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BuShips Problem M3-35

NAVY DEPARTMENT

Report of Test

of

Six Wire Wound Fixed Resistors

Submitted by Hardwick, Hindle, Inc.

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### AUTHORIZATION

1. This problem was authorized by Bureau of Ships letter reference (a). The governing specifications are listed as reference (b).

References: (a) BuShips Ltr. S67/63(480K) of 7 March 1942.  
(b) Specifications RE 13A 372J

### OBJECT OF TEST

2. The object of the test was to determine whether the wire wound resistors manufactured by Hardwick, Hindle, Inc. and submitted for test comply with the requirements of the Navy specifications, reference (b), for Grade 1 Class I resistors.

### ABSTRACT OF TEST

3. The samples were subjected to test to determine the following:

- (a) Compliance with mechanical requirements of these specifications, including tolerances, workmanship, markings, etc.
- (b) Resistance with respect to the tolerances allowed.
- (c) Power dissipation as related to temperature rise.
- (d) Resistance to thermal shock.
- (e) Resistance to effects of excessive humidity.

CONCLUSIONS

(a) It is concluded that these resistors do not comply with the specifications, reference (b), in the following respects:

- (1) They do not withstand exposure to high humidity.
- (2) The initial resistance of two samples was more than 5% higher than the rated value.

(b) It is further concluded that the subject resistors are not suitable for Naval use as Grade 1, Class I resistance units.

RECOMMENDATIONS

(a) It is recommended that the subject resistors be considered not suitable for Naval use.

COMMENTS

(a) All the tests listed under Abstract of Test were made on the subject resistors. Complete tests could not be made because all six units failed during the first humidity resistance cycle.

#### MATERIAL UNDER TEST

4. The material under test consisted of 6 wire wound, blue enamel, fixed resistors, manufactured by Hardwick, Hindle, Inc. and submitted for type tests for Grade 1, Class 1, Style A, under specifications, reference (b). This type of resistor is wound in a single layer on a ceramic tube and then covered with a baked vitreous enamel coating in the conventional manner. (See Plate 1).

#### METHOD OF TEST

5. The hot spot temperature was determined by adjusting the applied voltage so as to cause a 250°C. temperature rise. The temperature was measured by a calibrated thermocouple applied to the surface of the resistors at the midpoint.

6. The test of thermal shock consisted of raising the temperature of the resistors to 275°C, by applying full load, plunging them in water at 0°C., and observing any mechanical damage done to the resistors. The resistors were then dried and a blast of air was applied to further remove any particles of water. The resistors were then placed back on the rack and the voltage applied to bring them up to their rated temperature.

7. In the humidity test, the units were operated for 6 hours at a potential sufficient to cause a 250° temperature rise and then immediately transferred to a salt water bath at 100°C.; after two hours in this bath they were placed in another salt water bath at a temperature of 0°C. for a period of two hours. At the end of the two hour period, the samples were removed and washed with clear water, their surface wiped dry and particles of water removed from inside and out by an air blast. The units were then placed back on the rack and the voltage was gradually brought up to 1000. This test was conducted in the presence of a Hardwick, Hindle representative. He requested and was granted permission to rewash resistor #3 at the beginning of cycle No. 1. The resistance was determined by voltmeter ammeter method and by wheatstone bridge after cooling to room temperature.

#### DATA RECORDED DURING TEST

8. The data recorded during the tests, or values computed therefrom, are given under "Results of Tests" and in the appended table.

#### DISCUSSION OF PROBABLE ERRORS

9. The errors in the values measured are not greater than the following:

Resistance at 20°C.	+ .2%
Hot Spot Temperature	+ 3°C.
Power dissipated at the hot spot temperature	+ 1%

### RESULTS OF TEST

10. The results of tests are reported below in the order stated in paragraph 13-1 of specifications, reference (b), and the numbers in parentheses below correspond to the paragraph numbers in the specifications.

- (1) An inspection of the resistors indicates that they comply with the specifications in dimensions, markings and workmanship.
- (6) The resistances of two units at 20°C. are outside the + 5% tolerance as shown in Table 1.
- (10) The power dissipation at 275° averaged 123.5 watts for the six units. Individual figures are shown in Table 1.
- (11) The thermal shock test produced no visible mechanical damage to the resistors and the resistance of none of the units changed as much as the permissible 10%.
- (13) All six units failed to pass the first cycle. During this cycle the voltage could not be adjusted above 1000 volts without tripping the power supply overload relay. Unit #3 dropped in resistance from 49,630 ohms to 7000 ohms. A representative of the manufacturer was permitted to rewash and dry this unit and the resistance remained 7000 ohms. For data on all units see table #1.
- (15) There are no tabs or taps on the resistors tested.

### CONCLUSIONS

11. It is concluded that these resistors do not comply with the specifications, reference (b), in the following respects:

- (1) They do not withstand exposure to high humidity.
- (2) The initial resistance of two samples was more than 5% higher than the rated value.

12. It is further concluded that the subject resistors are not suitable for Naval use as Grade 1, Class 1, resistance units.

TABLE 1

Chronological Summary of Measurements  
Resistance in Kiloohms

	Date	Time	Unit #1	Unit #2	Unit #3	Unit #4	Unit #5	Unit #6
*Resistance at 20°C.	2 Feb	1000	52.55	51.94	49.63	54.04	51.67	51.05
Wattage at 275°C.	2 Feb	2100	121	132.5	125.	121	119.5	122
End of 6 hr. Preheat	2 Feb	2100	55.9	51.0	54.2	55.9	56.5	55.3
Thermal Shock	2 Feb	2100	54.2	49.5	52.0	55.3	54.2	54.2
Humidity Test	2 Feb	2300						
End of 6 hr. Heat	3 Feb	0500	56.5	51.5	54.2	56.5	56.5	55.3
*1st Cycle	3 Feb	1000	17.96	9.09	7.0	13.15	10.64	10.13

Tests Discontinued

\* Measured on Wheatstone Bridge. (45 volts)



PLATE I