

INSTRUMENT TEST REPORT NUMBER 644

Drift Test of a Hydrological Services TB3A TBRG

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Authorisation

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1. BACKGROUND

Instrument Test Reports Nos. 630 and 635 identified a number of problems in the Hydrological Services TB3 TBRG which had to be resolved for the instrument to meet Bureau requirements. The primary concern was the apparent drift in the reading due to wear in the bearings. Communication with the manufacturer has confirmed that each of the problems identified in the previous reports have been addressed. They stated that the drift in the calibration had been addressed by the use of a harder material for the axle (Tungsten). A modified instrument (TB3A) was submitted to the Physics Laboratory and was tested in late 1994. This Instrument Test Report is the formal documentation of those tests.

2. TEST PROCEDURE

On arrival the TBRG (serial number 94-47) was tested using the Physics Laboratory Procedure PHY001. The instrument was then shaken for one minute and its performance rechecked. Drift testing was then performed using a modification of PHY001; the instrument was tested repeatedly at only one rainfall rate instead of the full span. After the instrument had been tested 16 times it was shaken again and the drift testing continued. In total the instrument was tested 36 times (excluding the pre and post shake results). The drift testing was carried out in the period 17 Oct 1994 to 17 Dec 1994.

3. RESULTS

3.1 Full Span Testing

The results of the full span tests appear in Tables 1 and 2. Figure 1 shows these results with 95% confidence interval error bars¹.

Rainfall Rate (mm/hr)	Mean No. of Tips	σ	$\sigma\%$	Uncertainty (U_{95})	Mean Correction (%)
30.48	101.4	1.075	1.040	0.744	1.859
43.18	101.6	1.265	1.224	0.876	1.666
177.80	102.6	0.966	0.935	0.669	0.698
274.30	100.2	0.632	0.612	0.438	3.021
434.30	101.5	0.707	0.684	0.490	1.762
640.10	100.8	1.135	1.099	0.786	2.440

Table 1. Test of raingauge on arrival

¹ The tabulated value is the uncertainty in the mean and is calculated using

$$U_{95} = \frac{t_{95}\sigma\%}{\sqrt{N}}$$

where t_{95} is the 95% t distribution percentile for $N = 10$, $v = 9$, $t_{95} = 2.262$

Rainfall Rate (mm/hr)	Mean No. of Tips	σ	$\sigma\%$	Uncertainty (U_{95})	Mean Correction (%)
30.48	106.6	1.776	1.719	1.230	-3.155
43.18	107.0	1.054	1.020	0.730	-3.542
177.80	106.7	0.823	0.797	0.570	-3.251
274.30	105.3	0.675	0.653	0.467	-1.897
434.30	104.6	0.699	0.677	0.484	-1.219
640.10	102.3	0.483	0.467	0.334	1.006

Table 2. Test of raingauge after one minute shake

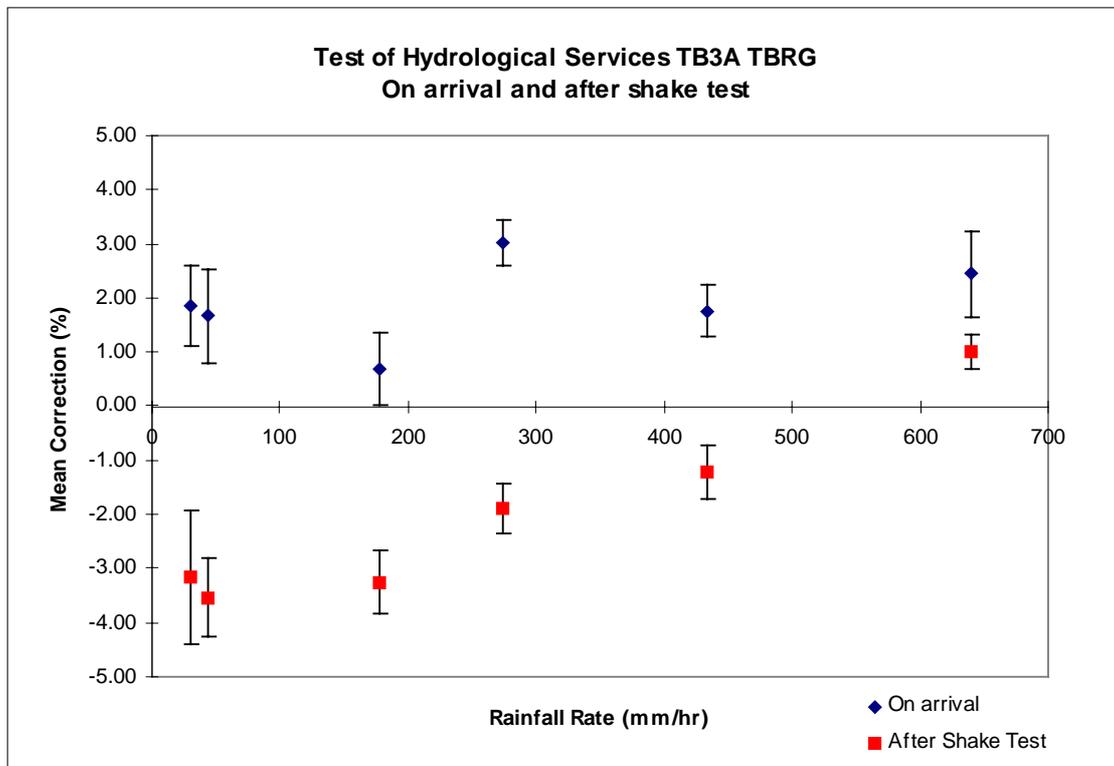


Figure 1 Test of raingauge on arrival and after shake test

3.2 Drift Testing

The results of the drift test appear in Table 3 and are shown in Figure 2. In each test there was 5 runs so the value of t_{95} is adjusted ($N = 5, \nu = 4, t_{95} = 2.78$). Tests 1 and 2 are the initial tests done on the instrument when it arrived. Tests 3 and 4 are the tests after the instrument had been shaken for one minute.

Test No.	Mean No of Tips	Mean. Correction (%)	$\sigma\%$	Uncertainty (U_{95})
1	102.4	1.09	0.86	1.07
2	100.8	2.64	1.06	1.32
3	107.8	-4.12	0.81	1.00
4	106.2	-2.58	0.43	0.54
5	108.2	-4.51	0.81	1.00
6	106.6	-2.97	0.53	0.66
7	106.6	-2.97	1.30	1.61
8	109.0	-5.28	1.53	1.90
9	110.2	-6.44	0.43	0.54
10	108.4	-4.70	0.86	1.07
11	108.0	-4.32	0.68	0.85
12	109.2	-5.48	1.73	2.15
13	108.8	-5.09	1.26	1.57
14	107.8	-4.12	0.81	1.00
15	109.0	-5.28	1.18	1.47
16	109.4	-5.67	1.10	1.37
17	108.6	-4.90	0.53	0.66
18	108.6	-4.90	1.30	1.61
19	108.6	-4.90	0.53	0.66
20	109.0	-5.28	0.00	0.00
21	108.4	-4.70	1.10	1.37
22	108.4	-4.70	1.10	1.37
23	110.8	-7.02	1.59	1.97
24	110.0	-6.25	2.27	2.82
25	110.4	-6.64	1.10	1.37
26	109.8	-6.06	0.43	0.54
27	108.2	-4.51	1.06	1.32
28	109.6	-5.86	1.46	1.82
29	110.6	-6.83	2.00	2.49
30	109.2	-5.48	0.43	0.54
31	109.6	-5.86	1.30	1.61
32	110.4	-6.64	0.53	0.66
33	109.2	-5.48	1.59	1.97
34	109.4	-5.67	1.10	1.37
35	108.8	-5.09	0.43	0.54
36	109.8	-6.06	1.73	2.15
37	109.4	-5.67	1.88	2.34
38	108.8	-5.09	0.81	1.00
39	108.8	-5.09	0.81	1.00
40	108.6	-4.90	0.86	1.07

Table 3 Drift test of rain gauge at nominal rate of 50.8 mm/hr

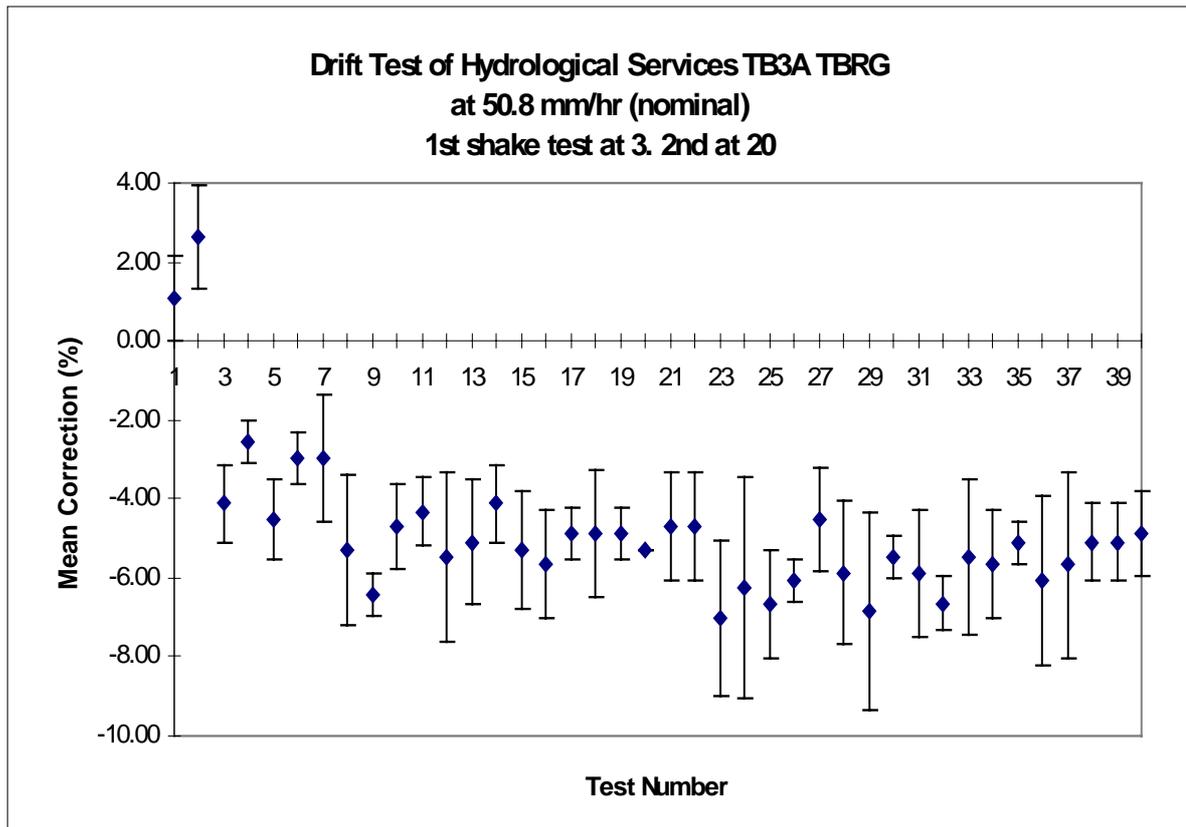


Figure 2 Drift test of rain gauge

4. DISCUSSION

On arrival the instrument met equipment Bureau specification A1980 for accuracy at all rain rates². After the first shake test the instrument failed to meet the specification for the 3 lowest rain rates. The instrument was not recalibrated at this point to limit the number of variables in the experiment. Instrument calibration is part of the installation procedure defined in the Inspection Handbook and the primary aim of this report was the investigation of drift.

Drift testing after the first shake test (prior to test number 3) showed no detectable change in calibration. A second shake test was performed prior test number 20 and no shift was observed.

5. CONCLUSION

The Hydrological Services TB3A TBRG is an improvement of the previous design in terms of drift. The large shift in calibration observed after the first shake test emphasises the need for the instrument to be checked and calibrated if necessary on installation.

The Hydrological Services TB3A TBRG is suitable for use by the Bureau of Meteorology.

² ± 3% for rainfall rates between 0 and 250 mm/hr, ±4% for rates up to 350 mm/hr.

6. REFERENCES

Equipment specification A1980 (issue 2). Bureau of Meteorology. A. F. Young. Nov 1989

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