and differing only in length; or
- b) 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 subdivisions 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 90 min at the minimum flow rate 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 NMI R 49-2:2015, 6.4.3.6.2.3 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 General

A water meter 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 fulfill the following provisions.

- a) Access shall only be allowed to authorized people, e.g. by means of a code (password) or of a special device (e.g. a hard key). The code shall be capable of being changed.
- b) It shall be possible for evidence of an intervention to be available for a period of time as defined in national regulations. The record shall include the date and a characteristic element identifying the authorized person making the intervention [see a)]. 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 interchangeable, 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;
- 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 of 6.8.2.2 shall apply. Moreover, these meters shall be provided with devices or means which do not allow them to operate if the various parts are not connected according to the approved [pattern](#). 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 NMI R 49-2:2015, Clause 4. Values are specified for flow rate, water temperature, water pressure, ambient temperature, ambient relative humidity, and ambient atmospheric pressure.

7.2 Pattern evaluation and approval

7.2.1 External examination

Before undergoing pattern evaluation tests, each pattern 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 NMI R 49.

7.2.2 Number of samples

The evaluation tests shall be made on the minimum number of samples of each pattern shown in Table 6 as a function of the water meter designation Q_3 of the pattern presented.

The body responsible for pattern evaluation may request further specimens.

Table 6 — Minimum number of water meters to be tested

Meter designation	Minimum number of meters to be tested for all patterns of meter, excluding the tests required for meters with electronic devices
Q_3	
m ³ /h or kL/h	
$Q_3 \leq 160$	3
$160 < Q_3 \leq 1\,600$	2
$1\,600 < Q_3$	1

The requirements of 4.2.2 or 4.2.3 shall apply to all the meters tested, according to the accuracy class of the meter.

For pattern approval of a water meter with electronic devices, five samples shall be supplied for the tests specified in Annex A, which may be different samples from those supplied for other testing, with at least one meter being subjected to all the appropriate tests. The same meter shall be subjected to all testing, except in circumstances where not doing so can be justified by the organization performing the pattern evaluation.

7.2.3 Errors (of indication)

The errors (of indication) of a water meter (in the measurement of the actual volume) shall be determined at least at the following nominal flow rates:

- 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) $1.1 Q_{x2}$.

The errors (of indication) observed for each of the above flow rates shall not exceed the MPEs given in 4.2.2 or 4.2.3.

Note: See NMI R 49-2:2015, 7.4.4 for the permitted flow rate ranges and NMI R 49-2:2015, 7.4.4 and 7.4.5 for the required number of measurements at each flow rate.

If all the relative errors (of indication) of a water meter have the same sign, at least one of the errors shall not exceed one half of the MPE. In all cases this requirement shall be applied equitably with respect to the water supplier and the consumer (see also 4.3.3, paragraphs 3 and 8).

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

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

7.2.4 Repeatability

A meter shall be repeatable: the standard deviation of three measurements at the same flow rate shall not exceed one-third of the MPEs given in 4.2.2 or 4.2.3. Tests shall be carried out at nominal flow rates of Q_1 , Q_2 , and Q_3 .

7.2.5 Overload water temperature

A water meter with $MAT \geq 50^\circ\text{C}$ shall be capable of withstanding a water temperature of $MAT + 10^\circ\text{C}$ for 1 h. The test is specified in NMI R 49-2:2015, 7.6.

7.2.6 Durability

7.2.6.1 General

A water meter shall undergo the durability tests specified in NMI R 49-2:2015, 7.11, simulating service conditions.

After each of these tests, the errors of the water meter shall again be measured at the flow rates given in 7.2.3 and the criteria given in 7.2.6.2 or 7.2.6.3 shall be applied.

The orientation(s) of a meter 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 meter is to be subjected to the durability test.

7.2.6.2 Accuracy class 1 water meter

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

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

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

7.2.6.3 Accuracy class 2 water meter

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

For flow rates in the lower flow rate 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 flow rates in the upper flow rate 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.

7.2.7 Interchange error

It shall be demonstrated that cartridge meters and exchangeable metrological modules for water meters with exchangeable metrological modules are independent of the connection interfaces they are made for as far as their metrological performance is concerned. The cartridge meters and exchangeable metrological modules shall be tested in accordance with the test laid down in NMI R 49-2:2015, 7.4.6.

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

7.2.8 Static magnetic field

It shall be demonstrated that a 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 NMI R 49-2:2015, 7.12. The purpose of the test is to ensure compliance with the provisions of 4.2 in the presence of static magnetic fields.

7.2.9 Documentation

7.2.9.1 The application for [pattern](#) approval of a water meter or a calculator (including indicating device) or a measurement transducer shall include the following documents:

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

- i) optionally, a user guide and installation manual.

7.2.9.2 In addition, the application for **pattern** approval of a water meter with electronic devices shall include:

- a) a functional description of the various electronic devices;
- b) a flow diagram of the logic, showing the functions of the electronic devices;
- c) 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 NMI R 49, in particular 5.1 and Annex B.

7.2.9.3 The applicant seeking **pattern** 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 **pattern**.

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

7.2.10 Pattern approval certificate

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

- a) name and address of the recipient of the certificate;
- b) name and address of the manufacturer, if it is not the recipient;
- c) **pattern** and/or commercial designation;
- d) sufficient information to identify the meter **pattern**, e.g. drawing, photograph or description;
- e) principal metrological and technical characteristics;
- f) **pattern** approval mark;
- g) period of validity;
- h) environmental classification, if applicable (see A.2);
- i) information on the location of marks for **pattern** approval, initial verification and sealing (e.g. a picture or drawing);
- j) list of documents accompanying the **pattern** approval certificate;
- k) specific remarks.

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

7.2.11 Modification of an approved pattern

7.2.11.1 The recipient of the **pattern** approval shall inform the body responsible for the approval of any modification or addition which concerns an approved **pattern**.

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

7.2.11.3 If the body that approved the initial **pattern** 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 **pattern** approval.

A new or supplementary **pattern** approval shall be issued whenever the modified **pattern** no longer fulfills the provisions of the initial **pattern** approval.

7.2.12 Pattern evaluation of a water meter with electronic devices

7.2.12.1 Design inspection

In addition to the requirements specified 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 NMI 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;
- c) verification of the presence and effectiveness of the test device(s) for the checking facilities, if required.

7.2.12.2 Performance

7.2.12.2.1 General

A water meter shall comply with the provisions of 4.2 and 5.1.1 with regard to influence quantities.

7.2.12.2.2 Performance under the effect of influence factors

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

7.2.12.2.3 Performance under the effect of disturbances

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

7.2.12.2.4 Equipment under test

Where the electronic devices form an integral part of a 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 devices may be tested separately.

7.3 Initial verification

In Australia, water meters are verified in accordance with the National Instrument Test Procedure for Utility Meters (NITP 14) and/or test procedures specified in Certificates of Approval. The following clauses (7.3.1 to 7.3.6) are retained for guidance only.

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.

Any special requirements for initial verification testing, detailed in the [pattern](#) approval certificate, shall be applied.

7.3.2 A water meter shall undergo the initial verification tests indicated in the following. This verification shall be carried out after [pattern](#) 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 min (NMI R 49-2:2015, 10.1.2).

7.3.3 Water meters of the same size and the same [pattern](#) may be tested in series; however, in this case the requirement of NMI R 49-2:2015, 10.1.3, step d) concerning water meter outlet pressure shall be met for each water meter and there shall be no significant interaction between water meters.

Upstream and downstream straight lengths (and straighteners if required) shall be in accordance with the flow profile sensitivity class of the meter.

7.3.4 The errors (of indication) of a water meter in the measurement of actual volume shall be determined for at least the following nominal flow rates:

- a) Q_1 ;
- b) Q_2 ;
- c) Q_3 ;
- d) for combination meters, 1.1 Q_{x2} .

Note: See NMI R 49-2:2015, 10.1.3, step 7) for the permitted flow rate ranges.

However, depending on the shape of the error curve, additional flow rates may be specified in the [pattern](#) approval certificate.

During a test, the water temperature shall be as required in NMI R 49-2:2015, 10.1.3, step 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 flow rates shall not exceed the MPEs given in 4.2.2 or 4.2.3.

7.3.6 If all the errors (of indication) of a water meter have the same sign, at least one of the errors shall not exceed one half of the MPE. In all cases this requirement shall be applied equitably with respect to the water supplier and the consumer.

If all the errors (of indication) of a water meter determined for initial verification have the same sign, but none of them is within half the MPE, additional errors at other flow rate(s) as specified in 7.2.3 shall be obtained: if one of these errors is within half the MPE or of the opposite sign, this criterion is deemed fulfilled.

Annex A

(Mandatory)

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 can 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 NMI R 49-2:2015, Clause 4).

A.2 Environmental classification

See OIML D 11^[3].

For each performance test, typical test conditions are indicated which correspond to the climatic and mechanical environmental conditions to which a water meter is 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;
- class M for **m**obile meters.

However, the applicant for [pattern](#) approval may indicate specific environmental conditions in the documentation supplied to the body responsible for [pattern](#) approval, based on the intended use of the instrument. In this case, the testing laboratory shall carry out performance tests at severity levels corresponding to these environmental conditions. If [pattern](#) 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 a meter is approved.

A.3 Electromagnetic environments

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

- E1 – residential, commercial and light industrial;
- E2 – industrial.

A.4 Pattern evaluation and approval of a calculator

A.4.1 When an electronic calculator (including indicating device) is submitted for separate pattern approval, pattern evaluation tests shall be conducted on the calculator (including indicating device) alone, simulating different inputs generated by appropriate standards (e.g. calibrators).

A.4.2 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 MPEs 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 4.2.5.

A.4.3 The examinations and tests for electronic instruments specified in 7.2.12 shall be performed.

A.5 Performance tests

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

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

OIML R 49-2:2015, subclause	Test	Characteristic under test	Conditions applied
8.2	Dry heat	Influence factor	MPE
8.3	Cold	Influence factor	MPE
8.4	Damp heat, cyclic	Disturbance	Significant fault
8.5.2	Mains voltage variation	Influence factor	MPE
8.5.2	Mains frequency variation	Influence factor	MPE
8.5.3	Low voltage of internal battery (not connected to the mains power)	Influence factor	MPE
8.6	Vibration (random)	Disturbance	Significant fault
8.7	Mechanical shock	Disturbance	Significant fault
8.8	AC mains voltage dips, short interruption voltage variations	Disturbance	Significant fault
8.9	Bursts on signal, data and control lines	Disturbance	Significant fault
8.10	Bursts (transients) on AC and DC mains	Disturbance	Significant fault
8.11	Electrostatic discharge	Disturbance	Significant fault
8.12	Radiated electromagnetic fields	Disturbance	Significant fault
8.13	Conducted electromagnetic fields	Disturbance	Significant fault
8.14	Surges on signal, data and control lines	Disturbance	Significant fault

8.15	Surges on AC and DC Mains power lines	Disturbance	Significant fault
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Annex B

(Mandatory)

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 type I:

- a) there shall be automatic correction of the fault; or
- b) only the faulty device shall stop if a water meter without that device continues to comply with the regulations; or
- c) there shall be a visible or audible alarm; this alarm shall continue until the cause of the alarm is suppressed.

In addition, when a 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 a 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

B.2.1 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.2.2 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 fulfill the following tasks:

- a) correct counting of pulses;
- b) detection of reverse flow, if necessary;
- c) checking of correct function.

This may be done by means of:

- a) three-pulse system with use of either pulse edges or pulse status;
- b) double-pulse line system with use of pulse edges plus pulse status;
- c) 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 **pattern** evaluation to verify that these checking facilities function correctly:

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

B.2.3 For electromagnetic meters only, where the amplitude of the signals generated by the measurement transducer is proportional to the flow rate, 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 flow rate between the minimum and maximum flow rates of a 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 MPEs. This checking facility shall be of type P or type I. For type I facilities, checking shall occur at least every 5 min.

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

B.2.4 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 m or not more than the value L expressed in metres according to the following formula, whichever is smaller:

$$L = \frac{k\sigma}{fC}$$

where:

- k is equal to 2×10^{-5} m;
- σ is the conductivity of the water, in S/m;
- f is the field frequency during the measuring cycle, in Hz;
- C is the effective cable capacitance per metre, in F/m.

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

B.2.5 For other technologies, checking facilities providing equivalent levels of security remain to be developed.

B.3 Checking facilities for the calculator

B.3.1 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.3.2 The checking facilities for the functioning of the calculation system shall be of type P or type I. For type I the checking shall occur at least either once per day or for every volume equivalent to 10 min 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:
 - i) summing up all instruction and data codes and comparing the sum with a fixed value;
 - ii) line and column parity bits (longitudinal redundancy check and vertical redundancy check);
 - iii) cyclic redundancy check (CRC 16);
 - iv) double independent storage of data;
 - v) storage of data in “safe coding”, e.g. 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:
 - i) write-read routine;
 - ii) conversion and re-conversion of codes;
 - iii) use of “safe coding” (checksum, parity bit);
 - iv) double storage.

B.3.3 The checking facilities for the validity of calculations shall be of type P or type I. For type I the checking shall occur either at least once per day, or for every volume equivalent to 10 min 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

B.4.1 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 have either the form as defined in B.4.2 or that as defined in B.4.3.

B.4.2 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:

- a) for indicating devices using incandescent filaments or light emitting diodes, measuring the current in the filaments;
- b) for indicating devices using fluorescent tubes, measuring the grid voltage;
- c) 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.4.3 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.3.3.

B.4.4 It shall be possible during [pattern](#) evaluation to determine that the checking facility of the indicating device is working, either:

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

B.4.5 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.

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 type 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.5 Checking facilities for the associated measuring instruments

Associated measuring instruments shall include a checking facility of type P or type 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; control of the driving current for 4–20 mA pressure sensors.

Annex C

(Informative)

Permissible errors in service and subsequent verification

The MPEs of a water meter while in service should be twice the MPEs given in 4.2.2 or 4.2.3 according to the accuracy class of the meter. Although subsequent verification is not covered in the scope of this part of NMI R 49, historically this has been found to be reasonable.

Subsequent verification should be applied in accordance with national regulations for legal metrology.

The National Measurement Act 1960 does not specify a re-verification period for water meters. However, where a water meter is tested for in-service performance, the National Trade Measurement Regulations 2009 specify the maximum permissible errors for in-service inspection.

Bibliography

- [1] OIML V 2-200:2012, *International vocabulary of metrology — Basic and general concepts and associated terms (VIM)*
- [2] OIML V 1:2013, *International vocabulary of terms in legal metrology (VIML)*
- [3] OIML D 11:2013, *General requirements for measuring instruments - Environmental conditions*
- [4] ISO 3, Preferred numbers — Series of preferred numbers
- [5] ISO 4006:1991, Measurement of fluid flow in closed conduits — Vocabulary and symbols
- [6] ISO 6817:1992, Measurement of conductive liquid flow in closed conduits — Method using electromagnetic flowmeters
- [7] ISO 4064-4:2014, Water meters intended for the metering of cold potable water and hot water — Part 4: Specification of non-metrological requirements not covered in Part 1
- [8] ISO 4064-5:2014, Water meters intended for the metering of cold potable water and hot water — Part 5: Specification of installation requirements
- [9] AS 2845.1:2005, Water supply - Backflow prevention devices – Part 1: Materials, design and performance requirements
- [10] AS 3565.1:2010, Meters for cold and heated drinking and non-drinking water supplies – Part 1: Technical requirements
- [11] AS/NZS 4020:2005, Testing of products for use in contact with drinking water