SIST

SLOVENSKI STANDARD
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Hidrometrija - Merilne zahteve in razvrstitev instrumentov za merjenje moči padavin

Hydrometry - Measurement requirements and classification of rainfall intensity measuring instruments

Messung der Regenintensität - Messbedingungen und Klassifizierung für auffangende Regenmesser

Hydrométrie - Exigences de mesure et classification des instruments de mesure d'intensité pluviométrique

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Hydrometry - Measurement requirements and classification of rainfall intensity measuring instruments

Hydrométrie - Exigences de mesure et classification des instruments de mesure d'intensité pluviométrique

Messung der Regenintensität - Messbedingungen und Klassifizierung für auffangende Regenmesser

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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European foreword

This document (EN 17277:2019) has been prepared by Technical Committee CEN/TC 318 "Hydrometry", the Secretary 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of an identical text or by endorsement, at the latest by April 2020, and conflicting national standards shall be withdrawn at the latest by April 2020.

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 document has been developed from the following:

— CEN/TR 16469:2013 Measurement of the rainfall intensity: requirements, calibration methods and field measurements,

— UNI 11452:2012 Hydrometry - Liquid precipitation intensity: measurements requirements and calibration methods for catching-type gauges

— BS 7843-3:2012 Code of practice for the design and manufacture of storage and automatic collecting rain gauges

— WMO Guide to Meteorological Instruments and Methods of Observation, WMO-n. 8, ed. 2014 (updated 2017). ISBN 978-92-63-10008-5.

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Introduction

Precipitation gauges are one of the basic components of world hydro-metrological networks. A requirement for more accurate instruments is crucial for many applications including water resources management, public safety and disaster mitigation.

This standard provides a consistent process for classification of catching type rainfall intensity gauges in laboratory conditions.

This standard will allow users to buy and use a rainfall intensity gauge knowing that it will perform to a specific class of performance before it is deployed to the field.

1 Scope

This document considers liquid atmospheric precipitation and defines the procedures and equipment to perform laboratory and field tests, in steady-state conditions, for the calibration, check and metrological confirmation of liquid precipitation measurement instruments. It provides a classification of catching-type measurement instruments based on their laboratory performance. The classification does not relate to the physical principle used for the measurement, nor does it refer to the technical characteristics of the instrument assembly, but is solely based on the instrument calibration. Attribution of a given class to an instrument is not intended as a high/low ranking of its quality but rather as a quantitative standardized method to declare the achievable measurement accuracy in order to provide guidance on the suitability for a particular purpose, while meeting the user's requirements.

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 10012:2003, *Measurement management systems - Requirements for measurement processes and measuring equipment ISO 10012:2003)*

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 http://www.electropedia.org/

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

3.1
precipitation (snowfall and rainfall)
the liquid or solid product of the condensation of water vapour falling from clouds or deposited from air onto the ground; it includes rain, hail, snow, dew, rime, hoar frost and fog precipitation

Note 1 to entry: The total amount of precipitation that reaches the ground in a stated period is defined "rainfall" when precipitation is liquid and "snowfall" when the precipitation is snow.

Note 2 to entry: Rainfall (total amount of liquid precipitation) is expressed in terms of the vertical depth of water (usually in millimetres, mm) to which it would cover a horizontal projection of the Earth's surface.

Note 3 to entry: Snowfall (total amount of snow) is expressed in terms of the vertical depth of water equivalent to which it would cover a horizontal projection of the Earth's surface. Snowfall is also expressed by the depth of fresh, newly fallen snow covering an even horizontal surface.

[SOURCE: WMO no.8 "CIMO Guide" Part I Chap. 6 new edition 2014]

3.2
rainfall intensity
RI
the amount of liquid precipitation (rainfall) collected per unit time interval; due to its variability from minute to minute, RI is measured or derived (from the measurement of the amount) over 1 minute time intervals and the measurement units are vertical depth of water per hour, usually in millimetres per hour or mm h^{-1}

Note 1 to entry: The RI is derived or measured directly using only rainfall intensity gauges (see definition 3.4).

[SOURCE: WMO no.8 “CIMO Guide” Part I Chap. 6 new edition 2014]

3.3
catching type rain gauge
rain gauge which collects precipitation through an orifice, often a funnel, of well-defined size and measures its water equivalent, volume, mass or weight that has been accumulated in a certain amount of time

Note 1 to entry: This type of gauge includes storage, level monitoring, tipping bucket and weighing rain gauges. These are the most common type of recording rain gauge in use in operational networks at the time of preparing this text.

3.4
rainfall intensity gauge
RI gauge
automatic recording rain gauge which measures RI at a resolution of at least one minute

3.5
delay time of the output of a RI gauge
possible time delay between the output signal of a RI gauge and the time when the measurement was performed

Note 1 to entry: This delay is usually due to internal calculations of the rain gauge.

Note 2 to entry: The internal calculation of the rainfall intensity in some rain gauges can cause a delay of the output data message (e.g. 1 min) that can easily be shifted automatically to the correct time without any degradation in measurement accuracy. This is typical of software corrected tipping bucket rain gauges through embedded electronic chips or interfaces. The delay time should not be confused with the time constant. If real-time output is not needed, software induced delay times are less critical than longer time constants or any other effects, because delay times can easily be corrected to retrieve the original RI information.

[SOURCE: WMO IOM – 99]

3.6
measurand
quantity intended to be measured

[SOURCE: *VIM 3rd edition, JCGM 200:2012*]

3.7
measurement uncertainty
non-negative parameter characterizing the dispersion of the quantity values being attributed to a measurand, based on the information used

[SOURCE: *VIM 3rd edition, JCGM 200:2012*]

Note 1 to entry: The parameter may be, for example, a standard deviation called standard measurement uncertainty (or a specified multiple of it), or the half-width of an interval, having a stated coverage probability.

Note 2 to entry: Measurement uncertainty comprises, in general, many components. Some of these may be evaluated by Type A evaluation of measurement uncertainty from the statistical distribution of the quantity values from series of measurements and can be characterized by standard deviations. The other components, which may be evaluated by Type B evaluation of measurement uncertainty, can also be characterized by standard deviations, evaluated from probability density functions based on experience or other information.

Instrumental measurement uncertainty (VIM 3rd edition, JCGM 200:2012): component of measurement uncertainty arising from a measuring instrument or measuring system in use

Instrumental uncertainty is used in a Type B evaluation of measurement uncertainty

Achievable measurement uncertainty (WMO no. 8, Part I Annex 1.B): it is intended as the measurement uncertainty achievable in field and/or operational conditions

3.8
non-catching rain gauge
rain gauge where the rain is not collected in a container/vessel

Note 1 to entry: The rainfall intensity or amount is either determined by a contact-less measurement using optical or radar techniques or by an impact measurement. This type of gauge includes optical disdrometers, impact disdrometers, microwave radar disdrometers, optical/capacitive sensors.

3.9
resolution
smallest change in a quantity being measured that causes a perceptible change in the corresponding indication

[SOURCE: *VIM 3rd edition, JCGM 200:2012*]

3.10
step function or unit step function
input signal that switches on at a specified time and stays switched on indefinitely for determining the response (output) of a dynamic instrument system

[SOURCE: CEN/TR 16469:2013]

3.11
step response
time-varying response of an instrument system to a step function (heaviside step function)

[SOURCE: CEN/TR 16469:2013]

3.12
step response time
duration between the instant when an input quantity value of a measuring instrument or measuring system is subjected to an abrupt change between two specified constant quantity values and the instant when a corresponding indication settles within specified limits around its final steady value

[SOURCE: *VIM 3rd edition, JCGM 200:2012*]

3.13
time constant
rise time characterizing the response of an instrument classified as a system of first order response (the way the system responds is approximated by a first order differential equation)

Note 1 to entry: It represents the time that the step response of an instrument system takes to reach the (1–1/e)•100[%] approximately 63 % of the final or asymptotic value.

[SOURCE: CEN/TR 16469:2013]

4 User requirements for RI measurements

This standard defines three classes of RI gauges according to their calibration. The standard will describe the three classes, the laboratory calibration methods and the requirements for checking the calibration in the field. The user shall determine what class of rain gauge to use for any given purpose, based on the local hydro-geological and meteorological conditions. The network/instrument manager shall declare the classification at the applicable RI ranges. Data from unclassified rain gauges shall be used with caution.

5 Measurement of RI

5.1 General

Rainfall intensity (RI) is defined as the amount of liquid precipitation (rainfall) collected per unit time interval. Due to its variability from minute to minute, there is an agreement of measuring RI over 1 min time intervals and then RI in mm/hour is derived from the measurements taken in 1 min. RI is measured directly using rainfall intensity gauges, for instance, using a gauge and measuring the flow of the captured water, or the increase in collected water as a function of time. A number of measurement techniques for the determination of the amount of precipitation are based on these direct intensity measurements by integrating the measured intensity over a certain time interval.

Traditionally, the volume of liquid precipitation received by a collector through an orifice of known surface area in a given period of time is assumed as the reference quantity, namely the rainfall amount. Under the restrictive hypothesis that rainfall is constant over the accumulation period, a derived quantity – the rainfall rate or intensity – can be easily calculated. The shorter the time interval used for the calculation, the nearer to the real rate of precipitation reaching the ground. This approximate measure of the rainfall intensity has been accepted for a long time as sufficiently accurate to meet the requirements of both scientific and technical applications. Reasons for this are on the one hand that most traditional applications in hydrology operate at the basin scale, thus dealing with a process of rainfall aggregation on large space and time scales, while on the other hand the available technology of measurement instruments, especially in terms of data storage and transmission capabilities, was lower than is currently available.

Rainfall data requirements have become tighter and applications increasingly require enhanced quality in RI measurements. The interpretation of rainfall patterns, rainfall event models and forecasting efforts, everyday meteorological and engineering applications, etc., are all based on the analysis of rainfall intensity arrays that are recorded at very fine intervals in time. The importance of RI measurement is dramatically increased and very high values of RI are recorded, due to the shortening of the reference period.

It is worth noting that the time scales required for calculation of RI at the ground are now much shorter than in traditional applications. The design and management of urban drainage systems, flash flood forecasting and mitigation, transport safety measures, and in general most of the applications where rainfall data are sought in real-time, call for enhanced resolution in time (and space), even down to the scale of one minute in many cases (**1-MIN RI**).

5.2 RI measurement accuracy

According to [17], the WMO “CIMO Guide” (Annex 1.E), the following values of expanded uncertainty apply for precipitation intensity (liquid) measurements, in laboratory (calibration in constant flow conditions) and in field conditions:

Table 1 — Uncertainty of precipitation measurements according to WMO

Under constant flow conditions in laboratory	5 % above 2 mm/h 2 % above 10 mm/h
In field conditions	5 mm/h, and 5 % above 100 mm/h

The definitions introduced by the WMO and the corresponding values of the maximum acceptable measurement uncertainties are adopted by this standard and, therefore, they shall be taken into consideration for any catching type RI gauge.

The compliance to this standard does not include further sources of instrumental errors such as sampling errors in tipping-bucket rain gauges.

5.3 Types of rain gauge

Rain gauges can be categorized in two main groups: (a) catching, and (b) non-catching types of rainfall intensity measurement instruments ([16]). Gauges of the first group collect precipitation through an orifice of well-defined size and measure its water equivalent volume, mass or weight that has been accumulated in a certain amount of time. At present, catching type gauges are widely used in operational hydro-meteorological networks to measure rainfall amount and intensity. Instruments of the second group determine the rainfall amount or intensity either by a contactless measurement using optical or radar techniques or by an impact measurement. A standardized procedure for the calibration of non-catching rain gauges is not yet available.

Catching type rain gauges can be characterized as follows:

— they can be calibrated in the laboratory;

— they are able to measure RI within sampling time intervals ranging from a few seconds to several minutes;

— they have finite resolution ranging from 0,001 mm to 1 mm;

— they have reasonably good reproducibility and long-term stability;

— they are widely used in operational practice and are cost effective;

— they are prone to wind-induced catching losses (depending on appropriate wind shielding);

— they are prone to wetting and evaporation losses, especially in low RI;

— regular maintenance, annual calibration and servicing, is needed to obtain high quality measurements.

The majority of catching type gauges used in operational networks are weighing gauges (WGs) and tipping bucket rain gauges (TBRGs) (see [16] for details).

In weighing gauges, precipitation is collected and continuously weighed. The WGs are those instruments where the volume of water is derived by using the gravitational acceleration and the density of water. These rain gauges do not use any moving mechanical parts in the weighing mechanism, only elastic deformation occurs. Therefore, mechanical degradation and consequently the need for maintenance are significantly reduced. The weighing is accomplished by various methods, e.g. a frequency measurement of a string suspension, a strain gauge, or load cells measuring collected