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NRL Report No. R-1929
BuShips Problem M1-31

NAVY DEPARTMENT

Report of

Test on Insulating Material (Prestite)

Submitted by

Westinghouse Electric & Manufacturing Co.

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WASHINGTON, D. C.

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RECOMMENDATIONS

It is recommended:

(a) That Prestite samples numbered 411 to 416 inclusive be approved as Grade F insulating material.

DESCRIPTION OF MATERIAL UNDER TEST

5. Two 1/4 by 6 inch square unglazed ceramic samples of Prestite numbered 393 and 394 by NRL were originally submitted with reference (d). Six unglazed ceramic circular disks, numbered 411 to 416 inclusive by NRL, measuring approximately 10.16 cm. in diameter and .64 cm. in thickness, were submitted July 3, 1942.

METHOD OF TEST

6. Physical measurements of the samples were made with micrometers and a metric rule; the electrical measurements, by the parallel substitution method of susceptance variation. The dielectric properties were determined from these data.

7. The standard measuring circuit consists of the following equipment:

1000 kc crystal controlled master oscillator power amplifier assembed by NRL.

NRL Standard inductance No. 6.

General Radio quartz insulated precision condenser, Type 722-Q serial No. 460.

General Radio vacuum tube voltmeter, Type 726-A, serial No. 1483.

8. The factor of merit of the variable capacitor is stated by the manufacturer to be better than 0.003×10^{-12} Farads. The factor of merit of the entire test circuit is better than 1.11×10^{-12} Farads or one C.G.S. electrostatic unit. The effective Q of the entire measuring circuit is approximately 344 units, measured at 1000 kc.

9. The dry loss factor w a s determined by allowing the test samples to come to a static equilibrium of ambient temperature and relative humidity with that of the standard measuring circuit, which is assumed to occur in about 24 to 48 hours. Each samples was made into a capacitor by a pplying foil to both surfaces with petroleum oil. The factor of merit of the standard circuit with and without the samples was measured and each expressed as the ratio of total effective conductance to the resonant angular velocity. The difference between the two factors thus measured is equal to the factor of merit of the sample. When the conductance of the sample is small and can be neglected in comparison with its susceptance, the power factor is equal to the ratio of the factor of merit to the capacitance. The capacitance is equal to the difference in reading of the standard, taken at resonance, with and without the sample; provided, the residual inductance (L) of standard capacitor is sufficiently small to make W^2LC_s negligible as compared to unity.

10. The dielectric permittivity (K) was determined from physical measurements made upon the sample, as outlined in A.S.T.M. Standards. The loss factor is defined as the product of the power factor and the dielectric permittivity. The wet loss factor was determined in a similar manner after the samples had been immersed in distilled water for a period of 48 hours in compliance with reference (b).

11. The moisture absorption tests were carried out on newly fractured pieces as detailed in paragraph 6 of reference (c) where the newly fractured surface was approximately 50% of the unfractured surface of each sample. The samples were first dried in an oven at 120°C for 24 hours. After being allowed to cool to the existing ambient temperature, the samples were accurately weighed. They were then immersed in distilled water at room temperature for 100 hours, during which time the water was boiled for a period of one hour during the 1st, 25th, 49th and 74th hours. At the end of 100 hours, all samples were removed from the water, carefully dried with filter paper and immediately weighed.

DATA RECORDED DURING TEST

12. The data recorded during test are given in Tables I, II and III.

PROBABLE ERROR IN RESULTS

13. The error in the determination of the power factor is not greater than 2%, while that of the loss factor is not greater than 3%. The error in the determination of the weight in the moisture absorption test is approximately 0.00125%.

RESULTS OF TEST

14. Results of test are given in Tables I, II and III and may be summarized as follows: The data recorded in Tables I and III show that the loss factor of all circular samples comply with paragraph 6-1 of reference (c) for Grade F insulating material.

15. Table II shows that sample No. 416 actually lost weight in the moisture absorption test. This loss in weight is extremely small and has been discussed in NRL Report No. R-1851. Observation of the data contained in Table III were taken as suggested by the Bureau of Ships and substantiates measurements made in Table I. The loss factor of a given sample of a dielectric material may be greater dry than wet. Measurements were made as indicated in Table No. III after the samples had been cleaned and dried in an oven for 24 hours at 100°C.

16. The wet loss factor of the original square samples of Prestite numbered 393 and 394 indicate a lower grade of material than the later circular samples numbered 411 to 416 inclusive. A representative of the manufacturer states that all of these samples are made of the same material and that the differences in electrical properties were caused by an insufficient applied pressure when they were fabricated.

The results of both tests were reported by phone to the Bureau of Ships when they were completed.

CONCLUSIONS

17. It is concluded:

(a) That the two square samples numbered 393 and 394, submitted with reference (d) do not comply with reference (c) for Grade F or G insulating material.

(b) That the six samples of Prestite, numbered 411 to 416 inclusive, comply with reference (c) for Grade F insulating material.

(c) That the moisture absorption does not exceed 0.01%.

TABLE I

WEstinghouse Electric & Manufacturing Co.

Dielectric Properties of Prestite

NRL No.	Dielectric Constant Dry	Wet	Power Factor Dry	Wet	Loss Factor Dry	Wet	Grade
393	6.1	6.2	0.85	1.64	5.18	10.2	
394	6.2	6.2	0.84	1.42	5.18	8.8	
411	6.36	6.17	0.858	0.813	5.46	5.02	F
412	6.40	6.33	.837	.796	5.36	5.04	F
413	6.39	6.33	.838	.808	5.36	5.11	F
414	6.39	6.36	.838	.819	5.36	5.21	F
415	6.39	6.38	.838	.805	5.36	5.14	F
416	6.40	6.31	.796	.804	5.09	5.07	F

TABLE II

Moisture Absorption

NRL No.	Weight Dry gr.	Wet gr.	Gain gr.	Gain %
416	45.526	45.512	-0.014	-0.031

TABLE III

Final Dielectric Properties of Prestite *

NRL No.	Dielectric Constant Dry	Power Factor Dry	Loss Factor Dry
411	6.36	0.831	5.28
412	6.27	.815	5.11
413	6.28	.836	5.25
414	6.29	.859	5.40
415	6.28	.805	5.06

* Data taken following measurements of Table I after cleaning samples and drying in oven 24 hours at approximately 100°C.

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APPENDICES

Dielectric Properties	Table I
Moisture Absorption Test	Table II
Final Dielectric Properties	Table III

AUTHORIZATION

1. This problem was authorized by BuShips letter, reference (a). References (b), (c) and (d) are also pertinent.

References: (a) BuShips ltr. S67/61(480V) to NRL of May 13, 1942.
(b) BuShips ltr. S67/61(5-23-480) of May 23, 1941 to NRL.
(c) Specification RE 13A 317F.
(d) WEMCo ltr. CMH:FB of May 7, 1942 to BuShips.

OBJECT OF TEST

2. The object of the test was to determine whether the samples of Prestite submitted by Westinghouse Electric and Manufacturing Company comply with reference (c) for Grade F or G insulating material.

ABSTRACT OF TEST

3. The dry and wet loss factors were determined by measurements made at 1000 kilocycles, in compliance with paragraph 2 of reference (b), paragraph 6-1 of reference (c), and in accordance with A.S.T.M. Standards on Testing Electrical Insulating Materials of December 1941. The wet loss factor was measured after the samples had been immersed in distilled water for 48 hours.

4. Moisture absorption measurements were made in accordance with paragraph 6-2 of reference (c).

CONCLUSIONS

It is concluded:

(a) That the two square samples numbered 393 and 394, submitted with reference (d) do not comply with reference (c) for Grade F or G insulating material.

(b) That the six samples of Prestite, numbered 411 to 416 inclusive, comply with reference (c) for Grade F insulating material.

(c) That the moisture absorption does not exceed 0.01%.