CHAPTER 19

RATE–OF–RAINFALL – TIPPING BUCKET RAIN GAUGE

19.1 GENERAL. The standard instrument for measuring rate of rainfall is the MSC Tipping Bucket Rain Gauge, provided with a daily or weekly chart recorder. The instrument is described in Technical Manual TM 04–01–03, (English and French versions). These publications deal with the installation, care and maintenance of the equipment. The following instructions cover the abstracting of recorded precipitation data for processing for climatological purposes.

19.1.1 The MSC Tipping Bucket Rain Gauge (daily chart) shall be operated in conjunction with an AES Standard Rain Gauge.

19.1.2 The processing system established for correcting the amounts of rainfall recorded by the Tipping Bucket Rain Gauge to the amounts measured by the standard gauge requires that the time of chart change coincide with the time of reading of the AES Standard Rain Gauge.

19.1.3 General instructions on the care and maintenance of the Tipping Bucket Rain Gauge are given in Technical Manual TM 04–01–03. However, the instructions in TM 04–01–03 regarding the operation of the recording gauge during the winter months, are superseded by those which follow here. These detailed procedures are provided in order that reliable rate–of–rainfall data may be calculated for occurrences of rain or drizzle, during the winter, at observing sites where a continuous weather watch is maintained. In the following instructions the term "liquid precipitation" does not include freezing rain or freezing drizzle.

19.1.3.1 Stations equipped with a Tipping Bucket Rain Gauge and which take fewer than 24 Hourly Observations per day (including climatological stations), shall measure rate–of–rainfall (operate the Tipping Bucket Rain Gauge and Recorder) only during that period of the year when liquid precipitation is the predominant form. For the remainder of the year (the period to be specified by the Region) the recording gauge shall be taken out of service. During this period, no charts would be used on the recorder. The period of operation should begin on the first day of a month and end on the last day of a month.

Note: When the Recording Rain Gauge is being withdrawn from service, the last chart for the season shall be annotated CLOSED FOR SEASON. Similarly, when the Recording Rain Gauge is placed in service, the first chart shall be annotated REOPENED FOR SEASON.

19.1.3.2 Stations equipped with a Tipping Bucket Rain Gauge and which take 24 Hourly Observations per day shall measure the rate–of–rainfall throughout the year. However, from the beginning of the snowfall season and continuing until a date specified by the Regional Headquarters or Supervising Office, the Tipping Bucket Rain Gauge shall be in service during periods of liquid precipitation only; recorder charts (Chart 99) shall be required for these periods only. The following routine shall be maintained:

(a) At the first occurrence of snow in the autumn, cover the Tipping Bucket Rain Gauge with a suitable lid, plastic bag, etc. After the chart which is then on the recorder drum has been removed at the normal time of chart change record on that chart: "Tipping Bucket Rain Gauge Taken out of Continuous Operation". Further recorder charts (Chart 99) are not required until the next occurrence of measurable liquid precipitation.

(b) When liquid precipitation (not accompanied by freezing or frozen precipitation) begins after a cover has been put on the Tipping Bucket Rain Gauge, remove the lid, cover, etc., while preparing the special observation which reports the beginning of the precipitation AND activate the recorder. The recorder pen should be positioned on the chart to indicate the elapsed time since normal time of chart change, for example:

(i) Normal time of chart change is 0700 Local Standard Time (LST).

(ii) Rain begins at 12:30 LST (winter operation).

(iii) The cover is removed from the Tipping Bucket Rain Gauge as soon as possible after the rain starts.

(iv) Activate or read the standard gauge. (It may be convenient to install a spare funnel and graduate during the period of liquid precipitation.)

(v) The recorder is activated.

(vi) The recorder pen is positioned on the chart at "5 1/2 hours after normal time of chart change", and that chart should remain on the recorder UNTIL NORMAL TIME OF CHART CHANGE.

If liquid precipitation begins again before normal time of chart change, the same chart may contain data for two or more periods of liquid precipitation. The time of chart change must coincide with the normal time of reading of the standard gauge, thus the amount of rain recorded on the chart can be readily compared with the corresponding amount measured by the standard gauge.

Note: The above procedure, on occasion, may require that a chart be removed from the recorder only a few minutes after the recorder is activated; i.e., when liquid precipitation begins only a few minutes prior to normal time of chart change.

(c) If liquid precipitation (not accompanied by freezing or frozen precipitation) is occurring at the time of chart change, a new chart is of course put on the recorder immediately.

(d) When liquid precipitation ends (during winter months) or if frozen precipitation starts while liquid precipitation is still occurring, replace the lid on the Tipping Bucket Rain Gauge. (The chart should not be removed from the recorder until normal time of chart change and the recorder pen need NOT be removed from the chart. Thus if liquid precipitation begins again before chart change, rate–of–fall data may be recorded as a continuation of the trace already on that chart. If freezing or frozen precipitation begins, an intermediate standard gauge reading should be made so that the rainfall amount collected by both gauges can be compared.)

(e) At these stations, Regional direction or the station OIC will determine when the operation of the Tipping Bucket Rain Gauge should change from "Winter Operation" to continuous operation.

(f) Stations in continuous operation may experience freezing or frozen precipitation events during early autumn or late spring. In these circumstances the Tipping Bucket Rain Gauge must be covered for the duration of the freezing or frozen precipitation event and an intermediate reading of the standard gauge made so that any rainfall amount collected by both gauges can be compared.

(g) Charts on which the recorded Standard raingauge amount is less than 0.2 mm (i.e. a trace) need not be sent to the Regional Data Processor.

19.1.3.2.1 Station programs regarding the operation of the Tipping Bucket Rain Gauge should be available to AES Downsview, on request, to indicate the following:

(a) Which stations do not operate the Tipping Bucket Rain Gauge during the winter, and for what period each of these stations measures rate–of–rainfall.

(b) The period of "winter operation" at each of the observing stations where 24 Hourly Observations are taken daily.

19.1.3.3 Implementation of the preceding procedures will produce data on Chart 99 from which more accurate rate–of–rainfall data may be determined and will result in the following advantages:

(a) Only liquid precipitation (not accompanied by freezing or frozen precipitation) should be recorded on Chart 99.

(b) A more realistic correction factor can be directly determined from data on the chart, i.e., from the total rainfall recorded on the chart in relation to the total amount of liquid precipitation as measured by the standard gauge.

(c) Data Processors will not be obliged to abstract useless data, i.e., hourly amounts resulting from melting snow or ice.

19.1.3.4 At each station where rate–of–rainfall is measured throughout the year, the Officer–in–Charge shall be responsible for establishing a local maintenance routine, which will ensure that the Tipping Bucket Rain Gauge System is always ready for immediate service; for example, by checking regularly to ensure that:

(a) The recorder clock is in working order

(b) The recorder pen has ink and is not clogged

(c) The recorder has Chart 99 installed (not dated) but otherwise ready for service

(d) The necessary removal of snow in the area of BOTH the standard gauge and the Tipping Bucket Rain Gauge is done in advance, so that these instruments, when required, can be immediately exposed without digging to locate them beneath snow cover.

19.1.3.5 When in the opinion of the Regional or Supervising Office, the above instructions for measuring rate–of–rainfall throughout the year are not feasible, the Tipping Bucket Rain Gauge shall be taken out of service for such period as considered necessary, an appropriate note should be recorded on Form 63–2325 and the Regional or Supervising Office shall advise the ADMA by letter accordingly. (See NOTE following para 19.1.3.1).

Note: The standard rain gauge however should NOT be taken out of service.

Amendment nº 14
June 1996

19.2 FORM 63–9686 – MSC TIPPING BUCKET GAUGE DAILY CHART 99

19.2.1 Time of Chart Change:

(a) At each station a normal time for changing the chart on the MSC Tipping Bucket Gauge shall be selected, and this normal time of chart change shall coincide with the reading of the standard rain gauge. On occasion it may be necessary to read the standard gauge and change the chart slightly before or after the normal time of chart change; however the time of chart change must coincide with the reading of the standard gauge.

(b) The time selected for the changing of the chart and the reading of the standard gauge shall be as nearly as possible on the hour.

(c) The chart shall be changed each day, whether precipitation has occurred or not, except during "winter operation". Refer to para. 19.1.3.1 and 19.1.3.2.

(d) The recorder pen should normally be positioned on each new chart on the line which indicates "0 hours after normal time of chart change". However, if the chart is changed slightly before or after "normal time of chart change", the pen should be positioned on the chart to indicate the time interval between actual time of chart change and normal time of chart change: e.g.,

(i) Normal time of chart change is 0700 LST.

(ii) The reading of the standard gauge and the changing of the chart are done 30 minutes later than "normal time of chart change": i.e., at 0730 LST.

(iii) The pen should be positioned on the chart half–way between "0" hours after "normal time of chart change" and "one hour after normal time of chart change".

Note: The design of Chart 99 is such that an abstract of data, suitable for processing, can be obtained even though, on occasion, the time of chart change may vary by as much as an hour from the normal time.

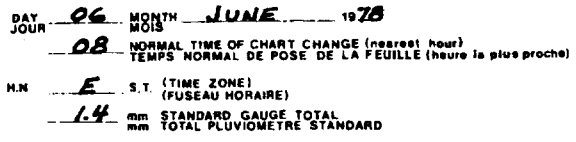
19.2.2 Entries on Chart 99.

19.2.2.1 Before placing Chart 99 on the recorder, enter the following:

(a) Station name and province (as in METSTAT). On the first chart for a new month, affix a preprinted label to the chart immediately above the space provided for the station name and province.

(b) Day (two figures), month, year

(c) Normal Time of Chart Change: Enter to the nearest hour the normal time of chart change and indicate the time zone. Do not use daylight saving time.



Note: This entry (to the nearest hour) should not vary from day to day or from month to month, unless for some reason it becomes necessary to establish a different "normal time of chart change", and if so, the change should be made at the beginning of a month.

The following examples illustrate the procedures which apply when the actual time of chart change departs from the normal time of chart change:

	Normal Time of Chart Change	Actual Time of Chart Change	Chart Change Entry	Pen Positioned on Chart at:
(1)	0750	0750	08	0 hours
(2)	0050	0040	01	0 hours minus 10 minutes
(3)	1250	1310	13	0 hours plus 20 minutes
(4)	0950	1050	10	1 hour after normal time of chart change
(5)	0150	0850*	02	7 hours after normal time of chart change.
(6)	0800	1230**	08	4 hours and 30 minutes after normal time of chart change

*Winter operation

**Chart overrun – late change. Data from the last 4 1/2 hours on the chart being replaced should be placed in the appropriate boxes on the new chart.

19.2.2.2 After removing Chart 99 from the recorder, complete the following entries on the chart:

(a) Standard Gauge Total. Enter the amount of RAIN as measured by the standard rain gauge to the nearest tenth of a millimetre, i.e., 29.2, 4.6, 0.8, for the period of the chart. Enter "0" for none; enter "M" for missing. Mark this amount with an asterisk if it includes any freezing precipitation. See also para. 19.1.3.2 (b) (iv) and 19.1.3.2(d) for special procedures during winter operation. (See para. 19.1.3.2(f) for procedures during freezing and frozen precipitation events.)

(b) Greatest Fall of Rain in 5 Min., 10 Min., etc. In the boxes provided, enter in millimetres and tenths, the greatest fall of rain as determined from the chart, (para. 19.2.2.4) for the various durations, i.e., the greatest recorded amounts for durations of 5 minutes, 10 minutes, 15 minutes, 30 minutes, 1 hour, 2 hours, 6 hours, and 12 hours. Enter "M" if there was rain during the period of the chart but the gauge was unserviceable. Leave blank if there was no rain.

Notes: (1) While lines have been provided on the chart for recording corrected amounts of greatest rainfall for various durations, and for corrected hourly amounts, entries in these lines are not required except where there is a Regional need for the completion of Form 63–9687.

(2) A plastic Rainfall Intensity Scale No. 50, Stock No. 6675–21–904–3703 and a Magnifying Glass with case, Stock No. 6650–00–346–9106 are available from AES Downsview Stores and are most useful aids when abstracting data from Chart 99.

(3) A series of control checks should be applied to the values recorded on Chart 99 for "Greatest Rainfall in 5 minutes, 10 minutes, 15 minutes, 30 minutes, 1 hour, 2 hours, 6 hours, 12 hours", viz:

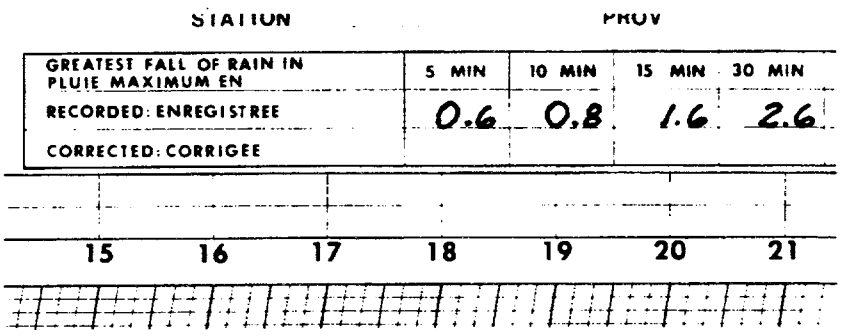
The amount assigned to any duration period up to one hour must not exceed twice the preceding amount, nor should it exceed the sum of the previous amounts.

The 30–minute amount must not exceed 3 times the 10 minute amount.

The 6–hour amount must not exceed 3 times the 2–hour amount.

The 12–hour amount must not exceed twice the 6–hour amount.

EXAMPLE (of incorrect data)



The entries shown above for the 5, 10, 15, and 30 minute intervals are not in keeping with the preceding rules, and are therefore not acceptable because the amount for 15 minutes is greater than the sum of the two previous amounts, and the amount for 30 minutes (2.6) is more than 3 times the amount for 10 minutes (0.8).

(c) Recorded Hourly Amounts:

(i) Enter the recorded hourly amounts to the nearest 0.2 millimetre as determined from the chart, (para. 19.2.2.3).

(ii) No entries are required for hours with no rainfall.

(iii) Enter "M" for hours when there was malfunctioning of equipment during periods of rainfall.

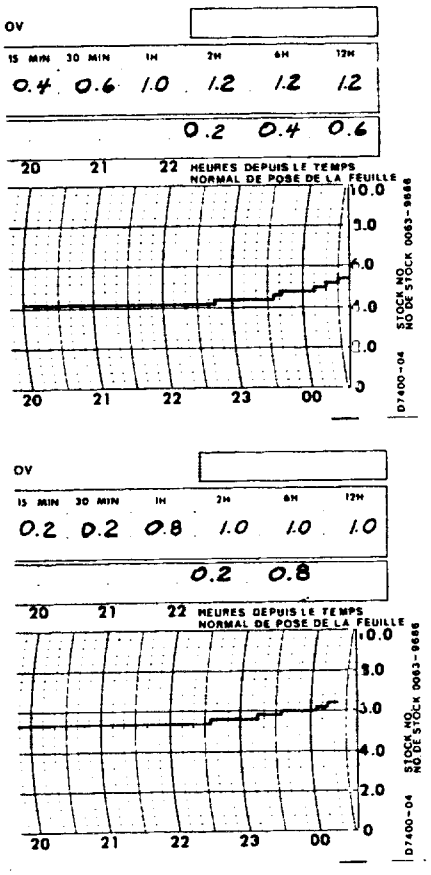
19.2.2.3 How to Determine Hourly Amounts From Chart 99. The recorded hourly amounts of rain shall be determined to the nearest 0.2 millimetre by counting the number of 0.2 millimetre steps on the chart. A step that occurs on the line separating two hours shall be credited to the first of these hours.

Note: One step = 0.2 millimetre of rain. Normally, there are two steps (0.4 mm of rain) made in the space between two horizontal lines. However, the observer is cautioned that occasionally, due to malfunctioning of the instrument, one step may extend over a full space or more. This double step shall be considered as 0.2 mm of rain.

19.2.2.3.1 When the chart has been changed slightly before or after the normal time of chart change, the trace on the recorder chart will not end exactly on the line indicating "24 Hours After Change". In such cases, the last hourly amount shall be determined as follows:

(a) When the last portion of the recorder trace extending beyond the "00" line (i.e., the last complete hour on the chart) represents a period of 30 minutes or more, count the 0.2 mm steps in this portion of the trace and record this amount in the appropriate box as the last hourly amount.

(b) When the portion of the recorder trace extending beyond the "00" line represents a period of less than 30 minutes, count the 0.2 mm steps in this portion, add them to the amount recorded in the previous hour and record the total as the hourly amount for the last full hour recorded on the chart.



19.2.2.3.2 If a chart is changed more than an hour after the normal time of chart change and the pen overwrites on the beginning end of the chart, because of the chart overlap, the vertical lines on the body of the chart will no longer correctly represent the time. It will be necessary to scale off the time as well as abstracting the rainfall on the overrun portion of the chart. In such a case, the data abstracted following hour 24 shall be placed in the appropriate boxes at the beginning of the chart for the next day.

19.2.2.4 How to Determine the Greatest Fall of Rain in Short Duration. The greatest fall of rain for the various durations indicated on the chart will be determined by examination of the chart. The durations for which data are required, are 5 minutes, 10 minutes, 15 minutes, 30 minutes, 1 hour, 2 hours, 6 hours and 12 hours. These durations are not bound by clock hours. For example, the greatest fall in a 10–minute period may begin at 13 hours and 52 minutes after chart change and end at 14 hours and 2 minutes after chart change. For the shorter durations it may be necessary to scan several different periods to find the steepest slope of the curve representing the greatest fall of rain. See example on next page.

EXAMPLE OF GREATEST FALL IN 5 MIN, 10 MIN ETC.
(SECTION OF MSC CHART NO.99)

STATION_____ PROV._____

GREATEST FALL OF RAIN IN PLUIE MAXIMUM EN	5 MIN	10 MIN	15 MIN	30 MIN	1H	2H
RECORDED: ENREGISTREE	0.4	0.6	0.8	1.0	1.6	2.6
CORRECTED: CORRIGEE