

1 October 1936

NRL Report No. R-1314
BuEng. Prob. M18-5

NAVY DEPARTMENT
BUREAU OF ENGINEERING

FR-1314

Report
of
Test of Thermometers Submitted
by
The Palmer Company.

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D.C.

Number of Pages: Text - 3 Tables - 1
Authorization: BuEng. ltr. S67/40/L5 (6-20-W8) of 14 August 1936.
Date of Test: 26 August to 22 September, 1936.
Prepared by: R.B. Owens, Associate Radio Engineer,
Chief of Section.
Reviewed by: A.H. Taylor, Principal Physicist, Superintendent,
Radio Division.
Approved by: H.M. Cooley, Captain, USN, Director.
Distributions:
BuEng. (5)

ejh

APPROVED FOR PUBLIC
RELEASE - DISTRIBUTION
UNLIMITED

Table of Contents

<u>Subject</u>	<u>Page</u>
Authorization	1
Object of Test	1
Abstract of Test	1
Conclusions	1-a
Recommendations	1-b
Description of Material under Test	2
Method of Test	2
Data Recorded during Test	2
Discussion of Probable Errors	2
Results of Test	2
Conclusions	3

Appendix

Calibration of Palmer Thermometers Table 1

NAVAL RESEARCH LABORATORY
MATERIALS DIVISION
WASHINGTON, D.C.

Author of Report
 111-2-1
 111-2-1
 111-2-1

Approved by
 111-2-1
 111-2-1

Approved by
 111-2-1
 111-2-1

(2)

APPROVED FOR PUBLIC
RELEASE - DISTRIBUTION
UNLIMITED

AUTHORIZATION

1. This work was authorized by Bureau of Engineering letter, reference (a). Other pertinent correspondence is listed as references (b) and (c).

Reference: (a) BuEng. ltr. S67/40/L5 (6-20-78) of 14 August 1936.
(b) Specifications RE 13A 486C.
(c) Drawing RE 40A 123B.

OBJECT OF TEST

2. The object of the test was to determine whether the two groups of thermometers submitted by the Palmer Company comply with specifications, reference (b), except as to dimensions, and with reference (c) with respect to dimensions.

ABSTRACT OF TEST

3. The thermometers were tested for accuracy of calibration, for accuracy of dimensions, to determine whether the expansion chamber provides protection up to a temperature of 100°C., to determine whether mercury contracts into the bulb at -10°C., and to ascertain their ability to withstand shock without separation of the mercury column.

Conclusions

(a) Both of these groups of thermometers comply with reference (c) with respect to dimensions.

(b) They comply with the requirements of reference (b) in all other respects so far as could be determined.

(c) These thermometers are considered to be suitable for Naval use.

Recommendations

DESCRIPTION OF INSTRUMENTS TESTED

(a) It is recommended that these thermometers be considered suitable for Naval use.

The thermometers submitted by the Bureau of Ordnance have a range from 15 to 35°C with graduations every 0.5°C and the other three have a range from 15 to 35°C with graduations every 1°C. The vertical position of these instruments is three inches long, and the horizontal position is 4-1/2 inches long.

RESULTS OF TESTS

1. The accuracy of the calibration of the thermometers was determined by comparison with a precision standard thermometer. The comparison was made with the instrument under test immersed in a bath of the kind in a water bath with the bulb in contact with that of the standard. The temperature of the bath was changed very slowly and readings were taken at a number of points on the scales of the instruments.

2. In order to ascertain whether the mercury can be trapped in the bulb at low temperatures, the instruments were chilled to -10°C and the position of the mercury in the capillary was noted.

3. The protection afforded by the expansion chamber in the event of overpressure was determined by heating the thermometers to a temperature of 100°C.

4. The ability of the instruments to withstand shock without separation of the mercury column was determined by subjecting them to an acceleration of 50 g in a sand cushion.

DATA RECORDS DURING TESTS

5. The data recorded during the test are given in Table I, appended, and under "Results of Tests."

DISCUSSION OF TESTED INSTRUMENTS

6. The total error in determining calibration accuracy of the thermometers is not greater than 0.05°C for those having a temperature range from 15 to 35°C, and not greater than 0.01°C for those having a temperature range from 15 to 35°C. The temperature in the -10°C test and in the 100°C test was determined to within 1°C. The error in the determination of the acceleration to which the instruments were subjected is the least that is less than 10 per cent.

CONCLUSIONS

7. The results of the tests are given below, with reference to the pertinent paragraphs of specifications, references (a), (b), (c) where no comment is made in any paragraph of these specifications, it is to be understood that the thermometers comply therewith so far as such is determined.

DESCRIPTION OF MATERIAL UNDER TEST

4. The material under test consisted of six mercury-in-glass angle thermometers submitted by The Palmer Company. Three of the samples have a range from 47 to 53°C. with scale graduations every tenth degree, while the other three have a range from 35 to 55°C. with graduations every one-half degree. The vertical portion of these instruments is three inches long, and the horizontal portion is 4-1/2 inches long.

METHOD OF TEST

5. The accuracy of the calibration of the thermometers was determined by comparison with a precision standard thermometer. This comparison was made with the instrument under test immersed to within 1 inch of the bend in a water bath with its bulb in contact with that of the standard. The temperature of the bath was changed very slowly and readings were taken at a number of points on the scales of the instruments.

6. In order to ascertain whether the mercury can be trapped in the bulb at low temperatures, the instruments were chilled to -10°C. and the position of the mercury in the capillary was noted.

7. The protection afforded by the expansion chamber in the event of overheating was determined by heating the thermometers to a temperature of 100°C.

8. The ability of the instruments to withstand shock without separation of the mercury column was determined by subjecting them to an acceleration of 50 g. in a hand centrifuge.

DATA RECORDED DURING TEST

9. The data recorded during the test are given in Table 1, appended, and under "Results of Test."

DISCUSSION OF PROBABLE ERRORS

10. The total error in determining calibration accuracy of the thermometers is not greater than 0.05°C. for those having a temperature range from 35 to 55°C., and not greater than 0.03°C. for those having a temperature range from 47 to 53°C. The temperature in the -10°C. test and in the 100°C. test was determined to within 1°C. The error in the determination of the acceleration to which the instruments were subjected in the shock test is less than 10 per cent.

RESULTS OF TEST

11. The results of the tests are given below, with reference to the pertinent paragraphs of specifications, reference (b). Where no comment is made on any paragraph of these specifications, it is to be understood that the thermometers comply therewith so far as could be determined.

- 2-2. These instruments appear to be ruggedly constructed of high grade materials.
- 2-3. The workmanship appears to be of a high grade.
- 2-7. All of these samples were heated to a temperature of 100°C. without any damage, indicating that the expansion chamber is sufficiently large.
- 2-8. At a temperature of -10°C., the end of the mercury column was approximately at the middle of the contraction chamber in all six samples.
- 2-9. There was no separation of the mercury column in any of these instruments when they were subjected to an acceleration of 50 g. These instruments appear to withstand shock satisfactorily.
- 3-1. Superseded by reference (c).
- 3-3. First sentence superseded by reference (c). These instruments are accurate to within 0.10°C. at all points in the calibrated range when the probable error is taken into consideration. See Table 1.
- 3-6. A magnifying bead is provided which extends the whole length of the stem.

12. These thermometers are of the "red mercury reading" type. A thin strip of red glass is molded into the stem in such a manner that the optical effect is to cause the mercury column to appear red. This is believed to facilitate somewhat the reading of the instruments. However, in sample #6, a number of narrow red horizontal lines are visible through the magnifying bead on the calibrated scale at certain points when the thermometer is indicating any lower temperature. The widest of the lines occurs at about 51°C. While these lines may not lead to confusion in reading the scale, yet it is possible that a minute amount of mercury adheres to the capillary at these points which may account for the fact that the calibration of this thermometer is low at temperatures below 51°C., but is quite accurate at 52°C., as shown in Table 1. The presence of these lines, whatever may be their cause, can be easily observed by a visual examination.

CONCLUSIONS

- 13. Both of these groups of thermometers comply with reference (c) with respect to dimensions.
- 14. They comply with the requirements of reference (b) in all other respects so far as could be determined.
- 15. These thermometers are considered to be suitable for Naval use.

Table 1

Calibration of Palmer Thermometers.

Temperature - °C.			
Standard	Palmer Thermometers		
	No. 1	No. 2	No. 3
35.05	35.0	35.1	35.0
37.45	37.5	37.5	37.4
40.40	40.4	40.4	40.3
42.82	42.8	42.8	42.8
45.00	45.0	45.0	44.9
46.86	46.9	46.9	46.8
50.56	50.6	50.6	50.5
53.74	53.8	53.8	53.7
54.64	54.7	54.7	54.6
	No. 4	No. 5	No. 6
47.60	47.67	47.68	47.48
48.20	48.25	48.25	48.07
48.69	48.75	48.74	48.57
49.00	49.06	49.05	48.88
50.07	50.12	50.10	49.98
50.36	50.46	50.43	50.30
51.97	52.05	52.00	51.98
52.47	52.56	52.53	52.52