

FR-2120

REPORT NO. R-2120

DATE 22 July 1943

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SUBJECT

Test on Insulating Material Submitted by Victor Insulators, Inc.

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22 July 1943

NRL Report No. R-2120
Buships Problem M99

NAVY DEPARTMENT

Report of

Test on Insulating Material

Submitted by

Victor Insulators, Inc.

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D. C.

Number of Pages:

Text - 4 Tables - 4

Authorization:

Bureau of Ships letter S67/61 (933-2) of
April 1, 1943 to NRL.

Date of Test:

10 May 1943 to 20 June 1943

Prepared by:

J. E. Martin
J. E. Martin, Contract Employee

Reviewed by:

W. B. Burgess
W. B. Burgess, Principal Radio Engineer
Head, Measurement & Direction Finding Section

A. Hoyt Taylor
A. Hoyt Taylor, Chief Physicist
Superintendent, Radio Division

Approved by:

J. L. Reinartz
J. L. Reinartz, Commander, U.S.N.R.

A. H. Van Keuren
A. H. Van Keuren, Rear Admiral, U.S.N. Director

Distribution
Buships (10)

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AUTHORIZATION

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

- References:
- (a) Buships problem let. S67/61 (933-2) of May 3, 1943 to NRL
 - (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 Victor Insulators, 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 Victor Insulators, Inc. does not comply with reference (b) as a Class L insulating material.

(b) That the material complies with reference (b) with respect to Loss Factor, Modulus of Rupture, and Thermal Shock for Grade L-2 insulating material.

(c) That the material does not comply with reference (b) with respect to Dielectric Strength.

RECOMMENDATIONS

It is recommended:

(a) That the material submitted by Victor Insulators, Inc. not be approved as Class L ceramic insulating material.

DESCRIPTION OF MATERIAL UNDER TEST

4. The six circular samples numbered 684 to 689 inclusive by NRL were approximately 6 inches in diameter and 0.17 inches thick. Samples numbered D-27 through D-32 were discs approximately 2 inches in diameter and 1/4 inch thick. Those numbered M-13 through M-18 and H-19 through H-24 were rods approximately 6 inches long and 1 1/8 inches thick. The material is designated as V-P4 high voltage porcelain.

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 1.11×10^{-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 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 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 (A.S.T.M. Designation D149) of the American Society for Testing Materials. The rate of 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) with respect to Loss Factor for Grade L-2 insulating material. Tables II and III show that the samples comply with reference (b) with respect to Modulus of Rupture and Resistance to Thermal Change. Table IV shows that the samples do not comply with reference (b) with respect to Dielectric Strength. Samples numbered D-28 and D-32 were the only two samples to break down. The oil broke down around the edge of the samples in the other four cases.

CONCLUSIONS

16. It is concluded:

(a) That this material submitted by Victor Insulators, 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 Thermal Shock.

(c) That the material does not comply with reference (b) with respect to Dielectric Strength.

TABLE I

Dielectric Properties

NRL No.	Dielectric Constant		Power Factor		Loss Factor	
	Dry	Wet	Dry	Wet	Dry	Wet
684	5.85	5.65	0.0088	0.0103	0.051	0.058
685	5.71	5.71	0.0088	0.0102	0.050	0.058
686	5.76	5.69	0.0087	0.0095	0.050	0.054
687	5.72	5.69	0.0088	0.0101	0.050	0.058
688	5.66	5.66	0.0087	0.0107	0.049	0.060
689	5.68	5.68	0.0088	0.0106	0.050	0.060
Average value for 6 Specimens	5.73	5.68	0.0088	0.0102	0.050	0.058

TABLE II

Modulus of Rupture

NRL No.	Direct Breaking Load in Lbs.	Diameter in Inches	Modulus of Rupture in Lbs. per In. ²
M-13	1044	1.106	9,840
M-14	960	1.090	9,440
M-15	924	1.090	9,080
M-16	1008	1.096	9,750
M-17	894	1.107	8,360
M-18	996	1.100	9,500

TABLE III

Thermal Shock
 Length = 6.25 inches
 Diameter = 1.10 inches

NRL No.	Cycles Completed
H-19	20
H-20	20
H-21	20
H-22	20
H-23	20
H-24	20

TABLE IV

Dielectric Strength

NRL No.	Breakdown Voltage in Kilovolts	Thickness in mils	Dielectric Strength in Volts per Mil
D-27	58.0	242	240*
D-28	30.4	249	122
D-29	59.0	244	242*
D-30	56.5	247	229*
D-31	59.0	237	249*
D-32	39.0	247	158

Ave. = 207

*Oil broke down around edge of sample.