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Hydrometry — Catching-type liquid precipitation measuring gauges

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 113, *Hydrometry*, Subcommittee SC 5, *Instruments, equipment and data management*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Rainfall totals and intensity rates are measured at frequencies ranging from seconds to months, and the data are required by the user on timescales ranging from immediate to several weeks. This document covers instrumentation that measures rainfall accumulation and rainfall intensity (RI) by collecting the volume of water that falls on a fixed area. The measurement unit and period of rainfall should be decided on gauge design and network purpose by the gauge user.

Unlike many other meteorological instruments, there is no absolute physical standard against which a raingauge (hereafter called catching-type liquid precipitation measuring gauges) can be compared. Many different types, shapes and sizes of catching-type liquid precipitation measuring gauges are acceptable for the measurement of rainfall and rainfall depth, each reflecting a specific requirement. Most consist of a circular collecting device, delineating the fixed area of the sample, and a funnel leading into a storage reservoir or measuring system, or both. Some types of automatic gauges do not require a funnel. Since various sizes and shapes of orifice and gauge heights are used in different countries, the measurements are not strictly comparable.

This document provides general information on the functions of catching-type liquid precipitation gauges. The annexes in this document provide guidance on the types of catching-type liquid precipitation measuring gauges currently available (see Annex A) and the measurement uncertainty associated with them (see Annex B). Although advances in measurement electronic technologies and smart instruments have led to the development of optical and hybrid type liquid precipitation measuring gauges, they are not included in this document.

NOTE 1 This document specifies only the general functions of catching-type liquid precipitation measuring gauges. For in-depth and extensive information on precipitation measuring gauges, see References [1] and [2].

NOTE 2 For detailed information on measurement unit and period of rainfall, see Reference [1].

NOTE 3 For detailed information on the design of a reference raingauge pit as well as installation, see Reference [3].

Hydrometry — Catching-type liquid precipitation measuring gauges

1 Scope

This document specifies the typical requirements of instrumentation for measuring liquid precipitation, primarily for the purpose of hydrological and meteorological observation. This document is applicable to both non-recording and recording catching-type precipitation gauges for the measurement of liquid precipitation. This document covers design criteria for the gauges and elements to be considered in their construction. This document does not include specification, design and installation conditions.

NOTE 1 Since the measurement of solid precipitation is outside the scope, the disadvantages of solid precipitation apply to all gauges listed in Annex A. The measurement of solid precipitation and associated disadvantages are well documented in Reference [1].

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.

ISO 772, *Hydrometry — Vocabulary and symbols*

BS 7843-3, *Acquisition and management of meteorological precipitation data from a gauge network — Part 3: Code of practice for the design and manufacture of storage and automatic collecting raingauges*

3 Terms and definitions

For the purpose of this document, the terms and definitions given in ISO 772 and BS 7843-3 apply.

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

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

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

4 Instrument specifications

4.1 General

Catching-type liquid precipitation measuring gauges are classified as non-recording and recording types. The non-recording type has ordinary and storage gauges. The recording type has weighing, tipping-bucket and floating types. Catching-type liquid precipitation measuring gauges have a resolution of 0,1 mm to 1 mm, and can measure rainfall intensities of 0,1 to 1 000 mm·h^{-1} or higher. Measurement errors can occur according to installation conditions, the measurement environment, solid precipitation and rainfall intensity.

A catching-type liquid precipitation measuring gauge shall be of circular orifice and shall be formed perpendicular to the outer slope and the inner surface with sharp edges. The diameter of the edge of the collecting device should not differ by more than 0,2 % of the stated diameter in any direction. Furthermore, the collector should be designed to prevent rain from splashing in and out. This can be achieved if the vertical wall is sufficiently deep and the slope of the funnel is sufficiently steep (at least 45 %). The container should have a narrow entrance and be sufficiently protected from radiation in minimize the loss of water by evaporation. The surface of the funnel shall consist of a stable, durable material such that the water drop is not retained by surface tension, is freely moved towards the orifice and is passed to the measuring mechanism.

NOTE This document specifies the functional requirements of catching-type liquid precipitation measuring gauges. Consideration of the siting and exposure of gauges is also important. More specifically, the installation conditions, measurement environment and solid precipitation (see References [1] and BS 7843-3).

4.2 General gauge specifications

The gauge manufacturer should provide general specifications that can impact the measurement of precipitation which include, but are not limited to:

a) range;

b) resolution;

c) accuracy;

d) size of orifice area;

e) standardized communication interfaces and protocols for data transmission;

f) power supply and consumption;

g) height of gauge (including rim height placement to avoid interference from deposited snow or other materials near gauge);

i) gauge materials.

Requirements for uncertainty, range and resolution for precipitation measurements should be considered. It should be be noted that, in some countries, trace observations are officially given a value of zero, thus resulting in a biased underestimate of the seasonal precipititation. This problem is minimized with weighing-type gauges since even very small amounts of precipitation will accumulate over time.

4.3 Environment

4.3.1 General

Liquid precipitation measuring gauges shall operate within the ranges of temperature in 4.3.2 and the ranges of relative humidity in 4.3.3. Wind should be taken into consideration in areas that are prone to inclement weather conditions.

4.3.2 Temperature

Catching-type liquid precipitation measuring gauges should function in their intended manner in the following environmental conditions.

Operating temperature for non-recording type and recording type gauges:

— maximum temperature: +60 °C;

— minimum temperature (catching-type liquid precipitation measuring gauges, excluding heating or weighing gauge without antifreeze): 0 °C;

— minimum temperature (catching-type liquid precipitation measuring gauge, with heating or weighing gauge with antifreeze): −40 °C.

4.3.3 Relative humidity

Catching-type liquid precipitation measuring gauges shall operate within the following relative humidity range.

Operating relative humidity for non-recording type and recording type gauges:

— maximum relative humidity: 100 % RH;

— minimum relative humidity: 0 % RH;

5 Recording

5.1 Recording format

For recording and non-recording type liquid precipitation gauges, the time stamp of each record to be stored in a data storage gauge or manual recording shall be at least eight digits for the year, month and day; and eight digits for the hour, minute, second and millisecond (e.g. 2019/12/31 09:00:00:00). For rainfall accumulation, there shall be at least five digits (e.g. 000,000 $mm \cdot h^{-1}$), not including the decimal place, for the liquid precipitation amount.

5.2 Recording interval

The recording interval for catching-type liquid precipitation measuring gauges shall be specified by the network operator to ensure regional and climatological constraints are taken into consideration that could affect the accuracy and precision of recorded measurements.

For recording type gauges, the measurement record of liquid precipitation should be transmitted to the recording device instantaneously or at a specified time according to the gauge user. The recording intervals are commonly hourly or every minute depending on gauge design and network purpose.

Non-recording type liquid precipitation gauges should be read manually at a specified interval to acquire the data. Ordinary and storage gauges should be emptied in line with network operating principles, commonly daily or monthly depending on gauge design and network purpose. Liquid precipitation is reported per unit of time. The manufacturer or network operator should specify the volume of liquid precipitation and time interval recorded in its most granular form.

6 Environmental protection and housing

The catching-type liquid precipitation measuring gauge should be constructed in a material that is durable and can endure natural weathering without changes to its surface characteristics. Sound watertight seams should be used throughout. The collecting funnel should fit firmly over the top of the measurement mechanism but should be removable without undue force. The gauge should be designed to minimize ingress by small animals and insects. The outer housing of the gauge should also prevent water from entering the measuring component of the gauge, apart from through the inlet funnel. Electrical connections for power supplies and outgoing signals should be provided using water-resistant plugs or terminals, suitable for the environmental conditions in which the gauge is deployed.[6] Any marking identifying connectors should be weather-resistant and remain legible for the expected lifetime of the catching-type liquid precipitation measuring gauge.

7 Installation

The manufacturer shall provide clear instructions for the installation of catching-type liquid precipitation measuring gauges. As mentioned in 4.1, the sitting and exposure of raingauges should be taken into consideration.

NOTE Measurements will be influenced by rim height, either through individual gauge design or local deployment to allow for factors such as snow depth where close to ground level deployment is not practical. All gauge types are expected to be sited to ensure operation within the manufacturer's design.

The rim of the gauge should be installed parallel to the ground surface. The design should maintain plane of rim level to within ±2° of the base plane. Failure to ensure that the rim is level will introduce a systematic error into measurement. The measurement mechanism of the gauge, for example, a tipping bucket mechanism, should be level to ensure there are no systematic errors.

The gauge should be installed securely to ensure that it remains stable. Impacts such as frost heave and changes in ground conditions should be taken into account.

The gauge should be sited to ensure that the surrounding surface minimizes splashback that can result in an over-catch. A surface of gravel or short grass is typical; and surfaces such as concrete should be avoided.

8 Estimation of measurement uncertainty

8.1 General

The uncertainty of a value derived from primary measurements can be due to:

a) signal noise which affects the value being measured (variation by the precipitation intensity);

b) resolution of the measurement process;

c) other factors (wetting, splashing, evaporation, wind induced under-catch, volume-mass conversions, time interval, etc.).

Type A and Type B are two methods of measurement uncertainty estimation for relating the dispersion of values to the probability of "closeness" to the mean value (see Reference [7]).

NOTE Although installation and environmental factors are major sources of uncertainties, they are outside the scope of this document.

8.2 Factors of measurement uncertainty

In practice, there are many possible sources of uncertainty in a measurement, including:

a) incomplete definition of the measurement;

b) imperfect realization of the definition of the measurement;

c) nonrepresentative sampling – the possibility that the sample measured is not representative of the defined measurement;

d) inadequate knowledge of the effects of environmental conditions on the measurement or imperfect measurement of environmental conditions;

e) personal bias in reading analogue instruments;

f) finite instrument resolution or discrimination threshold;

g) inexact values of measurement standards and reference materials;

h) inexact values of constants and other parameters obtained from external sources and used in the data-reduction algorithm;

i) approximations and assumptions incorporated in the measurement method and procedure;

j) variations in repeated observations of the measurand under apparently identical conditions.

Table 1 provides an example of operational measurement uncertainty requirements and instrument performance requirements.