

Guide to the acquisition and management of meteorological precipitation data —

Part 3: Specification for raingauges —

Section 3.2: Tipping bucket raingauge

ICS 07.060

Committees responsible for this British Standard

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- Environment Agency
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Foreword

This Section of BS 7843 has been prepared by Subcommittee CPI 113/5.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 19 and a back cover.

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Introduction

A tipping bucket raingauge (TBR) is a device that measures rainfall by way of a calibrated, reciprocating bucket mechanism that signals the achieved calibrated volume (rainfall depth) by a “tipping” action. The event of the “tipping” action empties one half of the bucket assembly of collected precipitation and offers the other bucket half ready for the measurement process.

1 Scope

This British Standard specifies the minimum performance requirements for any ground mounted tipping bucket raingauge (TBR). It does not specify any physical shape or dimension unless these are necessary to meet the performance requirements.

NOTE Recent R & D suggest that aerodynamically shaped gauges achieve a catch more similar to check gauges than do cylinder shaped gauges.

2 Principle of operation

A tipping action is generated by the weight of the precipitation (rainfall depth) exceeding the calibrated balance which causes the bucket assembly to rapidly tip over, emptying the bucket. Figure 1a) and Figure 1b) illustrate the tipping system. Figure 2 illustrates the arrangement of a typical TBR.

Precise measurement is achieved by adjusting the height of the calibration adjuster, a post that the bucket assembly sits on when it is at rest. Increasing the height allows the respective bucket to hold a smaller volume of water before the point of balance is exceeded. Similarly, reducing the height of the adjuster allows the respective bucket to hold a greater volume of water before the point of balance is exceeded.

Electronic sensors such as magnet and magnetic switches, optical interruption sensors or other non-intrusive means normally detect the action of the “tipping” event.

3 Performance specification

3.1 Static performance

NOTE A summary of the static performance requirements is given in Table 1.

Table 1 — Summary of static performance requirements

Subclause	Description	Minimum requirement
3.1.1	Period between calibrations	12 months or 10 000 tip events, whichever is first
3.1.2	Calibration tolerance	±2 %
3.1.3	Maximum variation between buckets	±2 % Bucket volumes shall be similar
3.1.4	Standard bucket sizes	0.2 mm/tip 0.5 mm/tip
3.1.5	Singular repeatability	±5 % These shall average out over long periods to achieve the requirements of 3.1.6
3.1.6	Multiple tip event repeatability — maximum averaged variation between same bucket sequential tip events	±1 % based on at least 200 tip events

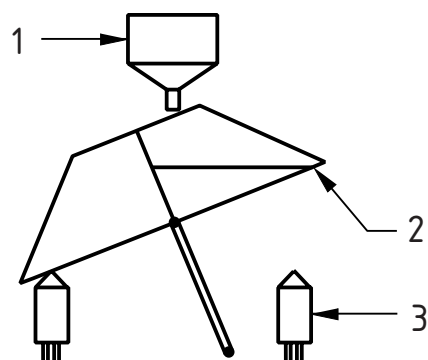
3.1.1 Period between calibrations

The minimum period between static calibrations shall be 12 months or 10 000 tip events, whichever occurs first.

NOTE 1 This will depend largely on the deployment environment and the materials used within construction.

Checks shall be conducted to ascertain the operation of the TBR. These checks may take the form of comparison with a known standard such as a co-sited storage gauge (comparison of recorded data), manually operated burette (known water volume) or other similar device.

NOTE 2 Consideration should be given to the limitations of conducting comparisons in a changeable environment.



Key

- 1 Centre funnel
- 2 Tipping bucket
- 3 Calibration adjuster

Figure 1a) — Tipping bucket operation — Position “A” before tip event

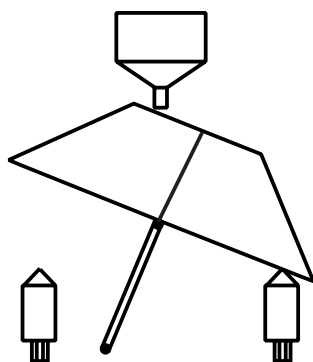


Figure 1b) — Tipping bucket operation — Position “B” after tip event

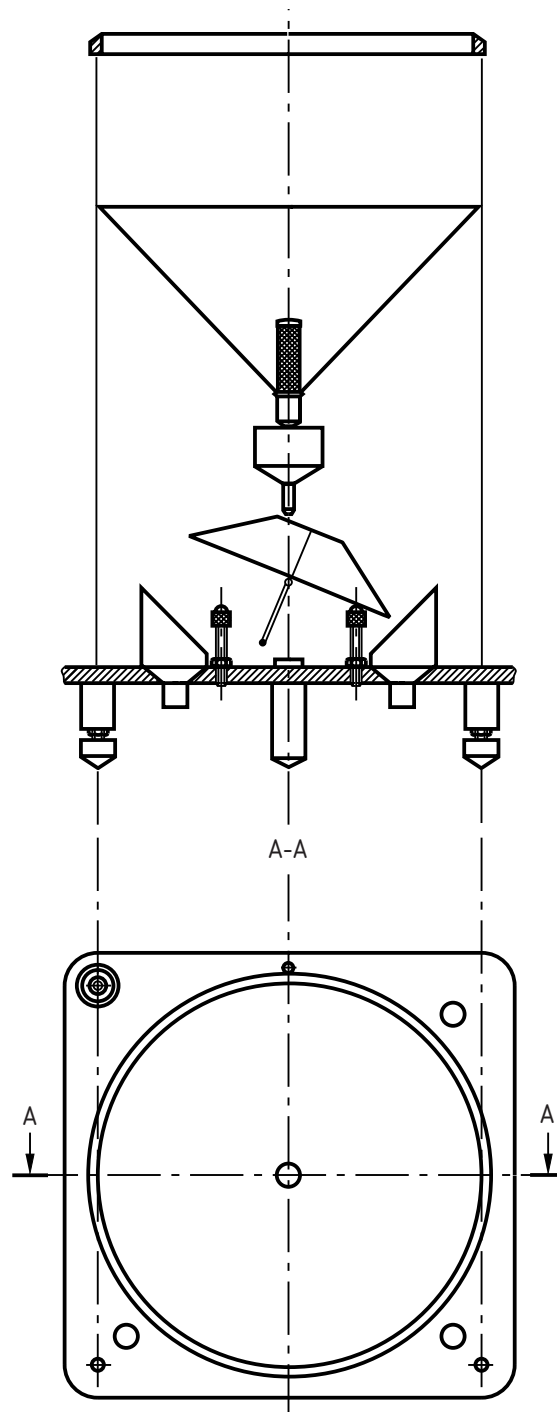


Figure 2 — Typical tipping bucket rain gauge

3.1.2 Calibration tolerance

Raingauges shall be calibrated to $\pm 2\%$ or better, using the calibration process as specified in Annex A.

NOTE This tolerance is based upon all potential effects that can affect the measurement (temperature, humidity etc.).

3.1.3 Maximum variation between buckets

As bucket assemblies contain two buckets, the maximum variation permitted between each bucket, based upon the volume of one bucket compared with the other, shall be $\pm 2\%$.

NOTE This is irrespective of the actual calibrated volume achieved.

3.1.4 Standard bucket sizes

Standard tip event sizes shall be either 0.2 mm/tip or 0.5 mm/tip. The precise volume required to achieve the tip event may be calculated using the formulae described in A.2.3.

NOTE The effect of bucket size is well documented. Small resolutions provide finer resolution and a clear indication of trends but have high accumulative errors. Large buckets provide more accurate totals but the coarse resolution provides poor trend data.

3.1.5 Singular repeatability

The variation between same-bucket sequential tip events shall not exceed $\pm 5\%$.

NOTE A tipping bucket raingauge, by nature of its mechanical operation, is subject to repeatability errors.

Over periods of large numbers of tip events, these variations shall even out to achieve a better repeatability figure (as specified in 3.1.6).

3.1.6 Multiple tip event repeatability

Over a large number of tip events (at least greater than 100 tip events), the repeatability shall achieve $\pm 1\%$ or better. The value shall be obtained by conducting the calibration process described in Annex A for a number of calibration tests and comparing the results. The total number of tip events achieved for each test operation shall be within $\pm 1\%$ of the *achieved* calibrated value (i.e. not the expected calibrated value).

3.2 Dynamic performance

NOTE A summary of the dynamic performance requirements is given in Table 2.

Table 2 — Summary of dynamic performance requirements

Subclause	Description	Requirement
3.2.1	Minimum and maximum rainfall rates that can be successfully measured within static tolerance	0.01 mm/h minimum 30 mm/h maximum
3.2.2	Maximum rainfall rate that can be successfully detected (outside static tolerance)	300 mm/h

3.2.1 Minimum and maximum measurable rainfall rates (within tolerance)

The TBR shall measure rainfall rates within the specified calibrated tolerance from 0.01 mm/h to 30 mm/h.

NOTE It is known that 0.2 mm/tip raingauges generally fail to measure rainfall intensities within tolerance for intensities above approximately 30 mm/h to 40 mm/h. Raingauges with 0.5 mm/tip buckets fitted will perform better, but with a reduction in resolution over the 0.2 mm/tip buckets. To maintain consistency, this standard applies the same rate to 0.5 mm/tip buckets.

3.2.2 Maximum rainfall rate

Although it is recognized that the TBR will be measuring rainfall with errors for intensities above approximately 30 mm/h to 40 mm/h, the raingauge shall be capable of being able to continue operation with rainfall intensities up to 300 mm/h (or higher).

NOTE It is possible to form an assessment of the dynamic calibration of any TBR and apply an alteration to the values recorded, dependent on the time between tip events (the rainfall intensity). Although every TBR is affected by high intensity rainfall differently, it should be possible to achieve a bulk or group calibration for a number of raingauges that are manufactured to the same product specification.

4 Physical attributes

NOTE A summary of the physical attribute requirements is given in Table 3. Figure 3a) and Figure 3b) indicate the layout and identified components of a typical TBR (connector and heater assembly omitted).