How to Measure Rainfall

METEOROLOGICAL DIVISION–DEPARTMENT OF TRANSPORT
CANADA

9056

Precipitation Observation

1. Introduction

- **Precipitation** — In Meteorology the term precipitation includes all forms of moisture that fall to the earth's surface, such as drizzle, rain, snow, hail, etc. It is the purpose of this pamphlet to indicate the means of measuring amounts of precipitation.

- **Drizzle** — Drizzle is precipitation in the form of very small drops of water. It may fall from clouds or may form part of a drizzling fog. On account of the small size of the drops, they appear to float or follow even slight motions of the air.

- **Rain** — Rain is precipitation in the form of water drops of various sizes in which most drops are larger than the drops in drizzle.

- **Hail** — Hail consists of hard pellets of ice of various sizes and shapes usually associated with a thunderstorm or thunderstorm type of cloud.

- **Snow** — Snow consists of ice crystals often in flake form and frequently six pointed star shaped.

- Liquid precipitation may freeze as it falls or may freeze upon coming in contact with the earth's surface or objects on the earth's surface.

Fig. 1.

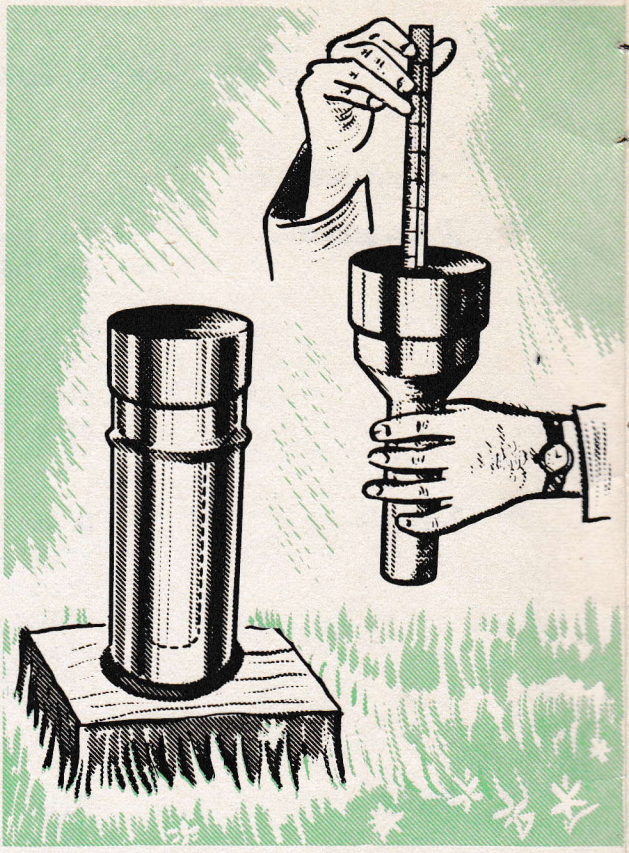

Fig. 2.

2. Rain Gauge for Rainfall Measurement

A simple instrument for collecting and measuring rainfall is called the rain gauge. (See Figure 1.) Essentially it is a cylindrical shaped object with a removable open top section. The area of the top opening is ten square inches. The funnel shaped device set into the top section directs the water collected into cylindrical containers inside the rain gauge. There are other types of rain gauges in use but the one described above is the official rain gauge for the Meteorological Division of the Department of Transport. Figure 2 represents another type of rain gauge which is used extensively but is not a part of the official equipment issued by the Meteorological Division.

3. Rules for setting up Rain Gauge

There are five main rules for setting up a rain gauge so that the water it collects will be representative of the rainfall on a horizontal surface. These rules are as follows:

- The top rim of the gauge must be level.
- The top rim must be circular.
- The gauge must be firmly mounted. This is best accomplished by mounting it on a post sunk in the ground to a depth of at least two feet.
- The gauge should preferably be located a distance from all objects equal to four times their height and must be located a distance from all objects at least equal to their height.
- The top rim of the rain gauge should be twelve inches above the ground level.

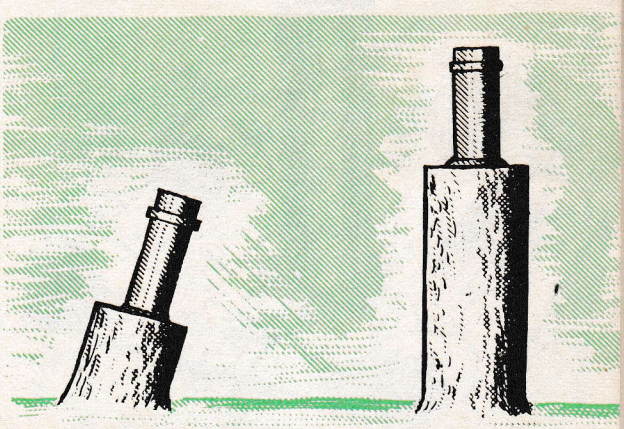

Fig. 3.
- Not level and too high

Fig. 4. and 5.
- Too close to objects

4. Practical Methods of Installing Rain Gauge for various types of Soils and at different Seasons

Wherever possible the rain gauge should be securely mounted and levelled on a post sunk into the ground. To prevent heaving due to frost action the post should extend below frost level, but quite often this is impractical, and therefore it is recommended that the post should be sunk into the ground a depth of not less than two feet. The post may project above ground level one and one half inches. As the gauge itself is ten and one half inches in height, the total height of the rim of the gauge will then be twelve inches above ground level. It will be necessary to check the level of the rain gauge each Spring so as to adjust the post for frost heaving. When a hole is dug for inserting a post, the soil should be back-filled and tamped solidly around the post.

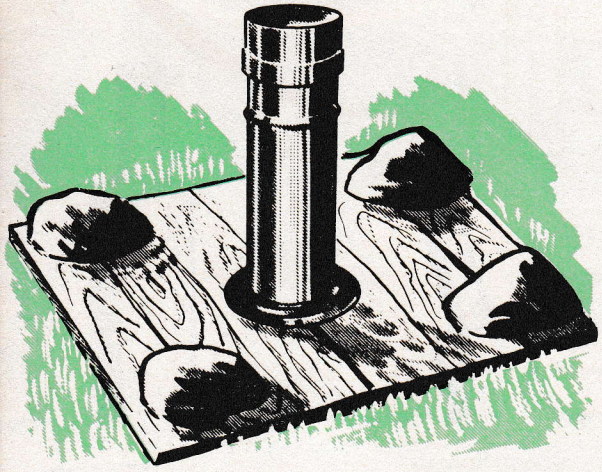

Fig. 6.

In rocky areas or soil mixed with rock it may not be possible to make any excavation whatsoever for a rain gauge. Under such circumstances, a platform approximately two feet square may be constructed and placed in a level position on the ground. The rain gauge should be secured to the centre of this platform and carefully levelled. Suitable rock may be distributed around the edge of the platform to ensure that it is securely anchored. (See Figure 6.)

In the summer season it is quite easy to install rain gauges in any type of soil as suggested above. The tools necessary for this work consist of a round nosed shovel, a pick, a saw, a hammer and nails, and a level. The hole is excavated with the pick and shovel; the post is sawn squarely so that the rain gauge can be properly set level. The nails are used to secure the rain gauge to the post.

Occasionally stations are established during the winter season when the ground is frozen solid and snow-covered. In such

cases a temporary installation of the gauge must be made. This may be done as outlined for figure 6 above. As soon as the ground is thawed out the gauge must be installed in a permanent location.

5. Measurement of Rainfall

It is necessary to make certain there are no obstructions to the funnel of the gauge such as leaves, or dirt, to prevent the water from running into the collectors located inside the rain gauge. There are two collectors in the rain gauge. The smaller container placed inside the larger one is of sufficient capacity to hold the drizzle or rain for all light rains. For very heavy rains, the inner container may overflow into the larger container and this overflow will be included in the measurements.

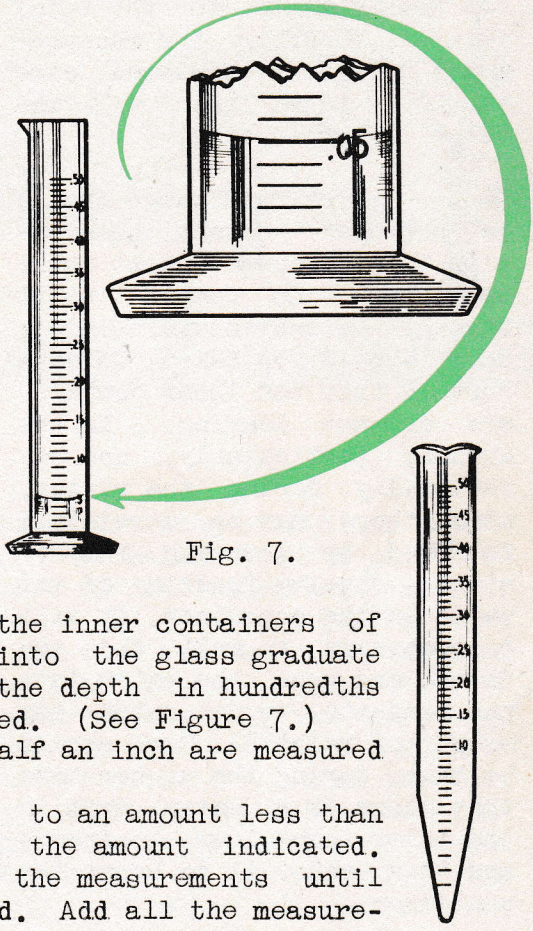

Fig. 7.

The water collected in the inner containers of the rain gauge should be poured into the glass graduate from which is read off directly the depth in hundredths of an inch of the rainfall collected. (See Figure 7.)

Rainfalls greater than half an inch are measured as follows:

Pour water into the glass graduate to an amount less than .50 on the glass and write down the amount indicated. Throw this water away and repeat the measurements until all the water collected is measured. Add all the measurement for the total rainfall.

For example if you measure first: .48 inch
next: .47 inch
and last: .32 inch
the total rainfall is: 1.27 inch

At stations equipped with a metal measuring cylinder instead of the glass graduate the rainfall is poured into this copper container. The rule supplied, which is marked off in hundredths of an inch, is inserted until it reaches the bottom of the container and the depth to which it is wetted is noted. From this

wet mark on the ruler can be read off on the scale the amount of rainfall collected. For rainfalls greater than one inch pour water into the measuring cylinder to an amount less than one inch and write down the amount indicated. You will note that the one inch mark on the stick is of course below the top of cylinder. Throw this water away and repeat the measurements using a dry stick until all the water collected is measured. Add all the measurements for the total rainfall. After the measurements have been completed care should be taken that all the water is thrown away.

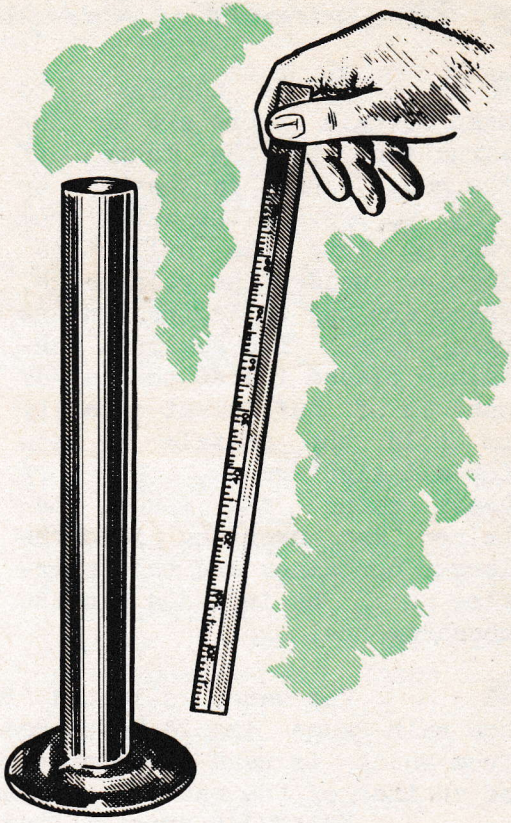

Fig. 8.- Metal measuring cylinder.

The rain gauge should be inspected at each observation to make certain that there has been no damage to it through misadventure. Also, care should be taken to make certain that the inner containers are not leaking. In the Autumn, particularly, and occasionally during the winter, when there may be a rainfall followed by lowering temperatures, causing freezing of the water in the container, it will be necessary to melt this ice formed and pour the water into the graduate to determine the amount of rainfall. Care should be taken during the winter time that there is no water left in the inner container to freeze and thus cause it to burst the container resulting in a leaking container.

Occasionally rain freezes upon striking the rain gauge. In such cases, the measurement may be accomplished by pouring a measured amount of hot water into the gauge and completely melting the ice in the funnel and containers. The amount of rain may then be determined by subtracting the added amount of hot water from the total measurement. The computation may be carried out as follows:

Measurement of hot water and melted ice	.84 inch.
Added hot water	.45 inch.
Measurement for frozen rain	.39 inch.

6. Measurement of Snow

Where snow has fallen without drifting conditions occurring, the measurement of snow can be accomplished quite satisfactorily. A rule one yard long, marked off in inches and tenths of inches, is used for snow measurement. An area is selected where the snow has fallen undisturbed by the wind and the ruler inserted vertically to the depth of the freshly fallen snow, that is, snow which has fallen since the last observation. If the surface of the old snow be not well defined and the depth of the old snow be known either to the ground or to the surface of some previous fall, the depth of the new fall may be found by subtracting the depth of the old snow from the whole depth measured from the upper surface of the new fall to the lower surface of the old snow. The depth of the snow is read off directly in inches and tenths of an inch on the rule. There should be several different probes made to determine the snow depth. These probes will be taken at distances of several feet from each other. The average of all of these depths of snow will be taken as the actual amount of snow that has fallen.

The measurement of snow where drifting occurs, especially on the Prairie regions of Western Canada, is most difficult, and no satisfactory method has yet been developed for making accurate snowfall measurements. The measurement of snow depth under these drifting conditions requires a great deal of judgment and experi-

ence on the part of the observer. There should be several probes made of the snow depth in an area which is considered as representative as possible of the level terrain. The average should be taken for the actual depth of snow, coupled with the depth of the drifts that have been formed. That is, the final snow depth results may be adjusted based on the size of the drift where it is considered that much of the snowfall has been blown free of the level surface.

It is customary to express total precipitation in terms of inches and hundredths of inches of water. The water equivalent of snow is found by regarding one inch of water as equivalent to ten inches of snow. Therefore, to convert the depth of snow into the water equivalent, we simply divide by ten. Thus, 2.5 inches of snow is equal to .25 inches water. .1 inch of snow is equal to .01 inch of water.

7. Measurement of Rain and Snow together

When rain and snow have occurred within the observation period, it is necessary to separate the amount of rain from the amount of snow so that the precipitation records will be complete. The best method to accomplish this is to melt the snow in the gauge including any accumulation in the funnel portion of the gauge and measure the water collected. Also with a rule (or scale), measure the average depth of snow and record this for the depth of snow. From the amount of water collected in the gauge subtract the water equivalent of the snow measurement and this will give the actual amount of rainfall. For example: if the melted snow and rain collected in the gauge is .38 inches, and the average depth of snow measured was 1.5 inches, (1.5 inches snow is equivalent to .15 inches water) then the amount of rainfall is .38 minus .15 equals .23 inches.

8. Measurement of Hail

The rain gauge is not a satisfactory instrument for measuring hail. Usually a great deal of the hail will bounce out of the rain gauge, so that the correct amount that would fall on a horizontal surface would not be collected in the rain gauge. The most practical method of measuring hail is to take the top section of the rain gauge and invert it over a horizontal surface, collecting the amount of hail contained within the area of the top of the rain gauge. Take this amount of hail and melt it and obtain the water equivalent.

9. Observations

It is preferable that observations of precipitation be made twice a day, once in the morning, and again in the late afternoon. That is; the first observation might be taken at breakfast time, and the second observation at supper time. Once the time of observations has been decided upon, it is necessary that it be continued at that same time each day.

Where it is impossible to take more than one observation a day, it is preferred that this be taken in the morning about breakfast time, and consistently at the same time each day.

Recording of Precipitation Observations

Forms 2299-1 are provided by the Meteorological Division for the official recording of measurements of precipitation. The form is divided into eleven columns. The calendar days of the month are listed one below the other in the first column. In the next two columns should be entered the measurements of rainfall observed at the times indicated by the headings. The amount of drizzle, rain or melted hail measured at the evening observation should be entered in the column headed "Rain P.M." on the line for the calendar date of observation. It will be noted that the next column is headed "Rain Next A.M." Since it is not usually feasible to take observations at midnight it is necessary to credit the rain which may have fallen between midnight and the morning observation to the previous day. Thus the Meteorological day is considered as ending with the following morning's observation. The rain measured at the morning observation should be entered in the third column but the entry credited to the previous calendar day. For example, suppose observations are taken daily at 7:30 A.M. and 6:00 P.M. and on the fifth day of the month rain began at 2:00 P.M. and ended at 4:30 P.M. and the amount was 0.21 inch. There should be an entry of 0.21 in column 2 on the line of the fifth. Further, suppose that there was another rainfall beginning at 9:00 P.M. on the fifth and ending at 6:00 A.M. on the sixth with a measurement of 0.76 inch made at the 7:30 observation on the sixth. This measurement should be entered in the third column opposite the date of the fifth.

Entries of snowfall are made in a manner similar to those for rainfall. Snowfall measured at the evening observation is entered in column four for the calendar date. Snowfall measured at the morning observation is entered in column five, crediting the amount to the previous calendar day. Snowfall

entries are always made to the nearest tenth of an inch as measured. If for example, on the sixth day of the month snow commenced at 1:00 P.M. and ended sometime during the night, and the amount of snowfall measured at the evening observation on the sixth was 3.4 inches, this would be recorded as 3.4 inches in column four. If in the morning there was measured an additional 4.2 inches of snow this amount would be entered in column five opposite the date of the sixth. In column six is indicated the total precipitation for the 24 hours. In the example above the 24 hour snowfall is 7.6 inches but in column six the water equivalent will be entered as 0.76 inch.

The observer should always take particular pains to enter Traces of precipitation when precipitation occurs but the amount is too small for measurement. In such cases the entry may be made as "Trace" or "T".

Observers may be able to provide information on the approximate times of beginning and ending of rain and snow in the spaces provided for this purpose. In all instances the entries will refer to the calendar day. In cases where the precipitation starts or stops during the night the entry may be made as "night" in the appropriate column. Spaces are also provided for general notes on each day's weather, and for the average depth of snow lying on the ground each Monday morning and at the end of the month (or for the state of the surface soil moisture when the ground is bare of snow).

A copy of Form 2299-1 is illustrated on Page 11 as a sample to indicate how the Form should be filled out before forwarding to the Meteorological Office, 315 Bloor Street, West, Toronto 5, or to a designated office when instructed to do so by the Controller of the Meteorological Division.

Please report immediately any faulty equipment by letter to the appropriate office. If you have any questions concerning the precipitation observations, we would be glad of the opportunity to answer them, and inquiries may be directed to your District Office. We list on Page 12 the addresses of each of the District Offices.

CANADA

DEPARTMENT OF TRANSPORT

METEOROLOGICAL DIVISION OF AIR SERVICES

RECORD OF RAINFALL AND SNOWFALL

2299-1
5-45

HEAD OFFICE
TORONTO, ONT.

Station. PLUMAS. Prov. MAN. Month. DEC. 19 51 Observer. H.C.W. AYLWIN

Times of Reading Rain Gauge..... 07:30 ..... A.M. ..... 07:30 ..... P.M.

Day of Month	Measurement of Precipitation (in inches) RAIN P.M.	RAIN Next A.M.	SNOW P.M.	SNOW Next A.M.	Total 24 Hours	Times of Precipitation RAIN Began	RAIN Ended	SNOW Began	SNOW Ended	General Notes on Weather.
1										early a.m. fog, then mild
2		Tr.			Tr.	22.00				fair, mild, fog in late p.m.
3			0.2		0.02		7.00	7.35	11.00	cloudy, fairly mild, lt. snow
4		Tr			Tr.					clear and mild
5	0.01	0.02	0.3		0.06	7.15 16.30	7.30	7.30	16.30	cloudy, fairly mild at 8.30 a.m. mild, light snow and rain
6	0.02		2.3	0.1	0.26		10.30	10.30	20.30	mild, wet snow and rain
7			0.1		0.01			9.00	10.00	cloudy, windy, cooler
8				0.1	0.01			night	night	fair, cold
9				0.7	0.07			2.00	3.00	cloudy, milder at night
10			0.1		0.01			night 12.00	5.00 15.00	cloudy, milder, then colder, first flurries of snow in p.m.
11			0.4		0.04			9.00	14.00	cloudy, colder in afternoon
12										clear and cold
13										fair, cold
14										clear, very cold
15										fair, cold
16										clear, cold
17										clear, very cold
18										clear, very cold
19										fair, very cold
20										fair, not quite so cold
21										fair, not quite so cold
22			Tr.		Tr.			12.30	13.30	cloudy, colder
23										fair, cold
24										clear and milder
25										fair, quite mild
26										fair, slightly colder
27			Tr	0.2	0.02			19.00	22.00	cloudy and colder
28										fair, windy, much milder
29				1.8	0.18					fair and mild
30			1.0	0.2	0.12			night	24.00	snow and drifting snow
31			Tr.		Tr.			11.00	12.00	cloudy, cold, north winds
Total	0.03	0.02	4.4	3.1	0.80					

Total Depth of Snow on Ground each Monday Morning and on Last Day of Month

Date	Mon. 3rd	Mon. 10th	Mon. 17th	Mon. 24th	Last of Month.
Depth (Inches)	1"	3"	3½"	3"	4"

State of Soil Moisture each Monday Morning and on Last Day of Month

Date	Mon. 3rd	Mon. 10th	Mon. 17th	Mon. 24th	Last of Month.
State of Soil	Snow	Snow	Snow	Snow	Snow

Number of Days with various Amounts of Precipitation

Rain	Snow	Precip.	0-.09"	.10-.19"	.20-.29"	.30-.39"	.40-.49"	.50" and over
2	11	11	28	2	1	0	0	0

Addresses

VANCOUVER, B.C.	District Controller, Air Services, Attention: District Meteorologist, Room 401, Winch Building, Vancouver, B.C.
EDMONTON, ALTA.	District Controller, Air Services, Attention: District Meteorologist, 302 Blowey-Henry Building, Edmonton, Alta.
WINNIPEG, MAN.	District Controller, Air Services, Attention: District Meteorologist, 611 Power Building, Portage Avenue, Winnipeg, Man.
TORONTO, ONT.	District Controller, Air Services, Attention: District Meteorologist, 260 Richmond Street West, Toronto, Ont.
MONTREAL, QUE.	District Controller, Air Services, Attention: District Meteorologist, Montreal Airport, Dorval, Que.
MONCTON, N.B.	District Controller, Air Services, Attention: District Meteorologist, P.O. Box 42, Moncton, N.B.