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Report of

Test on Insulating Material

Submitted by

Maryland Lava Company

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NAVAL RESEARCH LABORATORY
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WASHINGTON, D.C.

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Bu Eng. ltr S67/61(1-11-w8) of 2-1-34 to NRL.

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AUTHORIZATION

1. Previous tests of insulating material submitted by the Maryland Lava Company were reported in reference (f), as authorized by reference (b) which has been closed. The present tests were therefore conducted under reference (a). References (c), (d), (e), (f), and (g) are also pertinent.

- References:
- (a) Bu Eng. ltr S67/61 (1-11-W8) of 2-1-34 to N.R.L. Buproblem M1-4.
 - (b) Buships ltr S67/61 (480V) of Aug. 14, 1942 to NRL Buproblem M42.
 - (c) Buships ltr S67/61 (5-23-480) of May 23, 1941 to N.R.L.
 - (d) Buships ltr S67/61 (480V) of July 17, 1942 to N.R.L.
 - (e) Specifications RE 13A 317F.
 - (f) NRL report number R-1942 to Buships 9-29-42.
 - (g) Bendix Radio Baltimore ltr to NRL of Nov. 2, 1942.

OBJECT OF TEST

2. The object of the test was to determine whether the samples submitted by Maryland Lava Co., comply with reference (e) for Grade F or G insulating material and also to determine the modulus of rupture and moisture absorption of this 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 (e), 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. The modulus of rupture test was made on a Standard Southwark Testing Machine.

4. Moisture absorption measurements were made in accordance with paragraph 3 of reference (d), and paragraph 6-2 of reference (e).

CONCLUSIONS

It is concluded:

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

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

(c) That these samples do not comply with paragraph 6-2 of reference (e) and paragraph 3 of reference (d) with respect to moisture absorption.

RECOMMENDATIONS

It is recommended:

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

(b) That the waxed samples submitted by the Maryland Lava Company be approved as Grade F insulating-material.

DESCRIPTION OF MATERIAL UNDER TEST

5. The three unwaxed samples numbered 522, 523, 524 and the three waxed samples numbered 519, 520, 521 by N.R.L. were 15.2 cm square and approximately 0.69 cm thick. The six cylindrical samples numbered 55 to 60 inclusive by N.R.L. were approximately 6 inches long and 1-1/8 inches in diameter. All samples were designated as "gray" lava 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 factors of merit of the standard circuit with and without the samples were 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 difference in reading of the standard, taken at resonance, with and without the sample; provided, the residual inductance (L) of the 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 (e).

11. The moisture absorption tests were carried out on newly fractured pieces as detailed in paragraph 6-2 of reference (e) and paragraph 3 of reference (d) where the newly fractured surface was approximately 50% of the unfractured surface of each sample. The samples were first immersed in distilled water at room temperature for 96 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 96 hours the samples were removed from the water, carefully dried with filter paper and immediately weighed. They were then placed in a desiccator for 96 hours after which time they were again weighed.

12. The modulus of rupture test was made by applying a direct load, at a rate of 250 lbs. per minute, midway between two points of restraint. These points were separated by a distance of 5.00 inches. The radius of curvature of the three points was 0.125 inches. A standard Southwark Testing Machine was used for this purpose.

DATA RECORDED DURING TEST

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

PROBABLE ERROR IN RESULTS

14. 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%. The error in the determination of the modulus of rupture is not greater than 5%.

15. The data relating to dielectric properties have been corrected for the fringing of the dielectric flux external to the periphery of the electrodes.

16. Corrections to include the residual errors in the standard measuring circuit have not been applied to these data.

RESULTS OF TEST

17. Results of test are given in Table I, II and III. The data recorded in Table I shows the wet loss factor to be Grade F for the waxed samples. Wet loss measurements on the unwaxed samples could not be made because the conductance was too high to measure.

18. Table II shows that the samples do not comply with paragraph 6-2 of reference (e) and paragraph 3 of reference (d) for the moisture absorption test. When the waxed samples are boiled, they lose their wax. It was found in previous measurements on similar insulating-material submitted by the Maryland Lava Co. that when the waxed samples were boiled, they had a power factor too large to be measured.

19. Table III gives the value of the Modulus of Rupture for the samples numbered 55 to 60 inclusive. They are not as good as ceramics in this respect.

CONCLUSIONS

20. It is concluded:

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

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

(c) That these samples do not comply with paragraph 6-2 of reference (e) and paragraph 3 of reference (d) with respect to moisture absorption.

TABLE I

Maryland Lava Co.

Dielectric Properties

NRL No.	Dielectric Constant		Power Factor		Loss Factor		Grade
	Dry	Wet	Dry	Wet	Dry	wet	
519	5.66	5.70	0.304	0.680	1.72	3.88	F
520	5.81	5.84	0.396	0.660	2.30	3.89	F
521	5.56	5.62	0.434	0.930	2.41	5.22	F
522	5.48	-	0.744	-	4.08	-	-
523	5.48	-	0.841	-	4.61	-	-
524	5.49	-	0.770	-	4.23	-	-

TABLE II

Moisture Absorption

NRL No.	Weight in Grams		Gain	Gain
	Dry	wet	Grams	%
519	42.154	42.460	0.306	0.726
524	36.989	37.527	0.538	1.45

TABLE III

Modulus of Rupture

NRL No.	Direct Load lbs.	Diameter Inches	Modulus lbs/in ²
55	300	1.118	2730
56	420	1.129	3715
57	310	1.124	2780
58	330	1.108	3090
59	420	1.134	3660
60	300	1.112	2780