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NAVY DEPARTMENT

BUREAU OF ENGINEERING

Report on

Test of Submarine Loop Antenna Cable

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Distribution: BuEng (5)

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AUTHORIZATION

1. This problem was authorized by Bureau of Engineering letter, ref.(a), and other references pertinent to this problem are listed as refs.(b) and (c).

Reference: (a) BuEng let.SS/S67(3-13-W8) of 15 March 1935.
(b) BuEng let.S67/66/L5(4-4-W8) of 8 April 1935 to BuStds.
(c) Specifications RE 13A 464B.

OBJECT OF TEST

2. The object of the test was to determine if the samples of submarine loop antenna cables submitted comply with the specifications, ref.(c), except with regard to chemical analysis and tensile strength, which tests have been assigned to the Bureau of Standards by ref.(b).

ABSTRACT OF TEST

3. Tests were conducted to determine the following:

(a) The power factor of the insulation after 12 hours' immersion in salt water.
(b) The insulation resistance under the same conditions.
(c) The ability of the insulation to withstand a potential of 30,000 volts under the same conditions.
(d) The amount of water absorbed by the insulation after being immersed in distilled water for seven days at a temperature of 70°C.
(e) Whether water could be forced through a 1-foot length of cable along the conductors under a pressure of 150 lbs. per square inch.
(f) If the insulation is damaged by bending the cable around a 3-inch diameter form at temperatures between 10° and 40°C.

(The first four tests are made with both ends of the section of cable above the surface of the water.)

Conclusions

(a) Product A complies with all provisions of specifications, ref.(c), covered by the tests conducted except par.6-2 regarding the penetration of water along the conductors.

(b) Product B complies with all provisions of these specifications covered by the tests conducted.

Recommendations

(a) It is recommended that Product A be considered unsuitable for Naval use due to the fact that it fails definitely to comply with the specification regarding penetration of water along the conductors.

(b) It is recommended that Product B in so far as these tests are concerned be considered suitable for Naval use since it complies with all provisions of the specifications covered by these tests.

(c) It is recommended that specifications, ref.(c), be modified in the next revision as follows:

(1) In par.4-3 the voltage should be specified as d.c., or as effective or peak value (peak voltage was assumed in these tests).

(2) In the same paragraph the portion referring to the insulation test should be made to read, "and a 5-foot length while immersed in salt water shall show an insulation resistance of not less than 2000 megohms." This is considered preferable to the present specification based on the resistance of a thousand feet of cable.

(3) If the intent of par.6-1 is that the cable should withstand repeated flexings around the form specified, it is suggested that this paragraph state that the cable shall be tightly bent over the 3-inch diameter form at a given point on the cable, then straightened and the operation repeated four times at both 10° and 40° C.

DESCRIPTION OF MATERIAL UNDER TEST

4. The material under test consisted of two samples of submarine loop antenna cable made up of seven strands of #9 B&S gauge tinned copper wire, each strand insulated from the others by about 1/32" of rubber and the whole covered with rubber to form a cable having a diameter of approximately 1-1/2".

5. The names of manufacturers of the samples are given in Table 1 in the appendix.

METHOD OF TEST

6. For the measurement of power factor, a 5-foot section of cable was formed into a condenser by immersing it in a tank of salt water with both ends mounted above the surface of the water. Using the seven strands of the conductor as one terminal and the metal tank as the other, the radio frequency resistance and capacity of the cable were measured by the parallel substitution method, and the power factor computed. This measurement was made at a frequency of 300 kilocycles.

7. Under the same conditions the insulation resistance was measured by a 1000 volt megger; also an a.c. potential was applied and gradually increased until the peak value exceeded 30,000 volts.

8. The water absorbed through the insulation was determined by weighing a 1-foot length of the cable after drying for 18 hours at 70° C. and also after soaking for seven days in distilled water at 70° C. with the section of cable bent in the form of a "U" and the insulation clamped in holes in a metal plate which covered the vessel. Only about 1/2 inch of the cable extended above the water at each end. When the cable was removed from the hot water bath it was cooled to room temperature in distilled water, removed and shaken and immersed in alcohol to assist in evaporating the surface moisture, and then weighed. After a second drying period the samples were weighed a third time and the smaller of the weights after the drying tests was taken as the dry weight of the sample. From a measurement of the area the absorption in milligrams per square inch was computed.

9. The ability of the cable to withstand the penetration of water under pressure along the conductor was determined by mounting a 1-foot length with one end in a pressure tank filled with water and applying a pressure up to 150 pounds per square inch and noting at what pressure, if any, water appeared on the outside end of the cable. Care was taken in clamping the cable in the "stuffing box" to avoid the use of more pressure than was necessary in order not to choke off the passage of water by undue constriction.

10. The cables were bent sharply around a 3-inch diameter form four times at 10° and 40° C. at the same spot to determine if the insulation would undergo such treatment without damage.

DATA RECORDED DURING TEST

11. The data recorded during the test included the following:

(a) The radio frequency resistance and capacity of the sections used to determine the power factor.

(b) The insulation resistance noted and the potential applied.

(c) The diameter of the samples used in the water absorption test, the weight after drying and after soaking and also after a second drying.

(d) The pounds pressure applied to one end of the sample in the pressure test at which water was observed to penetrate along the conductors, or the maximum pressure applied.

DISCUSSION OF PROBABLE ERRORS

12. The error in the measurement of power factor is not greater than 5%. The insulation resistance is not less than the value given in Table 2, but may be considerably greater. The voltage applied is correct to within 10%. The error in the determination of the weights is not greater than .010 grams. The error in the determination of the areas of the samples used in the absorption test is not greater than 1%. The error in the determination of the pounds pressure applied in the water penetration test is not greater than 5 pounds.

RESULTS OF TEST

13. The results of the tests are summarized in Table 2 appended.

14. Product A complies with all provisions of the specifications covered by this report (Section 3 on chemical analysis and tensile strength is not covered) except par.6-2 relating to the pressure test. Instead of withstanding the pressure of 150 pounds without permitting water to pass through the conductor area of a 1-foot length, two sections of this cable failed on this test at around 50 pounds pressure to the extent of slight moisture on the outer end of the cable and at 150 pounds pressure to the extent of an amount of water sufficient to cause a practically continuous stream of drops. Product B was satisfactory in all tests conducted and showed no leakage at 175 pounds pressure. Two sections were subjected to the pressure test.

15. No injury to the insulation of either product was noted due to bending it four times sharply around a 3-inch diameter form at 10° and at 40° C. at the same spot on the cable. Both samples withstood the application of 38,000 volts after the bending test.

CONCLUSIONS

16. Product A complies with all provisions of specifications, ref.(c), covered by the tests conducted except par.6-2 regarding the penetration of water along the conductors.

17. Product B complies with all provisions of these specifications covered by the tests conducted.

Table 1

Key to Symbols and Description of Material

Product	Manufacturer	Diameter (in.)
A	Simplex Wire and Cable Company	1.57
B	American Steel and Wire Company	1.42

Note: Product A wires are individually coated with rubber, but these rubber coatings are not well bonded together, with the result that minute fissures exist between the coatings. The outer 1/4 inch layer of rubber appears to have been separately applied and may be treated to reduce sun checking.

In Product B, no cracks or fissures are visible around the wires which appear to be tightly gripped by the rubber. The outer 1/8 inch ring of rubber is a darker shade than the rest, indicating the presence of a material to reduce sun checking.

See Plate 1 for appearance of end of cable.

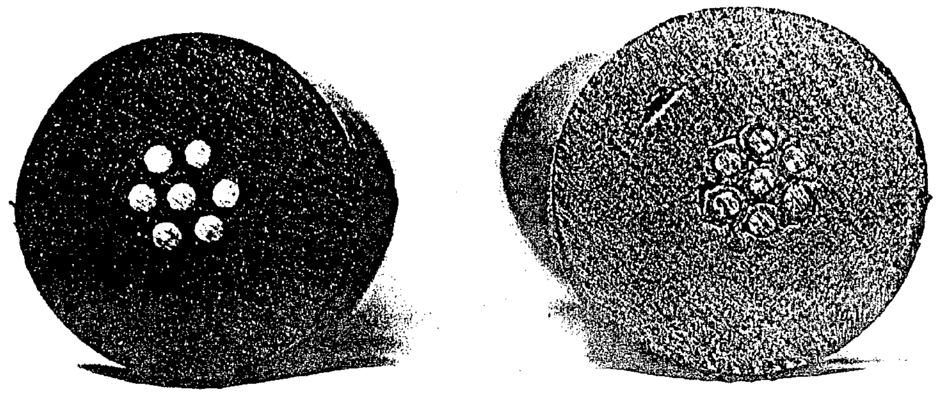
Table 2

Test Data on Submarine Loop Antenna Cable

	Specification Requirements	Test Results Product A	Product B
Power Factor (%)	Less than 2.0	1.30	1.15
Capacity per ft. (μμf)	-	50	40
Insulation resistance (megohms)	-	5000+ *	5000+ *
Test voltage (volts)	30,000	38,000 **	38,000 **
Water absorption (milligrams per sq.in.)	Less than 30	27.4	25.3
Water penetration along conductor 1-ft. long (pressure in lbs. per sq.in.)			
50	No leakage at 150 lbs.	Very slight leakage	No leakage
100		Water oozing out and dripping off end of cable.	" "
150		"	" "
175		-	" "

* Insulation resistance measured on a 5-foot section. Resistance in excess of 5,000 megohms.

** Maximum peak voltage applied; no breakdown of insulation.



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PRODUCT B

PRODUCT A

PLATE I