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COMPARISON OF WETTING LOSSES ON TWO TYPES OF RAINGAUGE

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ABSTRACT

The wetting losses of a Meteorological Office Mk I copper raingauge are compared with those of a Marquis 1000 plastic gauge. Laboratory tests of the Mk I gauge indicated a loss of 2.2 ml (13.7%) for a rainfall equivalent of 0.05 in. (16.1 ml), and a 2.7 ml loss (1.7%) for a rainfall equivalent of 0.50 in. (161 ml). The maximum amount of water that could be made to adhere to the Marquis gauge by mist spraying was 0.5 ml, but when droplets coalesced and ran off, the amount of adhering water was reduced to 0.2 ml. During a six-month field test the Marquis gauge registered a 6% increase in rainfall amount and a 10% increase in rainday numbers compared with the Mk I gauge. It is concluded that the Marquis 1000 raingauge is a more accurate indicator of point rainfall than the Mk I gauge.

INTRODUCTION

The raingauges used in this comparison were the Meteorological Office Mk I and the plastic Marquis 1000. All rainfall measurements were recorded in inches.

Meteorological Office Raingauge Mk I

The Mk I gauge is manufactured from sheet copper with soldered seams. It consists of a cylindrical portion with an accurately turned and bevelled brass rim, 5 inches (127 mm) in diameter, to which the funnel is attached. The funnel fits closely on top of an outer case with a splayed base in which is placed an open cylindrical inner collecting can. Inside the latter is placed a narrow-necked glass bottle (Air Ministry – Meteorological Office, 1956). This gauge has been the standard daily gauge used in New Zealand, excepting that the collecting bottle has been discarded so that normally when the gauge is read the rainfall is transferred from the inner copper can to a graduated measuring cylinder. Rainfalls of up to 18 in. (457 mm) can be recorded by the Mk I gauge.

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Marquis 1000 Raingauge

This gauge, which is manufactured in Australia, is made from a hard, glossy transparent plastic and consists of a 4-inch (101.6-mm) diameter collecting rim and funnel which fits closely to an outer cylindrical plastic container 12.4 in. (315 mm) high. Inside this container is a tapered graduated measuring cylinder of approximately 1.2 in. (30.5 mm) diameter. This inner direct-reading measuring cylinder has a capacity of 1.00 in. (25.4 mm), while the outer container boosts the total recording capacity to a maximum of 10 in. (254 mm) of rainfall. The Marquis 1000 gauge is being used increasingly in New Zealand by technical organizations.

LABORATORY TESTS

Mk I Raingauge

The gauge used had been in field use so that the copper surfaces were well weathered. Four different amounts of rainfall were considered – equivalent to 0.05 in. (1.27 mm), 0.10 in. (2.54 mm), 0.20 in. (5.08 mm) and 0.50 in. (12.70 mm). The quantity of water (16.1 ml) equivalent to 0.05 in. of rain was poured into the gauge in such a way that the funnel surface was completely wetted. Although this will not always be the case in actual practice, it is mainly true for small rains – the situation when wetting losses* are an appreciable proportion of the precipitation.

The contents of the gauge were emptied and ample time given to allow any drops from the collecting can to pass into the measuring cylinder. The cylinder was then weighed on a balance to the nearest 0.1 g. The funnel and collecting can were oven dried between each set of measurements and allowed to cool to room temperature.

This procedure was repeated using quantities of water equivalent to 0.10 in., 0.20 in. and 0.50 in. of rainfall. The average results from several measurements for each rainfall amount are given in Table 1.

The increase in the loss of water as the rainfall increases can be accounted for by the increase in area of the collecting can which is wetted as the volume of water increases.

Marquis Raingauge

As with the Mk I gauge used, the Marquis gauge had been in field use for approximately two years in a coastal area so that the

* Wetting losses are considered to be the amount of water which adheres to the various parts of the raingauge and which does not become available for measurement in the normal course of procedure.

TABLE 1 — Wetting losses of Mk I raingauge for different equivalent rainfall amounts.

Rainfall (in.)	*Equivalent volume (ml)*	*Loss of water (ml)*	*Percentage loss*
0.05	16.1	2.2	13.7
0.10	32.2	2.3	7.1
0.20	64.3	2.4	3.7
0.50	161	2.7	1.7

plastic surface could be regarded as well weathered. When considering this gauge, the only loss is incurred in the wetting of the surface of the funnel, as the measuring cylinder is read directly for rainfalls under 1.00 in. Thus the wetting loss is virtually a constant, independent of the amount of rainfall, assuming that the latter is not intermittent. The problem was to persuade water to adhere to the funnel surface. Various methods were tried, ranging from filling the funnel with water and then allowing it to drain, to spraying fine drops of water on the entire inner surface.

The maximum amount of water adhering to the plastic funnel when using a spray of small drops was found to be 0.5 ml. If the spraying was continued to the point when the drops began to coalesce, then the maximum adherence was found to be 0.2 ml. This was the same maximum as that observed when filling the funnel completely with water and allowing the water to drain before weighing the funnel and the adhering water. Thus, even allowing for the fact that the catching area of the Marquis gauge (4 in. diameter) is approximately two-thirds that of the Mk I gauge (5 in. diameter), the wetting losses per unit catching area are considerably smaller with the Marquis.

About 12 months after this initial laboratory testing, and following the field trial, the Marquis gauge was again tested in the laboratory. It was found that wetting losses were sensibly the same as before, viz, a maximum value of 0.5 ml when a fine spray was applied and 0.2 ml with large drops.

FIELD TEST

In order to evaluate the above laboratory findings, a comparative field trial was carried out by installing a Mk I gauge about 10 ft (3 m) from a Marquis gauge on a level open lawn at Napier. Care was taken during fine weather to ensure that the collecting and measuring cylinder of each respective gauge, as well as the funnel surfaces, were dried after each reading. This was essential for measurements during periods when the only precipitation was in the form of dew or frost. Both gauges were read daily at 0900 hours. Table 2 presents the results of readings taken during the 6-month period 1 June to 30 November 1970.

TABLE 2 — Comparison of Mk I and Marquis raingauge readings.

	Mk I	*Marquis*	*Difference*	*Percentage difference*
Rainfall (in.):	10.93	11.59	0.66	6.0
No. of raindays (i.e. amount $\geqslant$0.005 in.):	60	66	6	10

On 21 occasions there were measurable quantities of water ($<$0.005 in.) in the measuring cylinder of the Marquis gauge, as a result of dew and frost, when the Mk I gauge collecting can was dry. Three times during the 6-month test period the difference in readings between the two gauges was as much as 0.03 in. On 12 other days there was a difference of 0.02 in., and on one further occasion more than 0.01 in. was measured in the Marquis gauge when the Mk I gauge collecting can was completely dry. The weather on these 16 occasions was showery, with intervening bright intervals, thus allowing complete drying of the funnels between the showers.

DISCUSSION

The 6% greater rainfall catch of the Marquis raingauge during the field test is very close to the theoretical difference expected (*c.* 6.5%) on the basis of weighted calculations using laboratory Mk I gauge wetting losses (Table 1) and the daily rain size frequency distribution during the field test period (Table 3). An allowance for the very small wetting losses of the Marquis gauge equates the above values even more closely.

TABLE 3 — Daily rain size frequencies as percentages of total raindays for (a) 6-month field test period of Mk I. (b) 1964 dry year, (c) 1936 wet year and (d) 1890–1963 averages.

Rain size group (in.)	*(a)*	*(b)*	*(c)*	*(d)*
0.01–0.20	73.3	73.7	63.8	66.3
0.21–0.50	18.3	14.0	15.6	18.6
0.51–1.00	6.7	8.8	14.2	9.5
1.01–1.50	1.7	3.5	2.1	3.1
1.51–	–	–	4.3	2.5
Rainfall (in.):	10.9	22.1	48.6	32.8
No. of raindays:	60	114	141	124

While it is recognized that evaporation losses may differ between the two gauge types – a feature currently under study – it is tentatively concluded that the overall difference in the field results was largely due to the different wetting loss characteristics of each gauge. The smaller wetting losses of the Marquis 1000 raingauge make this gauge type a more accurate indicator of point rainfall than the Mk I gauge.

For early assessment of the implications of these results in relation to the Napier rainfall record (based on a copper gauge), the rainfall regime of the test period is compared (Table 3) with that of a dry year, a wet year and a long-term average.

It is seen that the rainfall regime of the test period compares closely with the regimes of the other periods shown. There is therefore good reason to state that recorded Napier annual rainfall amounts are deficient by about 6%, and the annual rainday numbers by about 10% (refer Table 2).

Certainly, if at any site a Mk I copper raingauge is replaced by a plastic Marquis 1000 gauge, a record inconsistency will result. This will be large enough for easy detection by double mass curve analysis. However, the magnitude of the record inconsistency, or percentage difference between the two gauge types, will vary with climatic regime both in space and in time.

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REFERENCE

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