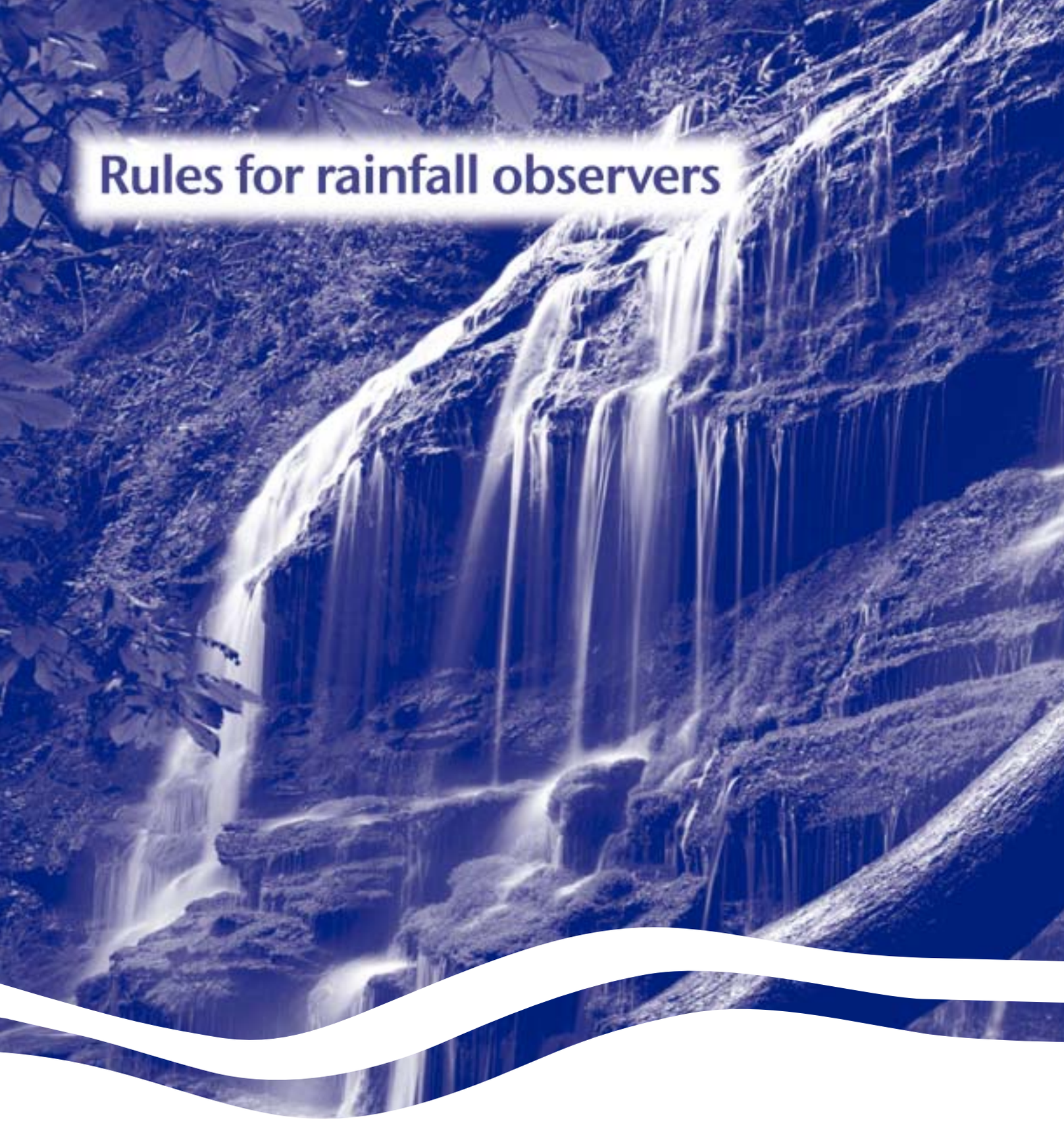


Rules for rainfall observers

The value of rainfall observations

Met Office

Rules for rainfall observers

Rules for rainfall observers

Introduction

Rainfall measurement is one of the most important of meteorological observations and is of vital interest to water authorities, drainage departments, engineers, public health departments, agriculturists, farmers, foresters and others. To many observers, an accurate knowledge of the rainfall in the neighbourhood is sufficient reward for the trouble of taking the measurements. To others, the knowledge that they are accumulating information that is used to study the distribution of rainfall over the United Kingdom is an added interest. In this respect, the recording of rainfall is a most satisfying hobby because the Met Office is ready to test and place on record all useful observations giving permanent value to what might otherwise be lost work. The records of each observer are archived by the Met Office and preserved with the same care as those commenced in 1677 by Mr Townley, the first known observer of rainfall in England, or those of the Rev. Gilbert White of Selborne, who was probably one of the best-known observers of nature.

In order to study the distribution of rainfall in a satisfactory manner, it is essential to have a large number of gauges covering all parts of the country. The areas where new gauges are most needed are usually the most sparsely inhabited.

Historical notes

The British Rainfall Organization (BRO) was founded as a private enterprise in 1859 by Mr GJ Symons, FRS and carried on after his death by Dr HR Mill. In 1919 the Government undertook to carry on the work which was then transferred to the Met Office. Continuing the policy of the BRO, the Met Office encourages the observation of rainfall by approved

Experimental gauges at Strathfield Turgis Rectory, Hants. Frontispiece, British Rainfall*, 1868, showing site of rain-gauge experiments at Strathfield Turgis, 1868 to 1870, National Grid reference SU (41) 69576043*

and uniform methods in order to bring together all reliable records for publication, preservation and study. From the start, observations have been obtained mainly from voluntary observers who provide their own rain gauges and send in their daily readings at the end of each month. In recent years, a very large network of gauges has been developed by the water authorities but again using mainly voluntary observers.

The number of rainfall stations in the United Kingdom is approximately 5,000. The two publications of the BRO, *British Rainfall* and *The Meteorological Magazine*, were continued by the Met Office but, after 1968, *British Rainfall* was replaced by a publication called *Monthly and annual totals of rainfall for the United Kingdom*, renamed in 1987 and called *Rainfall 1987,* etc. Both these publications have since been discontinued.

Rain gauges

Approved types, non-standard types and measures

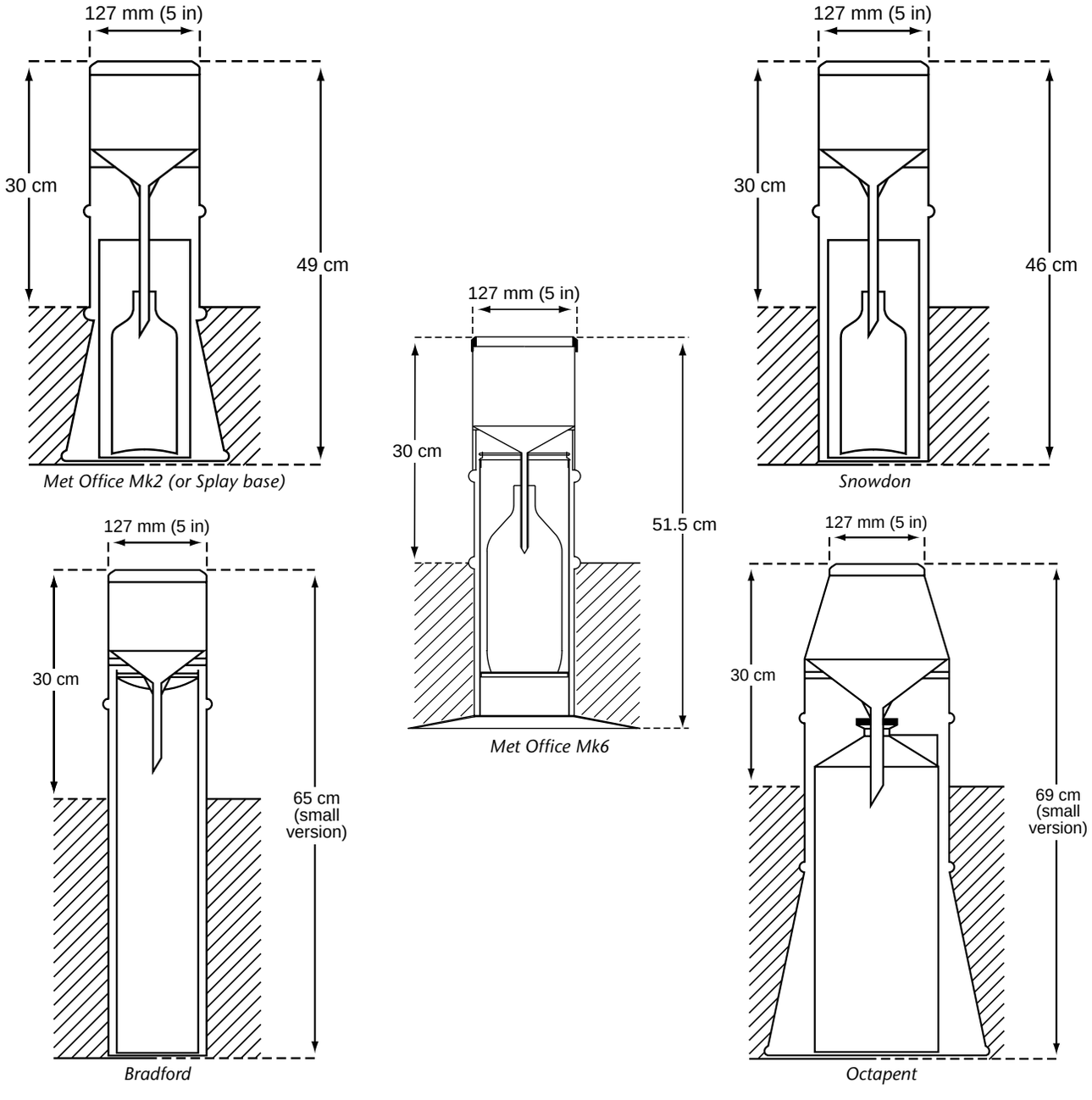
Essentially, a rain gauge is a carefully made vessel in which rain falling in a given area is collected and its volume measured. The design of a gauge is a vital factor in accurate measurement since it is essential to ensure that:

(a) rain falling into the gauge cannot splash out;

(b) rain falling outside the gauge cannot splash in;

(c) collected rain cannot evaporate or leak away;

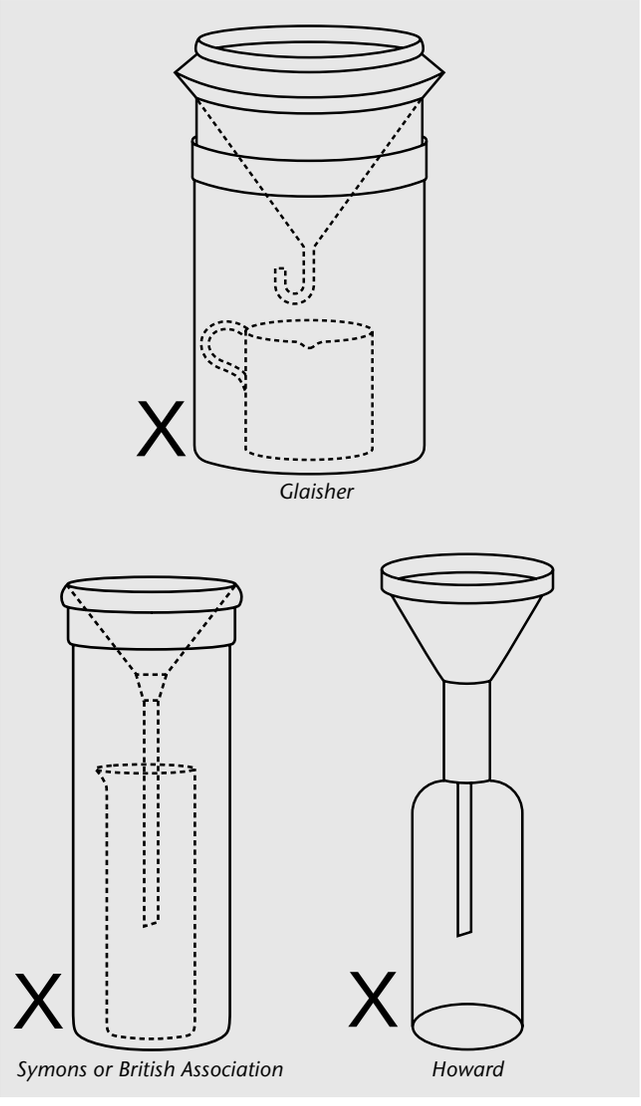
(d) collected rain cannot be increased either by condensation or flooding.



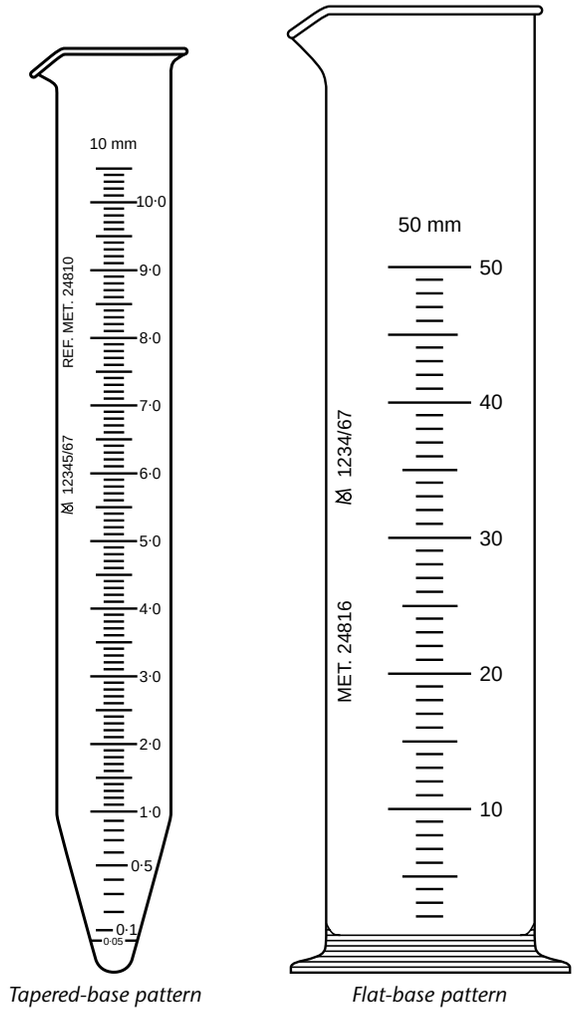
Approved types of rain gauge. *The Met Office and Snowdon patterns are intended for daily readings. The Bradford is suitable for weekly or monthly readings in a fairly dry locality. The Octapent is a monthly gauge suitable for wet areas such as moorland regions.*

Standard Met Office approved gauges conform to the above requirements. Rain gauges and measures can be purchased from most dealers in meteorological instruments but care should be taken to specify either a Splay-base or Snowdon type for daily readings, or a Bradford or Octapent type for monthly readings.

It is unfortunate that the cheaper types of rain gauge are subject to grave disadvantages and that some of these gauges are known by influential names. Observers are therefore cautioned that rain gauges of the Glaisher, Howard, Symons or British Association pattern should not be used, and observations taken from these gauges are not acceptable to the Met Office. The most serious defects in these gauges are: the shallow funnel with no Snowdon-type vertical rim; soft-soldered joints sometimes so placed that, if they are defective, water may leak into or out of the collecting vessel; insufficient capacity for very large rainfalls. Most of these rain gauges are also difficult to keep level and are easy to knock or blow over. The Glaisher rain gauge is obsolete and has several weaknesses. Dial-type gauges and gauges designed to be mounted on posts or walls are much less accurate than the normal pattern and are not recommended. Observers should not attempt to make their own rain gauges unless they are skilled in accurate metalwork.



Non-standard rain gauges which are not approved. *These gauges all have serious faults and should not be used.*



Approved glass measures for use with rain gauges. *The tapered measure is the pattern recommended for use with a daily gauge (a tapered measure with a flat base added is also acceptable). A large 50 mm flat-based measure is used with monthly gauges.*

Setting up a rainfall station

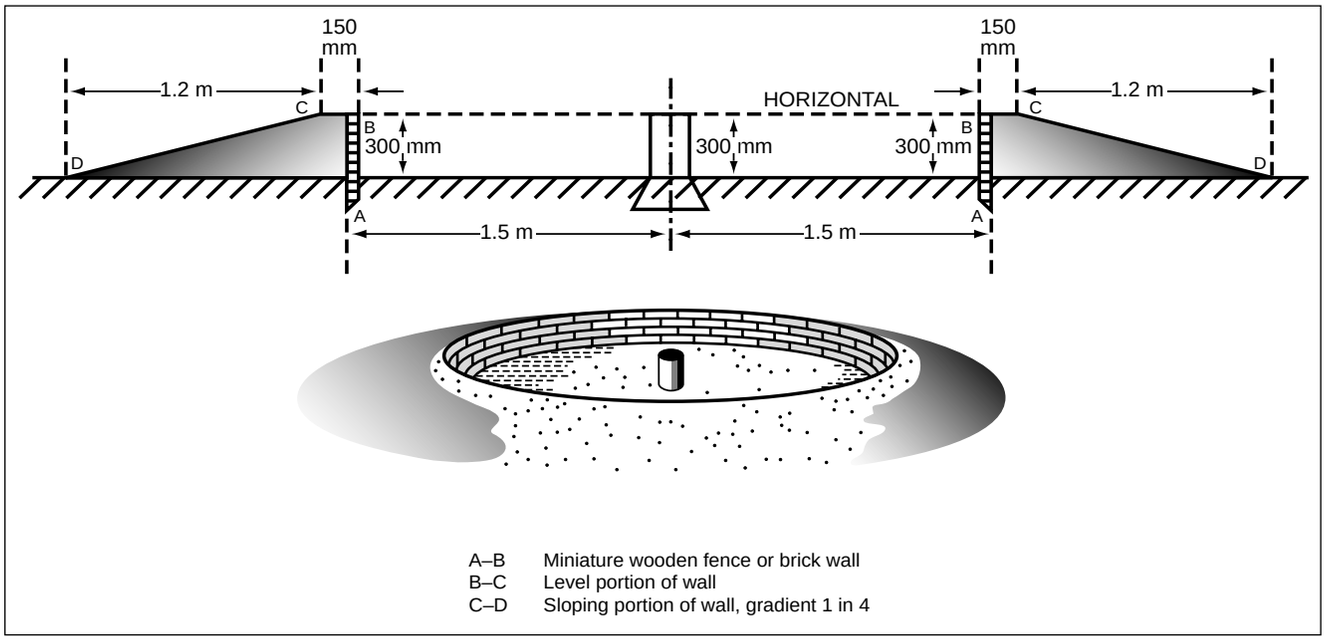
The site

The quantity of rain collected in a rain gauge depends to some extent on the exposure of the gauge, so the selection of a site is important. The site should be on level ground, not on a slope or terrace and never on a wall or roof. A rain gauge should on no account be placed so that the ground falls away steeply on the side facing the prevailing wind.* The distance to the gauge from each and every object should be not less than twice the height of the object above the rim of the gauge. This rule should be particularly borne in mind if the rain gauge is to be put in a garden where flowers or vegetables are growing. If observations at different sites are to be comparable, the exposures must be similar.

Provided that the above conditions are satisfied, a position sheltered from wind is preferable to an exposed one. At mountain, moorland and coastal stations especially, great care should be taken to ensure that rain gauges are not unduly exposed to the sweep of the wind.

A position in a slight hollow may be selected but, in very exposed areas where there is no natural shelter, it may be necessary to build a turf wall round the gauge (see diagram below). The turf wall should have an internal diameter of 3 metres. The crest should be horizontal and in the same plane as the rim of the rain gauge. The turf wall should be 150 mm thick at the top, the inside should be vertical and the outside should slope down by one in four. It is advisable to put a pipe through the wall for drainage purposes. It is essential that the height (300 mm) of the wall should be maintained.

* *Sites on slopes are always more exposed than sites on level ground.*



Turf wall for rain gauges in exposed areas. *Here, the ground around the gauge is assumed to be level. If it is sloping it should not be levelled but the turf wall should be built up until its rim is everywhere on the same level as the rim of the gauge. The ground around the gauge should be drained by inserting a pipe through the base of the wall. On sloping ground the pipe should emerge at the lowest point of the outer circumference of the wall.*

The rain gauge

A rain gauge of the splay-base pattern, or of the Snowdon pattern, and of 127 mm (5 inches) in diameter is recommended for daily measurements of rainfall. A gauge of 203 mm (8 inches) in diameter is, however, equally good provided that it is one of the two types mentioned above. If a 203 mm (8-inch) gauge is used, care should be taken to ensure that the glass measure is for use with a 203 mm (8-inch) gauge. The most important features of the standard gauges are:

(a) a knife-edged rim forming the aperture to provide a clean cut-off for the rain;

(b) the vertical cylinder, about 100 mm in depth above the sloping funnel, to retain snow and hail, to prevent out-splash and to prevent rain being blown out by the wind as it enters the gauge;

(c) simplicity of construction.

The rain gauge is provided with an inner can of adequate capacity and a collecting bottle in which the rain is collected. The inner can is essential to catch the overflow and avoid losses in very heavy falls.* The bottle has a narrow neck and good shoulders to reduce the risk of loss by evaporation. Another purpose of the bottle is to ensure accurate measurement, especially in windy weather, since it is easier to pour water from a bottle into the measure without spilling than from the inner can.

A graduated glass measure is required for measuring the rain. It is recommended that a tapered measure is used as this greatly facilitates the measurement of small quantities. A flat-base pattern should never be used with a gauge that is read daily.

Placing the gauge

The rain gauge should be dug into ground that is covered with short grass. It is useful to put a small circle of stone chippings or shingle immediately round the gauge. This should prevent damage to the gauge by a lawnmower. If a grass area is not available, the gauge should be dug into gravel or shingle. A hard surface such as concrete or a compacting surface such as bare earth should be avoided as these can cause in-splash in heavy rain. The gauge should be fixed firmly in the ground so that it cannot be either blown over or tilted by even the strongest wind. The soil should be pressed firmly round the gauge, but excessive ramming should be avoided otherwise there is a risk of splitting the seams. This is important as any ground water entering the bottom of the gauge can evaporate, condense on the underside of the funnel, and so run down into the bottle to give a false reading.

Height above ground

The rim of the funnel of the gauge should be set exactly level and at a height of 30 cm above the ground. This is just high enough to prevent excessive in-splashing yet not high enough for the gauge itself to cause undue turbulence.

Height of the station

The height above mean sea level of the ground on which the rain gauge stands is known as the height of the station and should be determined to the nearest metre, if possible. The approximate height may be easily ascertained in most cases by reference to an Ordnance Survey map. The National Grid reference of the station is also required and this too can be obtained from the Ordnance Survey map.

* *Observers often query the need for the inner can but very heavy falls do occur and could happen in any part of the British Isles. It would be most regrettable if the inner can was missing when such a fall occurred.*

The routine of observations

Hour of observation

Universal Time Co-ordinated (UTC) is the international time standard that has replaced Greenwich Mean Time (GMT). Rainfall should be measured daily at 9 a.m. UTC. Observers are recommended to adhere to UTC if possible, but if this cannot be done the fact should be stated on the return. When British Summer Time is in operation, 10 a.m. by the clock corresponds to 9 a.m. UTC.* The amount of rainfall read at 9 a.m. is entered on the return against the date of the previous day. Thus, for example, the figure to be entered against the 15th of the month is the amount read at 9 a.m. on the morning of the 16th.† Weekly gauges should be read at 9 a.m. on the same day of each week and also on the first day of each month. Monthly gauges should be read at 9 a.m. on the first day of each month, and the amounts entered for the previous month.

Taking the readings

Before removing the funnel of the rain gauge, care should be taken to see that there are no obstructions, such as fallen leaves, preventing water from flowing into the collecting bottle. The bottle should be examined each morning to ensure that there are no cracks. The water must be poured carefully from the bottle into the graduated measuring glass, which is then held upright between the thumb and first finger so that it swings naturally into a vertical position. The glass is then raised so that the eye is level with the water level to determine which line on the scale is nearer to the water's surface. This is not necessarily the line above or the line below the water's surface but whichever of these is the nearer. It is the lowest part of the water's surface which determines the reading. Some observers unknowingly hold the glass slightly out of vertical, the tilt being constantly in the same direction. This introduces a slight error which, though unimportant on any single occasion, is liable to become significant in the course of a year. Means for minimising this kind of error have been provided on the glass measure by duplicating the engraving of the main graduation marks on the back of the glass. If the level of the water is nearly opposite one of these marks, care should be taken to hold the glass so that the eye sees the back part of that engraved line directly behind the front part. If the level of the water is intermediate between two of these graduations, the glass should be held so that the back part of the upper graduation appears to be below the front part, while the back part of the lower graduation appears to be above the front part.

* *Universal Time Co-ordinated is confusing to many observers. The simple rule is that readings are taken at 9 a.m. clock time in winter and at 10 a.m. clock time in summer.*

† *Observers often ask the reason for this and it becomes clear when it is remembered that the readings refer to 24 hours from 9 a.m. one day to 9 a.m. the next day and that most of this time, i.e. the 15 hours from 9 a.m. to midnight, was on the first day.*

If there is more water in the gauge than can be measured at once, the measuring glass should be filled up nearly to the 10 mm mark and the reading noted. The contents should then be emptied into a jug and the glass refilled as often as necessary, noting the reading each time. The individual amounts should then be added together to get the total measurement thus: 9.8 + 9.7 + 2.3 = 21.8 mm. Observers with measuring glasses which read up to 10.5 mm should fill the glass to just over the 10 mm mark, the resulting sum being easier. The water in the jug should then be measured again to make sure that no mistake has been made. The amount should always be written down before the water is thrown away. Any doubts, particularly with large amounts, can thus be checked if necessary.

It is emphasised that great care should be taken to use the glass measure correctly because misuse is habit-forming and usually produces an error which is always biased in the same way. It is unlikely that the actual amount of error will reach 0.1 mm on any single occasion, but if the true level of the water surface falls between two graduation marks (as is usually the case) then a much smaller error than 0.1 is sufficient to alter the reading by 0.1. Suppose, for instance, that half the measurements contain an error of 0.1 mm and that rain fell on 200 days of the year, then the measured annual total will be no less than 10 mm in error.

All water found in the gauge is to be treated as rain, even though it comes from snow, hail, hoar frost, mist or dew on some occasions.

Method of entry on returns

The measurement is to be entered on the return in millimetres and tenths and the following points should be noted.

(a) If the measurement amounts to 1 mm or more a decimal point should always be inserted between the figure representing whole millimetres and the figure representing tenths of a millimetre.

(b) If the measurement is less than 1 mm, the entry should consist of '0' followed by a decimal point, followed by the observed number of tenths.

(c) The reading should be taken to one decimal place only, i.e. to the graduation mark nearest to the level of the water surface.

(d) If the reading is an exact number of whole millimetres, a decimal point and '0' should follow the number, e.g. 2.0.

(e) Days without any rain are indicated by drawing a short line.

(f) If there is any doubt about any figure a '?' should be placed beside it and an explanatory note added.

Small amounts

If the gauge contains less than one tenth (0.1) of a millimetre but half, or more than half, of that amount (0.05 mm or more), the measurement should be entered as 0.1.

The word 'trace' or 'tr' is entered:

(a) when there is less than 0.05 mm of water in the gauge and the observer knows that this is not the result of a drop or two draining from the sides of the bottle after emptying the water at the previous observation, i.e. the observer must be reasonably certain that there has actually been precipitation since the preceding measurement (if the observer knows that the precipitation has been in the form of dew or fog then this should be noted in the remarks);

(b) when there is no water in the gauge but the observer knows from his own observations that some rain (or other form of precipitation) has fallen since the preceding observation. This does happen on occasions, especially in warm, dry weather, because the small amount of rain evaporates before reaching the collecting bottle.

The tapered glass measure is provided with a special graduation mark on the conical part to indicate half a tenth of a millimetre (0.05) to help in differentiating between 'trace' and 0.1 (see diagram).

Snow

The term 'snow' is used to include all forms of solid precipitation, whether snow, hail, ice pellets, sleet or other forms. The observer should make a note of the form the precipitation takes, if possible. To ensure that reliable records are obtained during periods of snow, it is necessary to take special precautions. Points which need to be watched include:

(a) snow completely filling the funnel of the gauge, preventing any further collection;

(b) snow being blown out of the funnel, even if it is not full;

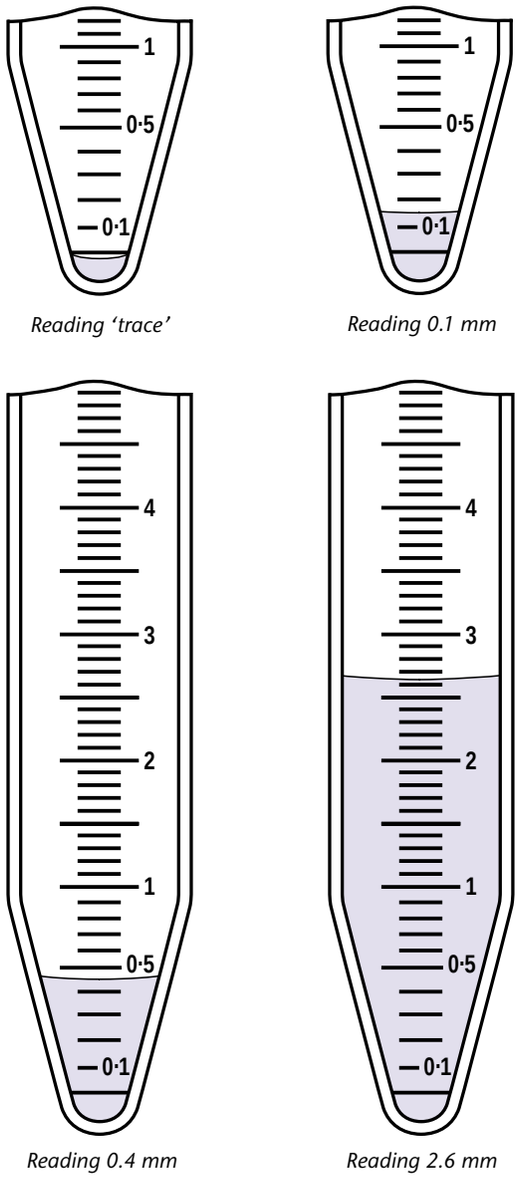
(c) drifting or blown snow, from snow already lying, being deposited in the funnel;

(d) the gauge becoming completely covered by snow.

It may be that the site, selected to give a good exposure during periods of rain, is liable to drifting snow with winds from certain directions.

Snow measurement (A)

The measurement of slight falls of snow does not present much difficulty and the following courses of action are open to the observer.



Reading 'trace' *Reading 0.1 mm*

Reading 0.4 mm *Reading 2.6 mm*

Reading the rain measure

(a) If precipitation is not falling at the time of observation, the funnel and collecting bottle may be brought indoors, their contents melted and measured in the ordinary way. The funnel should be covered with a flat plate during this melting period to prevent loss by evaporation.

(b) If snow is falling at the time of observation, one of the following two methods may be used. (1) A cloth dipped in hot water may be applied to the outside of the funnel and bottle as necessary to melt all the snow, and the water measured in the normal way. Care should be taken to ensure that no hot water enters the gauge.

(2) A known amount of very warm water may be poured into the gauge to melt the snow. Care must be taken not to break the bottle by using water that is too hot. About two measuring glasses of very warm water will be required if the funnel is full of snow. The amount of warm water used must, of course, be subtracted from the total amount measured.

Snow measurement (B)

Moderate or heavy falls of snow, particularly in windy periods, make more-elaborate methods of measurement necessary. Wind eddies may carry snow clear of the gauge or even blow it out of the gauge. Lying snow may be lifted by the wind and blown into the gauge and, in extreme circumstances, the gauge may become completely buried in snow. In these conditions, measurement is not easy but there are important reasons for taking readings, not least of which is the assessment of the amount of water which would be released in a sudden thaw and the possibility of flooding. Special efforts should therefore be made to obtain readings in the following ways.

(a) When all the precipitation is in the form of snow and no snow was lying on the ground prior to the period for which measurement is required, then a sample should be obtained by pressing the inverted funnel of the gauge downwards through level, undrifted snow. This sample core should be collected, melted indoors, and the resulting water measured in the normal way. It can be extremely difficult to judge where a representative sample should be taken as slight drifting is not always apparent. For this reason it is advisable, if possible, to take three samples a metre or so apart and report the average of these.

(b) When snow is lying on the ground prior to the period for which measurement is required (as would be the case after the measurement taken at (a) above), a clean surface must be prepared to receive any further falls. This can be provided by placing a white-painted wooden board on top of the snow with its upper surface flush with the snow. An unplaned slightly rough surface to the wood is best. This board should be swept clean after each snowfall measurement (taken as in (a) above) and replaced ready for the next measurement. The site selected for the board should avoid places where drifting is likely or overexposed places where snow may be blown away. The position of the board can be indicated by a thin cane so that it can be located under the snow.

(c) When precipitation changes from snow to rain or drizzle between scheduled readings, no special action is needed if the conditions are as described in **(A)**, but otherwise the observer should, if possible, carry out the procedure detailed in **(B)**, as appropriate, and clear and set the rain gauge to receive the liquid precipitation. A note should be made of the liquid equivalent of the sample taken, which should be added to the amount subsequently obtained from the rain gauge to give the total rainfall at the scheduled hour of reading.

When measurements are obtained by melting snow, observers are asked to indicate the fact by entering a small 's' against the readings. In addition, it is helpful to add a note in the 'Remarks' space, giving details of the duration or commencement of the snowfall, together with an indication of whether or not all the precipitation fell as snow.

In the case of monthly-read gauges, every effort should be made to secure a reading, even if the gauge is buried in snow or the contents of the gauge are frozen. The snow immediately above the funnel should be separated from the surrounding snow and pressed into the funnel. If possible, a quantity of hot water (measured beforehand and carried in a vacuum flask) should then be added to melt the snow. After taking a measurement and subtracting the amount of any water added, the funnel and receiver should be examined for leaks. A spare inner can may be used to replace the one containing the monthly amount (to which any snow in the funnel has been added) and the reading then made under cover as described previously.

In very severe weather it may be impossible to visit each gauge in a group of monthly-read gauges but efforts should be made to obtain a reading from at least one gauge. During periods of heavy snow it is desirable to obtain additional readings and this is especially true soon after a thaw sets in (as explained above); so if the gauges cannot be read, the depth of fresh undrifted snow at certain convenient places would be of value.

Heavy rain

Although a self-recording rain gauge affords the fullest information about heavy rain in short periods, a standard gauge can be used. The gauge should be read immediately after the end of heavy rain, the amount and the times of beginning and ending noted, and the water returned to the gauge, thus not affecting the reading on the following morning. As a fall exceeding 279 mm (11 inches) in one day has occurred in the British Isles and there have been numerous falls exceeding the capacity of a standard rain gauge, it is desirable that the gauge should be examined during a day of exceptionally heavy rain. If there appears to be any likelihood of the bottle overflowing it should be read and emptied, the amount being added to the next reading.

Maintaining a rainfall station

Testing the gauge

Inaccurate records of rainfall are often due to the use of a leaky gauge; it is therefore important that each part of the gauge should occasionally be tested for leaks by filling it with water to make sure that none escapes at any point. When testing the funnel it will, of course, be necessary to hold a finger over the lower end of the delivery tube. Alternatively, the funnel may be tested by closing the lower end of the delivery tube, inverting the funnel and pressing it downwards into a container of water. In this case the presence of a leak will be shown by the escaping bubbles of air. A mere examination of a gauge is not sufficient to detect a leak.

All leaks should be repaired as soon as detected. Leaks in the outer case of the gauge are no exception to this rule as any water in the bottom of the outer case can cause false readings as previously explained.

If the collecting bottle becomes unserviceable it should be replaced immediately. It should also be kept clean, as a dirty bottle inhibits the free flow of water drops and small amounts are difficult to read.

Site check

Garden sites can quickly overshelter a rain gauge whilst still remaining very tidy and well kept. Observers should therefore check the site occasionally to make sure that no plants are nearer to the gauge than twice their height.

Change of site

The site of the rain gauge should not be changed without the approval of the Met Office or other official authority in case certain criteria are not met, thus making the new site unacceptable.

Absence of observer

An assistant should, if possible, be trained to measure the rainfall in the absence of the observer. If this is not possible, the gauge should be left untouched until the observer's return. The accumulated amount should then be read and entered on the return, the days concerned being indicated with a bracket.

Large-capacity gauges

General

For use in remote areas on mountains or moors where readings can only be taken weekly or monthly, special gauges of large capacity are used. In selecting one of these gauges it has to be remembered that, owing to inclement weather, the gauge may be left for more than a month, and occasionally for two months.

Recommended gauges

(a) Bradford gauges

The Bradford gauge is available in two capacities: 380 mm and 685 mm. The smaller size is suitable for use as a monthly gauge only in relatively dry areas. The larger one is rather difficult to manipulate because of its length. Bradford gauges have a deep inner can with a fixed cover at the top (the purpose of which is to minimise evaporation), perforated for the delivery tube of the funnel and for pouring out the water. The amount is measured in the usual way using a large capacity (50 mm) measuring glass.

(b) Octapent gauges

The Octapent gauge is also available in two capacities: 685 mm and 1270 mm. The smaller size is suitable for most localities, but in exceptionally wet districts the larger size should be used. The Octapent gauge is a modified Met Office pattern daily gauge and consists essentially of a 203 mm (8-inch) diameter outer can fitted with a 127 mm (5-inch) diameter funnel (hence the name Octapent). The amount of water is measured in the usual way using a large 50 mm measuring glass. Provision is made for fitting a frost protector in these gauges. This consists of a stout rubber hose, plugged and weighted with lead at the lower end and of sufficient length to clear the top of the inner can when placed inside. The protector operates by collapsing under the pressure of expansion when the water in the can freezes. Pressure on the walls of the can is thus relieved and damage prevented.

Graduated rods (dip rods) are available for both of the above types of gauge but the use of these is not recommended except for a quick estimate of the amount of water in the gauge prior to exact measurement. Graduated rods should not be used for measurements recorded on the returns.

Recording gauges

General

A recording gauge produces a record of the amount of rain that falls and of the time at which it falls. The record may be a graphic one on a paper chart or it may be in digital form. The paper chart recorder-type, e.g. the tilting-syphon recorder, is rapidly being replaced by the tipping-bucket recorder (TBR) with loggers or direct telemetry systems attached to them. In general, one tip of the bucket is equivalent to 0.2 mm of rain, but some TBRs are set to tip at 0.5 mm or even 1.0 mm.

A recording gauge (even the best) requires expert attention and careful handling if it is to produce worthwhile results. Every recording gauge that is installed into a rainfall network should be accompanied by a standard gauge that is used as a check for quality control and as a guide to a drift from acceptable standards.

Rules for rainfall observers and forms

Supply of forms

Copies of *Rules for rainfall observers* are supplied free on application to the address given below. Forms for the return of observations to the Met Office are normally issued annually on a routine basis. Those observers who send their returns through a third party, e.g. the Environment Agency, will normally obtain their supply of forms from the agency, which is supplied in bulk with any Met Office forms required.

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