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NAVY DEPARTMENT

REPORT OF

Test on Insulating Material
No. 302
Submitted by

Globe Union, Inc. (Centralab Division)

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WASHINGTON, D. C.

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APPENDICES

AUTHORIZATION

1. This problem was authorized by Bureau of Ships letter, reference (a). Reference (b) is also pertinent.

References: (a) Buships problem let. (933-1)Ser 357 of August 2, 1943 to N.R.L.

(b) Specification C75.1-1943, Ceramic Radio Insulating Materials, Class L.

OBJECT OF TEST

2. The object of the test was to determine whether the test samples submitted by Globe Union, Inc., comply with reference (b), for Grade L-1, L-2, L-3, L-4, L-5 or L-6 insulating material.

ABSTRACT OF TEST

3. The wet loss factors were determined by measurements made at 1000 Kc, in compliance with paragraphs F-1, F-2a and F-2c of reference (b). Dry measurements were also made on the samples. The dry loss factors were calculated and included in this report.

CONCLUSIONS

It is concluded:

(a) That this material submitted by Globe Union, Inc. does not comply with reference (b) for class L insulating material.

(b) That the material complies with reference (b) with respect to Loss Factor, Modulus of Rupture and Dielectric Strength for grade L-5 insulating material.

(c) That the material does not comply with reference (b) with respect to Thermol Shock.

RECOMMENDATIONS

It is recommended:

(a) That the test samples submitted by Globe Union, Inc. not be approved as Class L ceramic insulating material.

DESCRIPTION OF MATERIAL UNDER TEST

4. The six circular samples numbered 738 to 743 inclusive by NRL were approximately 6 inches square and 0.2 inches thick. Samples numbered D-75 through D-80 were discs approximately 2 inches in diameter and 0.2 inches thick. Those numbered H-67 through H-72 and M-67 through M-72 were rods approximately 6 inches long and 0.75 inches thick. The material is designated as unglazed steatite type 302.

METHOD OF TEST

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

6. The following equipment was used to make the electrical tests:

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.

Ballantine voltmeter, Type 300, serial no. 1418.

Wappler transformer, Type A3, no. 8423

7. 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 $1,11 \times 10^{-12}$ Farads or one C.G.S. electrostatic unit. The effective Q of the entire measuring circuit is approximately 344 units, measured at 1000 kc.

8. 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 measure 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 the standard capacitor is sufficiently small to make W^2LCs, negligible as compared to unity.

9. 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 paragraph F-2c of reference (b).

10. The Modulus of Rupture tests were conducted in accordance with paragraph F-4 of reference (b). A direct load of 250 pounds per minute was applied 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.

11. The tests for Resistance to Thermal Change were conducted in accordance with paragraph F-5 of reference (b). The samples were immersed in four gallons of water at approximately 0° C for 10 minutes and transferred as quickly as possible to four gallons of boiling water (temperature approximately 100° C).

12. Tests for Dielectric-Strength were conducted under oil in accordance with paragraphs F-3a, F-3b, and F-3c of reference (b) and in accordance with Standard Methods of Testing Electrical Porcelain (ASTM D 116-42). The apparatus conforms to the requirements prescribed in Section 3 of the Tentative Methods of Test for Dielectric Strength of Electrical Insulating Materials at Commercial Power Frequencies (ASTM Designation D 149) of the American Society for Testing Materials. The rate voltage rise is governed by means of a manually operated variac in the primary of the high voltage transformer. The high voltage was determined by measuring the potential across a 10,000 ohm resistor which was connected in series with a 1000 megohm resistor across the secondary terminals. The needle-point sparking potential was also observed at the same time as a further check. The wave form of the voltage across the 10,000 ohm resistor as seen on an oscilloscope is practically sinusoidal.

DATA RECORDED DURING TEST

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

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 data relating to dielectric properties have been corrected for the fringing of the dielectric flux external to the periphery of the electrodes. Corrections to include the residual errors in the standard measuring circuit have not been applied to these data.

RESULTS OF TEST

15. Results of tests are given in Tables I through IV and may be summarized as follows: The data recorded in Table I show that the samples comply with paragraph E-1 of reference (b) for Grade L-5 insulating material. Tables II and IV show that the samples comply with reference (b) with respect to Modulus of Rupture and Dielectric Strength. Table III shows that the material does not comply with reference (b) with respect to thermol shock. The last column of Table IV gives the potential gradient applied to the test specimen at the time of breakdown.

CONCLUSIONS

16: It is concluded

(a) That this material submitted by Globe Union, Inc. does not comply with reference (b) for Class L, insulating material.

(b) That the material complies with reference (b) with respect to Loss Factor, Modulus of Rupture, and Dielectric Strength for Class L-5 insulating material.

(c) That the material does not comply with reference (b) with reapect to thermal shock.

TABLE I
Dielectric Properties

NRL No.	DIELECTRIC CONSTANT Dry	Wet	POWER FACTOR Dry	Wet	LOSS FACTOR Dry	Wet
738	5.70	5.67	0.00122	0.00123	0.00694	0.00696
739	5.74	5.72	0.00127	0.00132	0.00732	0.00756
740	5.82	5.81	0.00135	0.00142	0.00785	0.00821
741	5,92	5.70	0.00126	0.00131	0.00742	0.00746
742	5.84	5.81	0.00136	0.00136	0.00798	0.00788
743	5.81	5.60	0.00121	0.00128	0.00706	0.00717
Average Value for 6 Specimens	5.80	5.72	0.00128	0.00132	0.00733	0.00754

TABLE II

Modulus of Rupture

NRL No.	Direct Breaking Load	Diameter in Inches	Modulus of Rupture
M-67	612	.762	17,580
M-68	608	.764	17,360
M-69	584	.760	16,950
M-70	590	.759	17,200
M-71	634	.762	18,220
M-72	772	.762	16,450

TABLE III

Thermol Shock

NRL NO.	Diameter in Inches	Cycles Completed
H-67	.761	20
H-68	.763	20
H-69	.764	20
H-70	.763	20
H-71	.761	20
H -72	.760	18

TABLE IV

Dielectric Strength

NRL No.	BREAKDOWN VOLTAGE In Kilovolts	THICKNESS in mills	DIELECTRIC STRENGTH in Volts per mil
D-75	57.3 *	131	437
D-76	57.3 *	130	441
D-77	43.3	132	328
D-78	54.5	131	416
D-79	56.5	131	431
D-80	49.5	131	378
		Ave.	405

* Indicates sample did not break down.