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Report of

Tests on Weston Replacement Voltmeter for
Models RAA and RAB Receivers.

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TABLE OF CONTENTS

<u>Subject</u>	<u>Page</u>
1. AUTHORIZATION.....	1
2. OBJECT OF TEST.....	1
3. ABSTRACT OF TEST.....	1
(a) Conclusions.....	1a
(b) Recommendations.....	1a
4. DESCRIPTION OF MATERIAL UNDER TEST.....	2
5. METHOD OF TEST.....	2
6. DATA RECORDED DURING TEST.....	2
7. PROBABLE ERRORS IN RESULTS.....	2
8. RESULTS OF TEST.....	3
9. CONCLUSIONS.....	4

APPENDICES

EFFECT OF HUMIDITY TEST ON VOLTMETER ACCURACY.....	TABLE 1
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AUTHORIZATION

1. This problem was authorized by Bureau of Engineering letter, reference (a), 567/22(5-10-W8) of 14 May 1934.

OBJECT OF TEST

2. The objects of the test were as follows:

- (a) To determine if the special tropical treatment given voltmeters supplied as replacements by the Weston Electrical Instrument Corporation for those which had failed in the Model RAA and RAB receivers in service in the Canal Zone, protects such instruments from the effects of high humidities.
- (b) To determine the approximate life of these meters under accelerated humidity tests.
- (c) To develop a suitable method of applying humidity tests to such instruments.

ABSTRACT OF TEST

3. Both a tropically treated voltmeter and one originally furnished in a Model RAA receiver were subjected to excessive humidity over a period of several months, during which time the temperature was varied at intervals from the ambient to 50° C. and occasionally reduced to zero degrees C. A potential about 10% less than the full scale reading of the instruments was applied to them intermittently to simulate operating conditions, as suggested in reference (a). The reading of the instruments was noted from time to time.

Conclusions

While rigorous conclusions cannot be drawn with positive assurance from data based on the test of only one tropically treated meter and one not so treated, yet with this reservation the following conclusions appear to be warranted from the tests:

- (a) The tropically treated meter was much less affected in accuracy of indicated voltage during the accelerated life test than the meter not so treated.
- (b) The tropical treatment did not prevent the development of an open circuit in the multiplier of the meter after about four months of accelerated life test.
- (c) The meter which had not been tropically treated developed such a large error in voltage indication after less than two months under test as to be unsatisfactory for use.
- (d) It therefore appears that the useful life of a meter may be considerably extended by the use of the tropical treatment which was applied to the meter in question, but that failure under tropical conditions may be postponed rather than prevented.

Recommendations

- (a) It is recommended that meters which have been given the tropical treatment in question be considered more desirable than those not so treated.
- (b) If it is desired to secure more data on the efficacy of treatment of meters to withstand tropical conditions, it is recommended that at least three meters which have been subjected to a special type of treatment, together with three stock meters, be submitted for comparative tests.

DESCRIPTION OF MATERIAL UNDER TEST

4. Two Weston, Model 506, panel mounting, d.c. voltmeters, with a range of zero to 250 volts were tested. These meters are of the 2-1/2" diameter type with metal cases. The resistance of the multiplier is 50,000 ohms, or 200 ohms per volt. One instrument was supplied by the Weston Electrical Instrument Corporation as a sample of their tropically treated replacement meters for the Model RAA and RAB receivers and bore the type number CV-22124. The other meter was removed from a Model RAA receiver at this Laboratory and bore the type number CV-4580. The instruments differ only in that one had been treated for protection against tropical conditions.

METHOD OF TEST

5. The two meters were mounted in a humidity chamber provided with temperature control. The amount of humidity was kept at a high value by the use of an electric heater element immersed in a vessel of water. The temperature was varied from the ambient to 50° C. approximately once daily after the first week. A potential of 220 volts d.c. was applied to the meters for a period of several days at a time, and then removed for a day.

6. After the meters had been subjected to a relative humidity of approximately 90% with potential applied for a week at the beginning of the test, the instruments were passed through cycles of heating and cooling. From a relative humidity of 90% at 50° C., the temperature was allowed to drop by natural cooling after the source of heat had been removed, while the chamber was kept tightly closed in an effort to cause the air in the chamber to pass through the dew point. On several occasions the meters were chilled from 50° C. to zero degrees C. to produce the largest possible condensation of moisture from the air inside the meter cases. This general procedure was repeated with the relative humidity held between 70% and 95% during most of the time except for several periods of two days each during which the meters were removed from the chamber and maintained at the ambient atmospheric humidity and temperature. A vessel containing a supersaturated solution of salt water was kept in the humidity chamber during the greater portion of the test period.

DATA RECORDED DURING TEST

7. The relative humidity and the temperature of the chamber were recorded at intervals, as well as the periods during which the voltage was applied. The voltage reading of the two meters was also noted at various times.

PROBABLE ERRORS IN RESULTS

8. The error in the measurement of humidity is uncertain, but probably is not greater than 10%. The error in the measurement of

temperature is not greater than 1° C. The error in the measurement of voltage applied as determined by a standard instrument is not greater than $1/2$ of 1%. The error in the reading of the scales of the two meters under test is not greater than two volts.

RESULTS OF TEST

9. At the end of approximately two months of test, both meters were in an operating condition and had not been affected in appearance by the treatment. The error in the voltage indication at 200 volts on meter CV-22124 was only about 2% more than at the beginning of the test, while the error in meter CV-4580 was 19% greater than at the beginning of the test (see Table 1 for meter errors after two, three, and four months of test).

10. After three months the error in meter CV-22124 was still approximately 2%, while that in meter CV-4580 was 12%, greater than at the beginning of the test. The zero voltage of both meters had now shifted. When the voltage was removed, meter CV-22124 indicated about 15 volts and meter CV-4580 indicated about 6 volts. After 3-1/2 months the reading of meter CV-4580 was observed to fluctuate rapidly over a range of 15 volts at approximately 200 volts a number of times during one day; at no other time was this erratic voltage indication noted.

11. At the end of approximately four months of test conditions, and immediately following a period of one week under ambient atmospheric conditions, the tropically treated meter, type CV-22124, gave no deflection on the application of voltage, while meter CV-4580 still read high but was operative. The test was then discontinued and the meters were opened for inspection. The multiplier of meter CV-22124 was found to be open about 1 inch from the outer end. The d.c. resistance of the multiplier from the break to the other terminal was 49,300 ohms, indicating that only one open had occurred. Other than this, no effects of the four months' test were visible.

12. After the tropically treated meter had been repaired (one turn of the multiplier had been removed) it was left under atmospheric conditions for about three weeks at which time the zero setting was corrected. The error at 200 volts was about 4-1/2% more than at the beginning of the test. There was no change in voltage reading with gentle tapping, or other indication of defective functioning.

13. The meter CV-4580 showed no visible effect of the test other than the error in reading and a slight apparent indication of increased friction in the bearings as evidenced by the fact that the meter reading might change up or down about five volts at any portion of the scale as the meter was gently tapped. The d.c. resistance of the multiplier was observed to change during several days after it had been removed from the case for more than a week. Values of resistance were measured as follows: 46,700, 47,700, 45,800, and 45,400 ohms, the latter three readings being observed on the same day. Following completion of the humidity test,

meter CV-4580 was placed in the desiccator with a drying agent for eleven days. The resistance at the end of the drying cut period was 48,200 ohms and the voltage reading was 8% higher than at the beginning of the test. The reading could still be changed from five to ten volts by gently tapping the meter case.

14. From an examination of meter CV-22124 it appears that the tropical treatment consists in coating the multiplier with a waxlike substance, and in sealing the case at junctions and at the holes for terminal studs by the use of a suitable petroleum product.

15. It is not possible to state the period of tropical service to which the tests conducted may correspond.

CONCLUSIONS

16. While rigorous conclusions cannot be drawn with positive assurance from data based on the test of only one tropically treated meter and one not so treated, yet with this reservation the following conclusions appear to be warranted from the tests:

17. The tropically treated meter was much less affected in accuracy of indicated voltage during the accelerated life test than the meter not so treated.

18. The tropical treatment did not prevent a development of an open circuit in the multiplier of the meter after about four months of accelerated life test.

19. The meter which had not been tropically treated developed such a large error in voltage indication after less than two months under test as to be unsatisfactory for use.

20. It therefore appears that the useful life of a meter may be considerably extended by the use of the tropical treatment which was applied to the meter in question, but that failure under tropical conditions may be postponed rather than prevented.

TABLE 1

EFFECT OF HUMIDITY TEST ON VOLTMETER ACCURACY

<u>Meter</u>	<u>Months on test</u>	<u>% Error (Total)</u>	<u>% Error Due to test</u>
CV-22124	0	+3.0	-
"	2	+5.0	2.0
"	3	+5.0	2.0
"	4	Multiplier open	
CV-4580	0	+6.0	-
"	2	+25.0	+19.0
"	3	+18.0	+12.0
"	4	+13.0	+7.0

Note 1 -- Meter CV-22124 is tropically treated, while meter CV-4580 is not.

Note 2 -- Observations made at 200 volts.