
Hidrometrija - 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 - 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

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**Hydrometry - 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

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 318.

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If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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COMITÉ EUROPÉEN DE NORMALISATION
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European foreword

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

This document is currently submitted to the CEN Enquiry.

This standard is published in two parts:

prEN 17694-1 *Hydrometry - Performance requirements and test procedures for water monitoring equipment – Devices for the determination of flow - Part 1 Open channel instrumentation*

prEN 17694-2 *Hydrometry - Performance requirements and test procedures for water monitoring equipment – Devices for the determination of flow - Part 2 Closed conduit instrumentation*

This document has been prepared under a Standardization Request given to CEN by the European Commission and the European Free Trade Association.

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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 fluid. 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 fluid density.

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 terminological 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>
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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 to 1 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, associated electronics and flow computer, a bespoke gauge with a water level sensor, associated electronics and flow computer, a non-standardized primary device with a differential pressure sensor, associated electronics and flow computer.

3.4 determinand

the property that is required to be measured

3.5**expanded uncertainty*****U***

expanded measurement uncertainty 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]

3.6**flow-rate*****q***

volume of water passing through the CCI per unit time

3.7**influence quantity**

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

3.8**measurement range**

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

3.9**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

3.10**percentage error**

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

Note to 1 entry: In this document, the true or actual value is the reference value and percentage error is calculated using the following equation: $\text{percentage error} = 100 \times (\text{measured value} - \text{reference value}) / \text{reference value}$.

3.11**performance requirement**

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

3.12**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

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

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prEN 17694-2:2021 (E)**3.13****reference conditions**

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

3.14**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

3.15**repeatability**

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

3.16**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

3.17**totalized volume**

the 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

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For the purposes of this standard the following symbols apply.

b	Bias	oSIST prEN 17694-2:2021
S_r	Repeatability	https://standards.iteh.ai/catalog/standards/sist/18f2387a-d19b-4761-ad15-ce17296a0cb1/osist-pren-17694-2-2021
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 fluid 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 CCI are 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 performance of CCIs 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 [3] and ISO 12242 [4]. For CCI that are tested to demonstrate conformity with EN ISO 4064 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 [5]. The measured errors arising from the tests for each performance tests are converted to standard uncertainties, taking into account the probable 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 standard, 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) an 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);

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

- i) a clear 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);
- j) a means to subtract from the indicated volume or to record separately the reverse flow volume, for a bi-directional CCI;
- k) an upstream strainer or filter to protect the CCI, where recommended by the manufacturer;
- l) a minimum rated operating range for fluid conductivity between $50 \mu\text{S cm}^{-1}$ to $1200 \mu\text{S cm}^{-1}$ for an electro-magnetic device.

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;
- 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 structure 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 fluid surface;
- i) a statement of the minimum measurable fluid depth under free surface conditions (the maximum measurable fluid 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 [6];
- 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 standard. 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 standard 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;
- o) a statement of the rated operating conditions for water temperature, ambient temperature and humidity as appropriate;

NOTE 2 The influence of ambient temperature and relative humidity on the performance of a CCI is tested (see 7.4 and 9.3.6) over the rated environmental operating conditions.

- p) the minimum rated operating range for fluid conductivity for an electromagnetic CCI.

7 Performance requirements

7.1 Expression of performance requirements

Specific requirements are expressed as bias (b), variations in error (X), standard deviation (u) or expanded uncertainty (U) as shown in Table 1. Not all requirements will apply to every CCI

Annex A describes in detail how the values are calculated for each requirement.