

Guide to the acquisition and management of meteorological precipitation data —

Part 2: Field practices and data management —

Section 2.1 Technical aspects in the field

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Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee CPL/113, Flow measurement of surface and ground water, upon which the following bodies were represented:

- British Waterways Board
- Clyde River Purification Board
- Department of the Environment
- Institute of Measurement and Control
- Institution of Civil Engineers
- Institution of Water and Environmental Management
- National Rivers Authority
- Water Services Association of England and Wales

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

- Forth River Purification Board
- Imperial College, London
- Institute of Hydrology
- Meteorological Office

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Foreword

This Section of BS 7843 has been prepared by Technical Committee CPL/113. BS 7843 is a new publication and no other standard has been superseded or withdrawn.

This Section is one of a series of related publications on the acquisition and management of meteorological precipitation data, the overall structure of which is as follows:

- *Part 1: Network design;*
- *Section 1.1: The user requirement for precipitation data;*
- *Section 1.2: Network design and monitoring;*
- *Part 2: Field practices and data management;*
- *Section 2.1: Technical aspects in the field;*
- *Section 2.2: Methods of observation and data tabulation;*
- *Section 2.3: Data management;*
- *Section 2.4: Areal rainfall.*

This British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification, and particular care should be taken to ensure that claims of compliance are not misleading.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 22, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

BS 7843 provides guidance on procedures for the measurement of meteorological precipitation, and for the collection, quality control, archiving and exchange of the data obtained from the measurement.

Part 1 describes the user's criteria, and the design of rain gauge networks to enable the desired data to be obtained.

Part 2 gives guidance on practical aspects of field work for the acquisition of the data, and for the subsequent transmission, quality control and archiving of the data obtained.

This Section of BS 7843 considers in detail the wide choice of equipment commercially available to any agency wishing to set up or upgrade a precipitation measurement network, particularly for sub-daily measurements. Guidance is given on the minimum specification and design performance for commonly available devices which will allow them to meet the range of requirements for which they are intended. In the United Kingdom rainfall is the predominant form of precipitation and this standard deals principally with raingauges. Problems associated with solid precipitation using a raingauge are also described.

Because an instrument's accuracy of measurement is sensitive to exposure to the wind and to the proximity of other objects, this Section of BS 7843 also considers the desirable exposure which will allow an instrument with an acceptable specification to meet the accuracy requirement for the range of purposes for which it is installed in the field.

2 Normative references

This Section of BS 7843 incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on the inside back cover. For dated references, only the edition cited applies; any subsequent amendments to or revisions of the cited publication apply to this Section of BS 7843 only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

3 Definitions

For the purpose of this British Standard, the definitions given in BS 7843-1.1 apply.

4 Raingauge instrumentation

4.1 General principles of rainfall measurement and the design and construction of raingauges

Rainfall is measured by collecting the volume of water that falls on a fixed area. The collected volume of water is divided by the fixed area of the collector to give a value for volume per unit area, termed rainfall depth, and measured in millimetres.

Many different types, shapes and sizes of raingauge have been designed and used, each reflecting a specific requirement. Most consist of a circular collector, delineating the fixed area of the sample, and a funnel leading into a storage reservoir and/or measuring system.

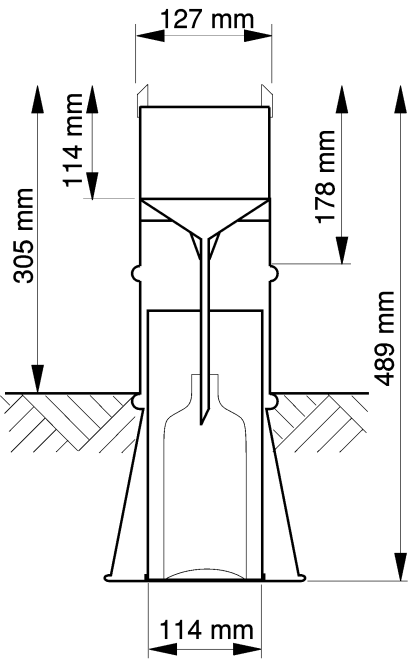
The amount of rainfall collected in a raingauge is affected by the speed of the airflow over the gauge collector and proximity of obstructions such as trees or buildings. In addition, the shape of the collector will cause an obstruction to the wind flow pattern and the increase in air speed across the gauge orifice may result in the smallest raindrops being swept away from the collector and not being measured.

Over the last 100 years, rainfall measurements in the United Kingdom have been made using a basic design (or close variants) having a level circular collector 127 mm (5 in) in diameter exposed at 305 mm (12 in) above the ground. The long record of rainfall data and extensive raingauge field trials have resulted in this type of storage gauge being established as the "standard" daily raingauge. The basic shape and dimensions of the daily storage raingauge are illustrated in Figure 1.

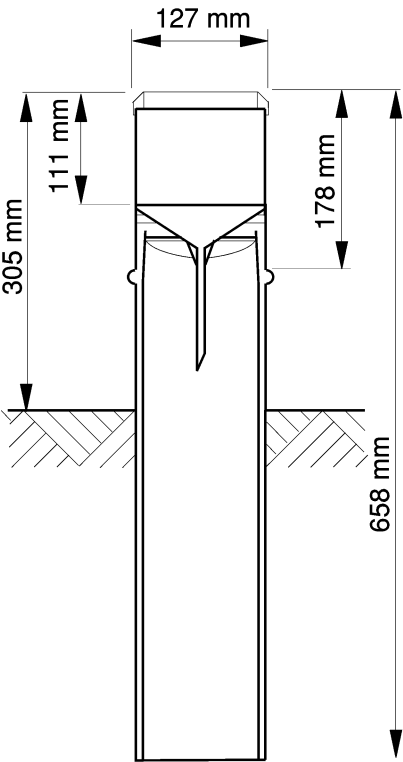
More modern gauge types have been and will continue to be developed but they should only be used to replace the standard gauge once they have been fully tested and compared with the standard gauge in a wide range of conditions and over a number of years.

Wind speed increases with height above the ground surface and this results in the loss of catch of rainfall by the raingauge the higher the rim of the collector is above ground level. By exposing the collector rim at ground level, the wind effects are reduced. The effects of in-splash are diminished by excavating a pit, 305 mm deep and 2 m square, mounting the raingauge in the centre of the pit with its collector rim level with the original ground surface and fitting a grid of rigid material covering the original surface area of the pit. At lowland sites a ground level gauge catches on average 3 % to 6 % more than a standard gauge exposed with its collector rim at 305 mm above ground. In windy mountainous areas the loss of catch in the standard gauge may reach 20 %.

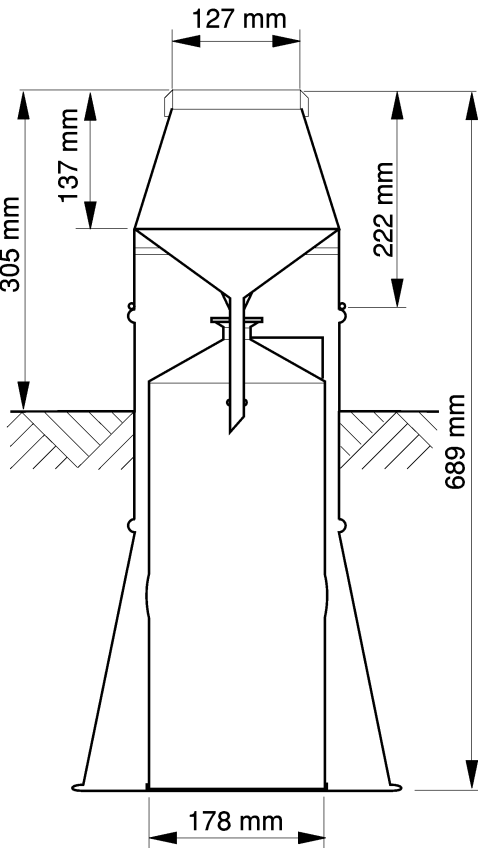
A detailed explanation of rainfall measurement errors is given in Annex A.



a) Meteorological office raingauge mk 2



b) Bradford raingauge



c) Octapent raingauge mk.2

Figure 1 — Patterns of manually read storage raingauges

The following criteria are considered to be important in raingauge design and manufacture.

- a) The raingauge should be constructed in a material that is durable and can endure natural weathering without changes to its surface characteristics.
- b) Sound watertight seams should be used throughout, particularly between collector and funnel, to ensure that any storage volume remains isolated from external flooding, up to a depth of 100 mm above ground level.
- c) The rim of the collector should be constructed with a knife edge having a vertical inner wall. This rim should be sufficiently strong to maintain the area of cross-section to better than $\pm 1\%$ of the design diameter in normal working conditions.
- d) The inner surfaces of the collector and funnel should be smooth and provide minimum adherence to water droplets, dust and other natural contamination. The inner surface of the collector should not be painted as paint deteriorates with time and will flake and become absorbent.
- e) Evaporation from raingauges which store rainfall should be kept to a minimum by ensuring that the funnel spout passes into the storage container with a minimum of space between the spout and the container, the container itself having a narrow necked aperture.
- f) Raingauges need to endure cold conditions which may cause the stored rain to freeze. In many cases, heat conduction from the surrounding soil occurs, which usually prevents its robust bottle from shattering. In cases of predicted extreme cold conditions, a plastic bottle may be required. Large capacity gauges (e.g. the Bradford and the Octapent) have specific design features to prevent frost damage; the former stores its contents well below the surface and the latter employs a rubber contraction tube.
- g) It is recommended that the height of the vertical wall between the collector rim and the slope of the funnel is greater than 90 mm. This ensures that any splash caused by droplets impacting on the inner surface of the funnel remains within the collector.

4.2 Standard daily raingauge and measuring cylinder

The Meteorological Office Mk. 2 raingauge illustrated in Figure 1 a) has a collector diameter of 127 mm and a splayed base to improve its stability when installed in the ground. This gauge, without a splayed base, is known as the Snowdon pattern gauge.

Rainfall readings are obtained by pouring the volume of water collected in the storage container into a specially constructed measuring cylinder [shown in Figure 2 a)]. The cylinder is graduated to give the rainfall amounts for the 127 mm diameter collector directly in millimetres. The calibration accuracy of the rain measure scale should be ± 0.05 mm. The measuring cylinder should have a capacity to read up to 10.5 mm with a tapered base to improve the reading accuracy for rainfall depths below 1 mm.

4.3 Large capacity raingauge and measuring system

Large capacity raingauges are required in areas with high annual rainfall or at sites that are visited at less frequent (often monthly) intervals. Two types of gauge, known as the Bradford [Figure 1 b)] and Octapent Mk. 2a [Figure 1 c)] gauges, both retain the 127 mm diameter collector and are installed with the collector rim at 305 mm above ground level. The Bradford gauge has a greater depth to its base than the Octapent gauge which has a broader base. Several versions of both types of gauge are available which have larger storage capacities while retaining the standard above ground dimensions. The Octapent gauge, installed at shallower depth than the Bradford gauge, has a frost protection device; a rubber tube is compressed when the stored rainfall freezes thus preventing the storage container being damaged.

Initially, measurements are made with calibrated dip rods to obtain an estimate of the rainfall amount before measuring the stored volume using the standard 50 mm rain measure [Figure 2 b)].

4.4 Tipping bucket raingauge

Sub-daily rainfall is now most commonly measured by a tipping bucket raingauge (illustrated in Figure 3) linked to a recording device. The principle of operation is that a bucket comprising two identical compartments is pivoted so that each compartment alternately receives rainfall from the gauge funnel. When a compartment is filled to a predetermined volume it becomes unstable and tilts, emptying itself and placing the other compartment under the gauge funnel. The volume of each compartment is set by two adjustable stops which determine the range of movement of the bucket mechanism. The movement of the bucket is sensed (e.g. by a reed switch responding to a magnet attached to the bucket) and this generates an electronic signal or pulse that is transmitted to a data logger. Provided the data logger has a calendar clock, these pulses can be logged as a time. These data are known as event data. Alternatively, the pulses may be accumulated over a fixed time period (e.g. 15 min). These data are known as time period data. The information is stored by an electronic data logger and/or telemetered to a central data store through a telecommunications system.

Important features in the design and operation of this type of gauge are as follows:

- a) The tipping bucket mechanism should be robust and reliable and once the point of instability is reached should tip in as short a time as possible. A simple knife edge bearing or rolling pivot are favoured. In addition, a counter weight arrangement may be used to stabilize the bucket and prevent the bucket tipping due to external vibrations, e.g. wind. It should be possible to ensure that the bucket is level.
- b) Practical experience has shown that some of the errors in the bucket operation are due to splashing when the water flows into the compartment, and to the adherence of water within the compartment. Hence it is reasoned that larger volume bucket compartments will perform better than smaller ones. In hot weather any rainfall remaining in the untipped bucket may evaporate and therefore the bucket volume should not be too large. It is recommended that the bucket compartment volume should represent not more than 0.5 mm of rain.
- c) The inner surface of the bucket has to permit water to run off easily and some models shape the lip of the bucket to ensure that no water is retained in the emptying compartment.

d) During heavy rainfall, water may flow into the bucket compartments whilst they are tipping. The relationship between rate of rainfall and calibration error should be determined for each model of gauge.

For example, for one model with a tip of 0.2 mm, the loss rate results in an error that is linear from zero to 10 % as the rainfall increases from zero to 130 mm/hour. In the UK, rates of rainfall in excess of 100 mm/hour are infrequent and generally occur for a short period of time, i.e. less than 1 min.

e) In sub-zero temperatures any water remaining in the tipping bucket may freeze and the design should ensure that no damage occurs. Thermostatically controlled heaters can be used to prevent freezing whilst causing minimal evaporation and helping to melt small quantities of snowfall. (See clause 8.)

f) One of the most common causes of failure in this type of raingauge is blockage of the funnel by debris. Simple screen mesh filters have been tried but require maintenance. If the diameter of the funnel drain tube is made too wide it may allow debris to pass into and remain in the tipping bucket mechanism. A diameter of 6 mm has proved to be practical. Regular attention and cleaning will ensure adequate performance.

Annex B gives details of comparisons between standard gauges and between a tipping bucket gauge and the standard gauge.

4.5 Tilting siphon rain gauge and recorder

A tilting siphon raingauge and recorder is illustrated in Figure 4. Rainfall is collected in the funnel and drains into a cylindrical chamber containing a float. When the water level in the chamber rises, the vertical motion of the float is mechanically communicated by means of a lever to a pen which records on a graduated chart. The chart is attached to a clockwork driven drum. When the chamber is full of water and the float has reached its maximum height a catch is tripped which permits the cylindrical chamber to tilt and the water to siphon out. When empty, the natural equilibrium of the chamber returns it to the upright position. The tilting motion ensures that the siphon starts and stops abruptly. All movements of the float, except when the siphon is operating, are transcribed in ink on a chart by the pen. This type of gauge has been in use for many years and its size and shape have become standard.

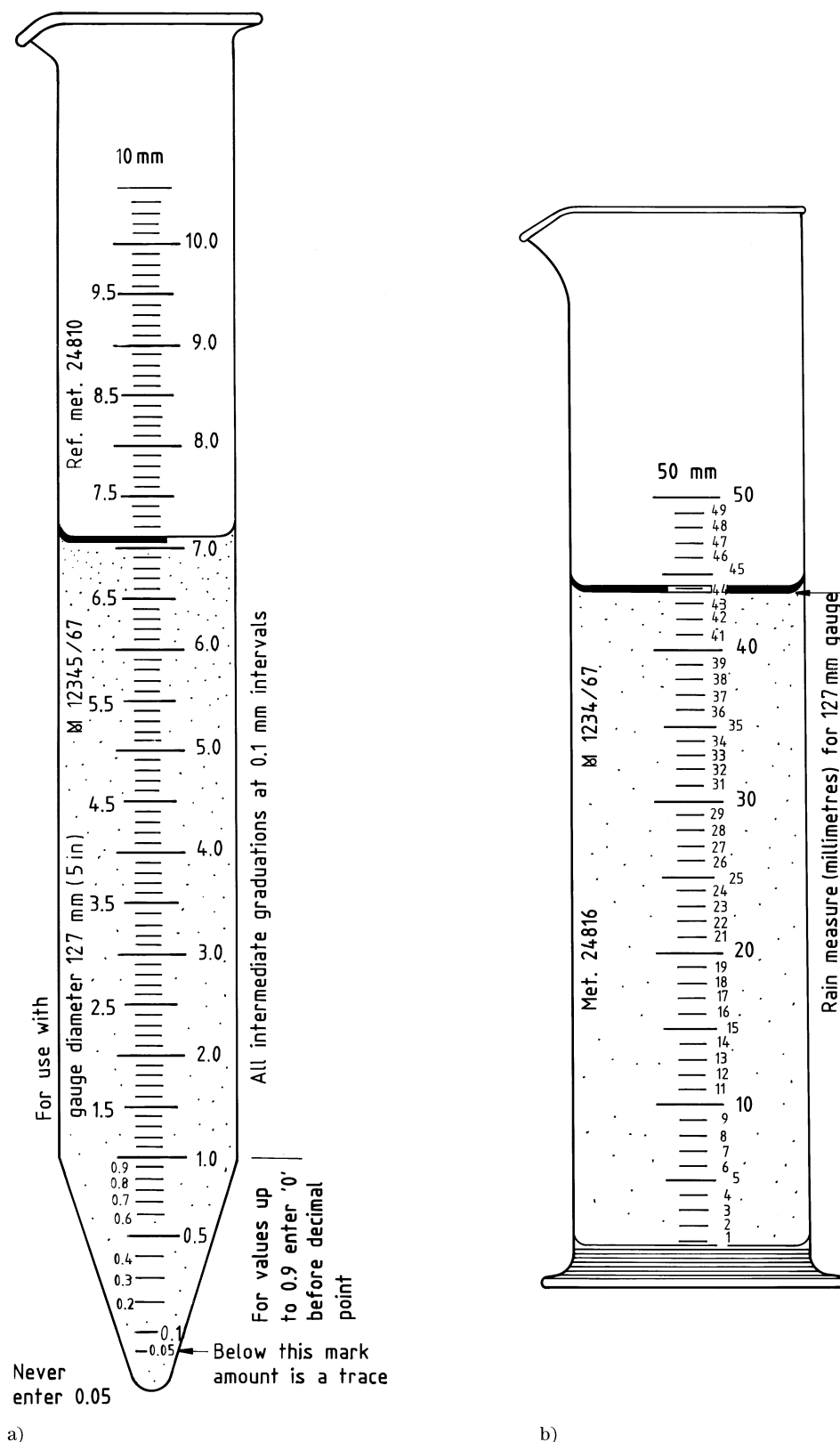


Figure 2 — Standard patterns of rain measures