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NAVY DEPARTMENT

Report of Test

of

Insulating Material

Submitted by Maryland Lava Company

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
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APPENDICES

AUTHORIZATION

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

References:

(a) BuShips ltr. S67/61 (480-V) August 14, 1942
(b) BuShips ltr. S67/61 (480-V) July 17, 1942
(c) BuShips ltr. S67/61 (5-23-480) May 23, 1941
(d) Specifications RE 13A 317-F

OBJECT OF TEST

2. The object of the test was to determine whether the samples of insulating material, submitted by Maryland Lava Company, comply with reference (d) 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 two of reference (c), paragraph 6-1 of reference (d), 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. Modulus of Rupture measurements were not made.

4. Moisture absorption measurements were made in accordance with paragraph 3 of reference (b).

CONCLUSIONS

It is concluded:

(a) That the samples of unwaxed "gray" material do not comply with paragraph 6-1 of reference (d) for Grade G or F insulating material.

(b) That the samples of waxed "gray" material comply with paragraph 6-1 of reference (d) for Grade G insulating material.

(c) That these samples do not comply with paragraph 6-2 of reference (d) with respect to moisture absorption.

(d) That when the samples of waxed "grey" material are boiled, they no longer comply with paragraph 6-1 of reference (d) for Grade G or F insulating material.

RECOMMENDATIONS

It is recommended:

(a) That the waxed samples submitted by Maryland Lava Company be approved as Grade G insulating material.

(b) That the unwaxed samples not be approved as Grade G or F insulating material.

DESCRIPTION OF MATERIAL UNDER TEST

5. The three unwaxed samples numbered 447, 448 and 449 and the three waxed samples numbered 450, 451 and 452 by Naval Research Laboratory were approximately 10.11 cm. square and 0.625 cm. thick. All samples were designated as "gray" material.

METHOD OF TEST

6. Physical measurements of the samples were made with micrometers and a metric rule; the electrical measurements by the susceptance variation method of parallel substitution. 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, assembled 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 was determined after 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 sample was made into a capacitor by applying foil to both surfaces with petroleum oil. The factor of merit of the standard circuit and that of the standard circuit with 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 resonnance, with and without the sample; provided, the residual inductance (L) of the standard capacitor is sufficiently small to make W^2LCs 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 a s 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 (d).

11. The moisture absorption tests were made in accordance with paragraph 3 of reference (e) and paragraph 6-2 of reference (d). After being broken into pieces such that 50% of the surface was newly fractured, the samples were immersed in distilled water at room temperature for 96 hours. The water was boiled for a period of one hour during the 1st, 25th, 49th and 74th hours. The samples w ere then removed from the water, carefully dried with filter paper and immediately weighed. Next they were placed in a desiccator for 96 hrs. after which time they were again weighed.

DATA RECORDED DURING TEST

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

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. The unwaxed samples were found to be very porous which made it difficult to apply the electrodes without the application of too much oil. The wax boiled out of the waxed samples, a considerable portion of it collecting on the rim of the beaker used for boiling and the rest hardening on the surface of the samples. After soaking in distilled water for 48 hours, the loss factor of the unwaxed samples were so large that they could not be measured. The loss factors of the waxed samples fell well within Grade G even after soaking for 48 hours. However, when the waxed samples were boiled for two hours and then soaked for 48 hours, they could not be measured. Sample numbered 451 was placed in an oven at 80° C for seven hours and then soaked in distilled water for 48 hours. This did not alter the Grade G rating of the sample, as can be seen

from Table III. The wax meted but it did not leave the interior of the sample.

15. Due to the fact that most of the wax boiled out of the waxed samples, the per cent moisture absorption of the unwaxed and waxed samples was approximately the same as seen from Table II.

CONCLUSIONS

16. It is concluded:

(a) That the samples of unwaxed "gray" material do not comply with paragraph 6-1 of reference (d) for Grade G or F insulating material.

(b) That the samples of waxed "gray" material comply with paragraph 6-1 of reference (d) for Grade G insulating material;

(c) That these samples do not comply with paragraph 6-2 of reference (d) with respect to moisture absorption.

(d) That when the samples of waxed "gray" material are boiled, they no longer comply with paragraph 6-1 of reference (d) for Grade G or F insulating material.

MARYLAND LAVA COMPANY

TABLE I

DIELECTRIC PROPERTIES

Unwaxed Samples

NRL NO.	Dielectric Constant Dry	Wet	Power Factor % Dry	Wet	Loss Factor % Dry	Wet	Grade
447	0.562	-	0.673	-	0.378	-	O
448	0.557	-	0.710	-	0.396	-	O
449	0.562	-	0.773	-	0.434	-	O

Waxed Samples

450	0.582	0.585	0.410	0.740	0.239	0.433	G
451	0.578	0.577	0.382	0.642	0.221	0.370	G
452	0.579	0.569	0.418	0.832	0.242	0.473	G

TABLE II

Moisture Absorption

	Weight in Grams Dry	Wet	Gain Grams	Gain %
447 Unwaxed	46.6552	47.0675	0.4123	0.884
450 Waxed	43.9953	44.4540	0.4587	1.043

TABLE III

Heat Treated

NRL NO.	Dielectric Constant Dry	Wet	Power Factor Dry	Wet	Loss Factor Dry	Wet	Grade
451	0.578	0.578	0.416	.0571	0.240	0.330	G