SLOVENSKI STANDARD
SIST EN 17694-2:2023

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Hidrometrija - Minimalne zahteve za tehnične lastnosti in preskusni postopki za opremo za nadzor vode - Naprave za ugotavljanje pretoka - 2. del: Instrumenti za merjenje v zaprtem vodu

Hydrometry - Minimum performance requirements and test procedures for water monitoring equipment - Devices for the determination of flow - Part 2: Closed conduit instrumentation

Hydrometrie - Leistungsanforderungen und Prüfverfahren für Wasserüberwachungsgeräte - Geräte zur Bestimmung des Durchflusses - Teil 2: Messgeräte für geschlossene Rohrleitungen

Hydrométrie - Exigences minimales de performance et modes opératoires d'essai pour les équipements de surveillance de l'eau - Dispositifs de mesure de l'écoulement - Partie 2 : Instruments de mesure pour écoulements en conduite fermée

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (EN 17694-2:2023) has been prepared by Technical Committee CEN/TC 318 “Hydrometry”, the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 2023, and conflicting national standards shall be withdrawn at the latest by November 2023.

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

This standard is published in two parts:

— EN 17694-1, *Hydrometry — Minimum performance requirements and test procedures for water monitoring equipment — Devices for the determination of flow — Part 1: Open channel instrumentation*

— EN 17694-2, *Hydrometry — Minimum performance requirements and test procedures for water monitoring equipment — Devices for the determination of flow — Part 2: Closed conduit instrumentation*

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

Introduction

This document is a product standard for instrumentation for the determination of the flow of waters in closed conduits (e.g. effluent discharges from industrial installations, and wastewaters from sewage treatment works, water irrigation channels and water transfer channels). A closed conduit instrument (CCI) is a device that is normally fixed in position and used mainly to measure either volumetric flow-rate and/or total volume passed. Certain CCI, e.g. Coriolis devices measure mass flow-rate and/or total mass passed, from which volumetric flow may be derived, using the density of the water. This document defines general requirements, minimum performance requirements, and test procedures. A CCI that is shown, by means of the tests, to conform with the general requirements and performance requirements is considered to be fit for purpose. However, this document does not cover the installation and on-going use of a CCI, and also excludes instrumentation that is subject to separate legal control, for example, the Measuring Instruments Directive.

The acronym “CCI” is used throughout this document except where it is necessary to be specific about the particular type or component (e.g. sensor) of a device.

The general requirements and performance requirements specified in this document are intended to be independent of measurement technology and applicable to all CCIs. The general requirements include several features that are necessary to meet users’ applications and information that should be included in associated documents.

The performance tests comprise testing carried out under laboratory and field conditions. They are designed to determine, in a systematic and consistent way, the capability of CCI to make reliable measurements. The testing focuses on key performance characteristics. Statistical procedures are defined for evaluation of the test data.

Measurement ranges are not specified as part of the performance requirements though a minimum ratio (maximum measured value: minimum measured value) is specified. It is for the manufacturer of the CCI to decide on the measurement range over which the performance requirements are shown to be met by the specified test procedures. Similarly, it is for the CCI manufacturer to decide on the intended uses (applications) which will inform the design of the field trial.

Water monitoring equipment is widely used for compliance monitoring purposes under national and European regulations.

1 Scope

This document specifies general requirements, minimum performance requirements and test procedures for instrumentation used to measure either volumetric flow-rate and/or total volume passed of water in closed conduits. It covers all closed conduit instrument (CCI) technologies intended to operate in closed pressurized pipes and partially filled pipes. Requirements are expressed in volumetric units which may be converted to mass using the density of the water.

It is recognized that for some CCIs certain tests cannot be carried out.

The data obtained from the testing of CCIs in accordance with the requirements of the Measuring Instruments Directive [1] or EN ISO 4064-1 [2] can be used to meet, in part, the requirements specified in this document. However, for the avoidance of doubt, compliance with the requirements of this document does not equate to compliance with the requirements of the Measuring Instruments Directive or EN ISO 4064-1.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— IEC Electropedia: available at https://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
combined performance requirement
combination of individual performance requirements

3.2
conduit
pipe through which water is flowing

3.3
closed conduit instrument
CCI
device(s) which measures the flow-rate or totalized volume of water passing along a conduit or computes such quantities from measurements of one or more properties which have a defined relationship with the flow-rate

Note 1 to entry: A closed conduit instrument can, for example, include a complete flow-metering system, such as: a flow sensor and transmitter, a mechanical CCI including any ancillary device required to derive an electronic output, a velocity-area CCI comprising a water velocity sensor with a water level sensor and associated electronics, or a non-standardized primary device with a differential pressure sensor and associated electronics.

3.4
determinand
property that is required to be measured

3.5
expanded uncertainty
expanded measurement uncertainty
U
product of a combined measurement uncertainty and a factor larger than the number one

Note 1 to entry: The factor depends upon the type of probability distribution of the output quantity in a measurement model and on the selected coverage probability.

Note 2 to entry: The term "factor" in this definition refers to a coverage factor.

Note 3 to entry: Expanded measurement uncertainty is termed "overall uncertainty" in paragraph 5 of Recommendation INC-1 (1980) (see the GUM) and simply "uncertainty" in IEC documents.

[ISO/IEC Guide 99:2007, 2.35 plus notes] [3]

3.6
flow-rate
q
volume of water passing through the CCI per unit time

3.7
influence quantity
quantity, generally external to the CCI, which may affect the performance of the equipment

3.8
insertion sensor
sensor designed to be inserted into a pipe through a tapping or other fitting, or mounted internally within a pipe, in direct contact with the water and connected to a transmitter mounted externally to the pipe

3.9
measurement range
range over which the CCI conforms within the performance requirements specified in this document

Note to 1 entry: The measurement range is defined from a minimum non-zero value to a maximum value.

3.10
non-invasive sensor
sensor for application to a pipe which attaches to the outside of a pipe and requires no tapping, drilling or cutting of the pipe to install, for example clamp-on ultrasonic transducers

3.11
percentage error
error in measurement expressed as a percentage of the true or actual value

Note 1 to entry: In this document, the true or actual value is the reference value and percentage error is calculated using the following equation: percentage error = 100 × (measured value – reference value)/reference value.

3.12
performance requirement
one of the quantities (described by values, tolerances, range) that defines a CCI's performance

3.13
rated operating conditions
minimum to maximum values of any environmental, fluid or electrical parameter within which a CCI is designed to operate without adjustment, within the performance requirements specified in this document

3.14
reference conditions
specified set of values (including tolerances) of influence variables, delivering representative values of performance requirements

3.15
reference method
method to be used to obtain the determinand value to a stated uncertainty, against which the readings from the CCI under test can be compared

3.16
repeatability
ability of a CCI to provide closely similar indications for repeated applications of the same determinand under the same conditions of measurement

3.17
sensor
transducer consisting of one or more components from which is derived an electrical or mechanical output related to a property from which the flow-rate may be computed

3.18
totalized volume
total volume of water which has been measured by the CCI over a period of time which commenced when the totalizer was set to zero

4 Symbols

For the purposes of this document the following symbols apply.

b	bias
S_R	repeatability
X_V	errors due to variations in supply voltage
X_O	errors due to variations in output impedance
X_{FT}	errors due to variations in water temperature
X_T	errors due to variations in ambient air temperature
X_{RH}	errors due to variations in relative humidity
X_{SL}	errors due to variations in sensor location
X_{SC}	errors due to variations in stray currents
U_C	combined performance requirement

5 Principle

This document sets general requirements, minimum performance requirements and test procedures for a CCI that is to be used for determining the flow of water in closed conduits.

The general requirements are based on experience of users' needs when operating a CCI in a range of applications. Many are consistent with general requirements specified in EN ISO 4064-1.

The minimum performance requirements specify limit values in terms of percentage error for measurement bias, repeatability, a range of environmental and sensor operational parameters, and for a combination of all of these values. A CCI that can be demonstrated by the specified tests to conform with the performance requirements is judged to be fit for purpose.

For the majority of applications where a CCI is used, the required parameter is volumetric flow-rate.

In Table 2 the combined performance requirement is less than the sum of the specified individual performance values combined in quadrature. This allows for some differences in the performance of a CCI with respect to the individual requirements within an overall combined performance requirement.

The laboratory performance tests are designed to show whether a CCI can conform with the applicable performance requirements under a range of environmental and sensor operational conditions. Laboratory testing is used to determine the performance characteristics in a systematic and consistent way in a controlled environment. Several of the laboratory tests correspond to tests specified in EN ISO 4064-2 [4] and ISO 12242 [5]. For CCI that are tested to demonstrate conformity with EN ISO 4064-1 and ISO 12242 the test data can also be used for the purposes of this document thereby minimizing the amount of testing.

Statistical procedures are defined for evaluation of the laboratory test data to produce the individual performance characteristic measurement uncertainties, u, and the combined performance characteristic measurement uncertainty, U_C. They are based on the ISO/IEC Guide 98-3 [6]. The measured errors arising from the tests for each performance tests are converted to standard uncertainties, taking into account the distribution of errors. To obtain the combined performance characteristic, the individual uncertainties are combined using a root sum of squares, as described in the GUM, with due account taken of the contribution of each component through the use of sensitivity coefficients. To determine sensitivity coefficients, it is necessary to know the functions by which each component contributes to overall error. In the case of CCI testing this will rarely be known. Hence, for the purposes of this document, the sensitivity coefficients are all taken as 1.

The combined performance characteristic, U_C, is expressed as an expanded uncertainty. The expanded uncertainty, (U), is obtained by multiplying the standard uncertainty by a coverage factor. The coverage factor is determined by the confidence level. This document uses a 95 % confidence with a coverage factor assumed to be 2.

The field trial is used to demonstrate that the performance of a CCI can be maintained under operational conditions and to determine the CCI's up-time.

6 General requirements

6.1 Requirements for closed conduit instrumentation

A CCI shall have:

a) a unique designation that unambiguously identifies the CCI (e.g. model, serial number);

b) a means of protection against inadvertent or unauthorized access to the control functions (e.g. password, physical locks, etc);

c) an output signal and/or display scaled in metric units (the units of measurement shall be displayed on the indicating device);

d) one or more output signals and/or a means of displaying the measured determinand and/or either the totalized volume and/or volumetric flow-rate. If the CCI does not incorporate a local display, it shall be possible for an authorized person to obtain the current reading by communicating with the CCI on site using a portable device, such as a laptop, tablet or smart phone. Communication with a portable device to display a reading shall not interrupt the measurement and shall not allow the user to defeat access security features;

e) a means of displaying its operating status, for example, normal operation, stand-by, maintenance mode or malfunction;

f) a means to return to normal operating mode from maintenance, service or programming mode if no user interactions have been detected after a defined time period;

g) an audible or visual method of indicating loss of power supply (applies only to CCI operating from an external power supply), e.g. a relay that fails open;

h) an audible or visual method of indicating when the power supply voltage is below its normal operating limit (applies only to CCIs operating from a battery);

i) a means for preventing unauthorized resetting of the total recorded volume for abstraction metering and/or effluent discharge monitoring; a symbol, incorporated into the indication device to show the flow direction, for bi-directional CCI;

NOTE A pointer rotating clockwise with increasing flow and counter-clockwise with reverse flow is acceptable, but reliance on an increasing or decreasing total is not.

j) a clear physical marking of the direction of forward flow (in the case of a bi-directional CCI this should be the direction of flow which gives an increase in the total flow recorded. For a CCI which has been wet calibrated, this should be the direction of flow in which the CCI has been calibrated);

k) a means to subtract from the indicated volume or to record separately the reverse flow volume, for a bi-directional CCI;

l) an upstream strainer or filter to protect the CCI, where recommended by the manufacturer;

m) a minimum rated operating range for water conductivity between 50 µS cm^{-1} to 1200 µS cm^{-1} for an electro-magnetic device;

n) a means for displaying the firmware and software versions installed.

6.2 Requirements for associated documentation

The following information shall be incorporated into the associated documentation:

a) operating instructions which cover the full functionality and measurement principle of the CCI. These instructions shall make clear if they are applicable to specific versions of software or firmware;

b) generic guidance on the time period over which the CCI can operate continuously without requiring manual adjustment or intervention;

NOTE 1 Automatic routines for cleaning, maintenance or recalibration can be used to maintain performance within the required limits between manual interventions. It is up to the user to ensure that a suitable regime is adopted for an individual application.

c) a statement of the types of primary device, where applicable, for which the CCI can compute flow-rate without the input of data other than the type and dimensions of the primary device and a zero datum;

d) a statement of whether the CCI is designed to measure flow in both forward and reverse directions;

e) a statement defining minimum up and downstream straight lengths of conduit of uniform section adjacent to the sensor required to meet the performance requirements of this document;

f) a statement of any limitations on the material of conduit into or onto which the CCI's sensor can be installed;

g) a statement of any limitations on the conduit dimensions or shape (including wall thickness or pipe schedule if appropriate), into or onto which the CCI's sensor can be installed. If multiple sensors are required, for example in a large conduit, the number and spacing of those sensors shall be stated;

h) for non-contact velocity sensors, a statement of the minimum and maximum separation distances from the sensor face to the water surface;

i) a statement of the minimum measurable water depth under free surface conditions (the maximum measurable water depth is assumed to be full bore), for CCIs intended to operate in partially filled pipes. The manufacturer shall also state whether the CCI can maintain performance within the requirements of this document under surcharged conditions. A CCI that can only operate in partially filled pipe with free surface conditions should be tested in accordance with EN 17694-1 [7];

j) a statement, where appropriate, of the rated operating conditions for water pressure;

k) a statement of the quality (e.g. contaminants, salinity) nature and quantity of particulate or other material that the CCI can pass whilst maintaining its performance within the limits of this document. If a minimum level of particulate is required for operation of the CCI, this too shall be stated;

l) a statement of any specific requirements relating to the location or shielding of components necessary to maintain performance within the limits of this document under varying environmental conditions;

m) a statement, for electronic CCI, of the rated operating conditions for the power supply;

n) a statement, for electronic CCI, of the rated operating conditions for the signal load impedance on the analogue output, if present. This shall include any resistive effects of cabling and terminations;