SLOVENSKI STANDARD
SIST EN 17694-1:2023

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Hidrometrija - Minimalne zahteve za tehnične lastnosti in preskusni postopki za opremo za nadzor vode - Naprave za ugotavljanje pretoka - 1. del: Instrumenti z odprtim kanalom

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

Hydrometrie - Leistungsanforderungen und Prüfverfahren für Wasserüberwachungsgeräte - Geräte zur Bestimmung des Durchflusses - Teil 1: Messgeräte für offenes Gerinne

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 1 : Instruments de mesure pour écoulements à surface libre

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This European Standard was approved by CEN on 13 February 2023.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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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 17694-1:2023) 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of an identical text or by endorsement, at the latest by November 2023, and conflicting national standards shall be withdrawn at the latest by November 2023.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 open channel instrumentation for the determination of the flow of waters in artificial channels (e.g. effluent discharges from industrial installations, wastewaters from sewage treatment works, water irrigation channels, and water transfer channels). An open channel instrument (OCI) is either a level sensor used in conjunction with a gauging structure or a velocity area instrument or a velocity sensor. It is normally fixed in position and used to determine either volumetric flow-rate and/or total volume passed. This document specifies general requirements, minimum performance requirements, and test procedures. These specifications are derived from ISO 11655 [1]. An OCI 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 an OCI for which relevant standards exist.

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

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 OCI to decide on the measurement range over which the performance requirements are shown to be met by the specified test procedures.

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 open channel instrumentation used to determine either volumetric flow-rate and/or total volume passed of waters in artificial open channels. It covers the following technology categories:

— Level sensors with associated electronics designed to be used with a conventional gauging structure. (The requirements and test procedures for gauging structures, such as weirs and flumes, are excluded. The stage discharge characteristics for many of these structures are established and published in national and international standards).

— Water velocity sensors.

— Integrated velocity area instruments comprising level and velocity sensors that may be separate or combined in a single assembly.

— Velocity sensors that determine the mean water velocity through a channel.

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

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN ISO 772, *Hydrometry - Vocabulary and symbols (ISO 772)*

CEN ISO/TS 25377, *Hydrometric uncertainty guidance (HUG) (ISO/TS 25377)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 772 and CEN ISO/TS 25377 and the following 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
aspect ratio
for side mounted sensors, the ratio of the measurement range to height where the range is the horizontal distance from the instrument and height is the vertical distance to the surface or bottom

Note 1 to entry: Aspect ratio is fully defined in ISO 15769 and applies specifically to side mounted water velocity sensors.

3.2
combined performance requirement
combination of individual performance requirements

3.3
determinand
property that is required to be measured

3.4
open channel instrument
OCI
device which measures the flow-rate and/or totalized volume of water passing along an open channel, or computes such quantities from measurements of one or more properties which have a relationship with the flow-rate

Note 1 to entry: For the purposes of this document an open channel instrument is:

— a level sensor with associated electronics designed to be used with a conventional gauging structure (e.g. weir or flume for which the stage discharge characteristics are established and published, in a national or international standard) or a water velocity sensor;

— an integrated velocity area device comprising level and velocity sensors that may be separate or combined in a single assembly;

— a velocity sensor that determines the mean water velocity through a channel.

3.5
flow-rate
q
volume of water passing per unit time

3.6
influence quantity
quantity, generally external to the OCI, which may affect the performance of the equipment

3.7
measurement range
range over which the OCI conforms within the performance requirements specified in this document

Note 1 to entry: For level sensors the measurement range is expressed in terms of the depth of water above a fixed datum (stage). For integrated velocity area devices, the measurement range is expressed in terms of volumetric flow-rate and for velocity sensors the measurement range is expressed in terms of mean water velocity.

Note 2 to entry: The measurement range is defined from a minimum non-zero value to a maximum value.

3.8
non-contact sensor
velocity or level sensor that is not in direct contact with the water

3.9
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.

3.10
performance requirement
one of the quantities (described by values, tolerances, range) that define an OCI's performance

3.11
rated operating conditions
minimum to maximum values of any environmental, water or electrical parameter within which an OCI is designed to operate without adjustment

Note 1 to entry: The performance requirements are specified in this document.

3.12
reference conditions
specified set of values (including tolerances) of influence variables, delivering representative values of performance requirements

3.13
reference method
method to be used to obtain the determinand value to a stated uncertainty, against which the readings from an instrument under test can be compared

3.14
repeatability
ability of an OCI to provide closely similar indications for repeated applications of the same determinand under the same conditions of measurement

3.15
totalized volume
total volume of water which has been measured over a period of time which commenced when the totaliser was set to zero

3.16
totalizer
indicating device showing the totalised volume

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 fluid temperature
X_T	errors due to variations in ambient air temperature
X_{RH}	errors due to variations in relative humidity
X_{LX}	errors due to variations in incident light
X_{SR}	errors due to variations in direct solar radiation
X_S	errors due to variations in sensor location
X_U	errors due to variations in the user defined curve
U_C	combined uncertainty performance requirement

5 Principle

This document sets general requirements, minimum performance requirements and test procedures for an OCI that is to be used for determining the flow of water in artificial channels.

The general requirements are based on experience of users' needs when operating an OCI in a range of applications.

The minimum performance requirements are parameters, derived from ISO 11655, that identify the capability of an OCI to provide reliable measurements. The requirements specify limit values in terms of percentage of reading for measurement bias and repeatability, and for a range of environmental and sensor operational parameters, and for a combination of all of these values. These limit values were established originally through dialogue with OCI manufacturers, users and regulators. They have been in use for over 20 years and have been validated through extensive testing of OCIs. An OCI 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 OCI are used, the required parameter is volumetric flow-rate. For an integrated velocity area instrument the performance requirements are expressed as percentage of volumetric flow. For level sensors, the performance requirements are tighter because account has to be taken of the inherent uncertainty of the conventional gauging structure with which it is to be used. (The requirements and test procedures for gauging structures, such as weirs and flumes, are excluded. The stage discharge characteristics for many of these structures are established and published in national and international standards.) ISO standards state that the uncertainty inherent in the algorithm used to convert the measured determinand to flow of the conventional gauging structure can be in the range of 1 % to 3 %. Mean velocity instruments require an input of the channel cross sectional area, usually derived from a level sensor, to determine volumetric flow-rate. Allowance therefore is made for the uncertainty of the level sensor. The performance values in Table 2 have therefore been chosen such that the root sum square of the values for the separate level and velocity sensors equal the value for the integrated velocity area instrument for example:

$$S_{\mathrm{Rint}} = \sqrt{\left(S_{\mathrm{Rvel}}^2 + S_{\mathrm{Rlevel}}^2\right)}$$

where

S_{Rint} is the repeatability of an integrated instrument;

S_{Rvel} is the repeatability of a velocity sensor; and

S_{Rlevel} is the repeatability for a level sensor.

The overall measurement reliability of an OCI is captured by bringing the individual performance characteristics together in the form of a combined performance characteristic expressed as a measurement uncertainty. However, the combined performance requirement for each category of OCI is less than the sum of the specified individual performance values combined in quadrature. This allows for some differences in performance of OCIs within a category with respect to the applicable individual requirements.

The laboratory test procedures are designed to show whether an OCI 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.

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 Guide to the Expression of Uncertainty in Measurement (GUM). The procedure for calculating the combined performance characteristic

measurement uncertainty involves converting the individual performance characteristic uncertainties to standard uncertainties. This takes account of the distribution of errors. In the GUM, standard uncertainties are combined using a root sum of squares with due account taken of the contribution of each component through the use of sensitivity co-efficients. To determine sensitivity co-efficients, it is necessary to know the functions by which each component contributes to overall error. In the case of OCI testing this will rarely be known. Hence for the purposes of this document, the sensitivity co-efficients 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 an OCI can be maintained under operational conditions and to determine the OCI's up-time.

6 General requirements

6.1 Requirements for open channel instrumentation

An OCI shall have:

a) a unique designation that unambiguously identifies the OCI (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 OCI does not incorporate a local display, it shall be possible for an authorized person to obtain the current reading by communicating with the OCI on site using a portable device, such as a laptop, tablet or smartphone. 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 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 OCIs operating from an external power supply);

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

i) where required by the user, a means for using a user defined stage-discharge or velocity index rating for computing flow from a level and/or velocity measurement sensor;

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

k) a means for displaying the firmware and software versions installed;

l) a means to ensure that there is no interference between adjacent sensors where multiple sensors are required to make a measurement, for example in a wide channel.

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 OCI. These instructions shall make clear if they are applicable to specific versions of software or firmware;

b) guidance on the time period over which the OCI 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 gauging structures where applicable, for which the OCI is pre-programmed to compute flow-rate without the input of data other than the type and dimensions of the structure and a zero datum;

d) a statement defining minimum up and downstream straight lengths of channel of uniform section adjacent to the sensor required to meet the performance characteristics of this document;

NOTE 2 Where these dimensions are specified in other standards include an appropriate reference.

e) a statement of any limitations on the channel dimensions or shape into or onto which the OCI's sensor can be installed; to meet the performance requirements of this document. If multiple sensors are required, for example in wide channels, the number, and spacing of these sensors shall be stated;

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

NOTE 3 The maximum separation distance will be the measurement range of the level sensor plus the minimum separation distance.

g) a statement of the positioning required for the operation of submerged sensors (e.g. aspect ratio, distance from channel base, minimum depth of overhead water);

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

i) 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;

j) a statement of the measurement resolution for level sensors according to EN ISO 4373 [2];

NOTE 4 The stated measurement resolution can be included in the calculation of the combined performance requirement; see Annex A, A.5.

k) a statement of the rated operating conditions for the power supply;