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Report
of
Test of Thermometers and Thermostats
Submitted by
The Taylor Instrument Companies.

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WASHINGTON, D.C.

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AUTHORIZATION

1. The work reported on herein 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 (8-3-36) of 5 August 1936.
(b) Specifications RE 13A 486B.
(c) Drawing RA 40A 225B.

OBJECT OF TEST

2. The object of the test was to determine whether the thermometers and thermostats submitted by The Taylor Instrument Companies comply with Navy Specifications, reference (b).

ABSTRACT OF TEST

3. The thermometers were tested for accuracy of calibration and the thermostats for accuracy of operating temperature and for sensitivity. Both thermometers and thermostats were tested to determine whether the expansion chamber provides protection to 100°C., to determine whether mercury contracts into the bulb at -10°C. and to determine the effect of shock. The thermostats were made to operate 300,000 times in a life test.

Conclusions

(a) These thermometers conform to specifications, reference (b), in all respects except that the expansion chamber did not protect one of the two instruments at 95°C., and except as to dimensions in which respect they conform to reference (c).

(b) These thermostats conform to the governing specifications in all respects.

(c) Both the thermometers and thermostats are considered suitable for Naval use.

Recommendations

(a) On the basis of the test of two instruments of each type, it is recommended that these thermometers and thermostats be considered suitable for Naval use. (Specifications, reference (b), paragraph 7-5, require the test of three samples for type approval.)

DESCRIPTION OF MATERIAL UNDER TEST

4. The following mercury-in-glass thermal devices were submitted by The Taylor Instrument Companies:

- 2 Right angle thermometers having a range from 49° to 51°C . with the scale graduated every five hundredths degree, having a vertical length of $3\text{-}3/8"$ and horizontal length of $6"$;
- 2 Straight thermostats with operating temperature of 50°C . and a length of $6"$.

The thermometers bear the serial numbers 7A852907 and 7A852912. The thermostats bear the serial numbers 7A935962 and 7A935963.

METHOD OF TEST

5. The thermometer scale readings were compared with those of a standard precision thermometer while the bulbs of the two instruments were in contact and immersed in water to within one inch of the bend of the instrument under test. The rate of change of temperature of the circulating water was very slow, and precautions were taken to avoid introducing errors into the readings.

6. The operating temperature of the thermostats was determined with the instrument totally immersed in an insulated chamber provided with forced air circulation. The thermostat bulb was held in contact with that of the standard thermometer while both were immersed in a water bath in the heated chamber. The thermostat under test was used to control the temperature of the bath, which was allowed to change very slowly. The temperature of the standard thermometer was noted at the "make" and the "break" of the thermostat circuit repeatedly. The difference between the temperature at the "make" and the "break" is the measured sensitivity of the thermostat.

7. Each of the thermostats was subjected to a life test to determine whether it would make 300,000 contacts at a potential of 12 volts and a current of approximately 12 milliamperes d.c. In this test the instrument was mounted in a small ventilated box near a lamp bulb which served as a source of heat. The circuit through the lamp was interrupted by a relay which was actuated by the thermostat. The number of contacts made were indicated on a Veeder counter.

8. Both the thermometers and the thermostats were chilled to -10°C . to observe whether gas could be trapped in the bulb when in a horizontal position. They were heated to 100°C . to ascertain whether the expansion chamber provides protection from breakage at that temperature. They were subjected to an acceleration of 50 g. in a hand centrifuge to determine the ability of the instruments to withstand shock without separation of the mercury column.

DATA RECORDED DURING TEST

9. The data recorded during the test are given in the results of test and in the table appended.

DISCUSSION OF PROBABLE ERRORS

10. The errors involved in the observed values are not greater than the following: Accuracy of thermometers and operating point of the thermostats, $\pm .03^{\circ}\text{C}$.; temperature of the minus 10 and plus 100 $^{\circ}\text{C}$. tests, $\pm 1^{\circ}\text{C}$.; acceleration applied in the shock test, $\pm 10\%$.

RESULTS OF TEST

11. The results of the tests are given below. At the end of each paragraph is given the number of the governing paragraph in specifications, reference (b).

Accuracy

The thermometer calibrations are accurate to within the allowed tolerance of $.10^{\circ}\text{C}$., as shown in Table 1. (Par. 3-2).

The thermostats operated at 50.03° and 50.04°C ., respectively. The allowed tolerance is $\pm .05^{\circ}\text{C}$. (Par. 4-3).

Sensitivity of Thermostats

The temperature of the thermostats at the "make" was within $.01^{\circ}\text{C}$. of that at the "break," which represents a high degree of sensitivity. (Par. 4-4).

Test at -10°C .

The end of the mercury column in the thermometers extends approximately $3/4$ inch above the bulb at a temperature of -10°C ., and that of the thermostats is in the enlarged neck of the capillary, immediately above the bulb. Gas cannot be trapped in the bulb of these instruments at -10°C . even when they are mounted in a horizontal position. (Par. 2-8.)

Test at 100°C .

The bulb of one thermometer cracked at 95°C . while the other thermometer and both thermostats withstood a temperature of 100°C . without damage. (Par. 2-7.)

Shock Test

Both thermostats withstood an acceleration of 50 g. without separation of the mercury column, as well as the thermometer which had not been damaged in the 100°C . temperature test. These instruments appear to withstand shock satisfactorily. (Par. 2-10.)

Life Test of Thermostats

Each of the thermostats operated satisfactorily in the life test in which approximately 304,000 contacts were made. No discoloration in the capillary around the contact nor loss in sensitivity was observed as a result of this test. (Par. 4-6.)

Dimensions

The thermometer samples conform in all dimensions and in temperature range to drawing, reference (c); see "Material under Test." They do not comply with the dimensional requirements of specifications, reference (b). (Par. 3-1.) The thermostats comply with the dimensional requirements of sheet 13B, reference (b). (Par. 4-1.)

These instruments comply with all other items of specifications, reference (b), so far as could be determined.

CONCLUSIONS

12. These thermometers conform to specifications, reference (b), in all respects except that the expansion chamber did not protect one of the two instruments at 95°C., and except as to dimensions in which respect they conform to reference (c).

13. These thermostats conform to the governing specifications in all respects.

14. Both the thermometers and thermostats are considered suitable for Naval use.

Table 1

Calibration of Taylor Thermometers.

<u>Standard Thermometer Temperature (°C.)</u>	<u>Thermometer 7A852907</u>	<u>Diff.</u>	<u>Thermometer 7A852912</u>	<u>Diff.</u>
50.70	50.80	+ .10	50.79	+ .09
50.40	50.49	+ .09	50.47	+ .07
50.02	50.09	+ .07	50.07	+ .05
49.50	49.58	+ .07	49.56	+ .06
48.95	49.01	+ .06	49.01	+ .06

Note: Tolerance allowed, 0.10°C.