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NAVY DEPARTMENT

Report of Test FR-718

on

AN Connectors

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NAVAL RESEARCH LABORATORY
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AUTHORIZATION

1. This problem was authorized by Bureau of Ships letter F42-1/39 (10-24-R1) of 27 October 1939.

OBJECT OF TESTS

2. The object of these tests was:

(a) To determine the breakdown voltage of connector units under test when used at altitudes up to 50,000 feet.

(b) To determine relative factors that influence the breakdown point.

(c) To determine possibility of reducing dimensions of connectors.

ABSTRACT OF TESTS

3. A number of electrical connector plugs and receptacles manufactured in accordance with A.N. 3534 specifications were obtained from three firms. They were subjected to a series of tests intended to determine their suitability for use in Naval aircraft service. The data obtained are noted and discussed under "Results of Tests." Primarily, the tests are intended to check compliance with the electrical requirements of A.N. 3534 specifications.

Conclusions

As a result of these tests, the following conclusions have been reached:

(a) All units tested meet the breakdown potential requirements of AN 9534 specifications.

(b) Samples A and B do not meet the requirement of Section D-3 of AN 9534 specification, (spacing between contacts); Samples C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q and R meet these requirements. This is fully discussed under "Results of Tests."

(c) The square contact pins used in Samples A, B, L, and F are desirable (though not required by specifications). The only objectionable feature is that noted under (b) of "Conclusions."

(d) Dust and other foreign matter on the surface of the insulation influence the breakdown potential.

(e) The spacings now specified for a given voltage rating may be reduced or the voltage rating for the present spacings may be increased.

Recommendations

The following recommendations are made:

(a) That the square connectors used in Samples A and B be rejected for reasons noted in (b) of "Conclusions" and (10) of "Results of Tests."

(b) That the operating voltage ratings be increased or that the spacing be reduced for the same voltage rating.

MATERIAL UNDER TEST

4. The material under test consisted of electrical connectors, plugs, receptacles and inserts obtained from three manufacturers and intended to meet the AN 9534 specifications. They are itemized in Table 1 of the Appendix.

METHOD OF TEST

5. The units under test were placed in a bell jar and connecting leads brought out. Direct current was applied to the connector terminals and the voltage measured with an electrostatic voltmeter. A high resistance was inserted in series with the supply source and the voltmeter so as to indicate breakdown the instant it occurred.

6. The jar was evacuated in order to simulate pressure conditions at several altitudes up to 50,000 feet. Four different altitude breakdown points were determined as follows: sea level - 20,000 feet, 35,000 feet, and 50,000 feet. For each connector unit a separate pair of terminals was used for determining each breakdown point. The breakdown tests were repeated with several inserts of the same type. No attempt was made to control the humidity.

DATA RECORDED DURING TESTS

7. The data recorded during these tests consist of the breakdown voltage at several pressures for each unit. These data are contained in Table 2 of the Appendix of this report.

DISCUSSION OF PROBABLE ERRORS

8. The accuracy of measurements is dependent on the following factors:

(a) The accuracy of the electrostatic voltmeter, which is rated at ± 3 per cent.

(b) Error due to the human element involved in accurately reading the voltmeter at the instant of breakdown.

RESULTS OF TESTS

9. The Samples A, B, C, D, K, L, Q and R have 24-volt service designation. The location of each terminal is identified by a raised letter on the front and rear faces of the insert. For the voltage breakdown tests, four pairs of terminals were used as follows: a and b, d and e, k and j, g and f. The tests were conducted as outlined under "Method of Test."

10. The inserts for Samples A, B, E and F units are made of two molded bakelite pieces. The contact terminals are made of square stock and

fit into square holes in the insulation. The object of using square elements is to avoid turning of connector in the insulation because it is conducive to breakage of the soldered connection, especially under conditions of severe vibration. The disadvantage is that with inserts having many contact terminals (such as 2 p and 2 s for A and B units which have 14 terminals) the spacing is reduced considerably. In these two types of inserts, the spacing is one-sixteenth inch. This does not meet the specification requirements as noted in AN 9534, Section D-3, which calls for a minimum of one-eighth inch. However, in spite of the reduced spacings, these inserts meet the breakdown potential requirements.

11. The inserts for E and F have only two contact terminals and are seated into the insulation with the flat sides parallel. The spacing is one-fourth inch and meets the specification noted in Section D-3 of AN 9534.

12. The inserts for C, D, G and H units are made in two pieces, one section of molded bakelite and the other of laminated bakelite. The connectors are round and have no provision to prevent them from turning in the insulation. The spacing of the units submitted for test meets the AN 9534, Section D-3, requirements. However, the breakdown potential characteristics of comparable units with smaller spacing (A and B) are essentially the same.

13. The inserts for Samples I, K, L, M and N units are made of two molded bakelite pieces. The connectors are round and have no provision to prevent them from turning in the insulation. The Sample J unit has the connectors molded in a solid bakelite piece. The above units meet the spacing requirements of specification AN 9534, Section D-3.

14. The inserts for Samples O, P, Q and R are constructed the same as described in (10) above except that the connectors have two flat surfaces intended to prevent turning. This results in effectively increasing the spacing between connectors as compared to the previous samples submitted by the same manufacturer.

15. The data resulting from these tests are shown in Table 2. The breakdown voltage versus altitude is plotted graphically as follows: for Samples A and B in Plate 1, for C and D in Plate 2, for E and F in Plate 3, for G and H in Plate 4, for I and J in Plate 5, for K and L in Plate 6, for M and N in Plate 7, for O and P in Plate 8, for Q and R in Plate 9. Plate 10 contains four curves: A and B, G and H, I and J, O and P. Plate 11 contains three curves: C and D, K and L, Q and R. It will be noted that the voltage breakdown of Q and R, K and L, follows the same trend, while that of C and D tends to be of a higher magnitude at altitudes above 30,000 feet. Plate 12 contains two curves: E and F, M and N. It will be noted that the voltage breakdown characteristics approach each other at high altitudes.

16. Examination of Plate 10 shows that the breakdown voltage for the same spacing varies over wide limits. The accumulation of dirt on the surfaces causes a variation of breakdown voltages. Samples A, B, K, and L were carefully cleaned with carbon tetrachloride and thoroughly dried, then immediately placed under test. Breakdown voltages at sea level increased in

excess of 30 per cent. Another cause of this variation in breakdown potential may be due to a lack of uniformity in the quality of the insulating material used. No attempt was made to investigate the latter. However, the breakdown voltages given in Table 2 are the ones which may be expected for the plugs as delivered by the manufacturer.

CONCLUSIONS

17. As a result of these tests, the following conclusions have been reached:

(a) All units tested meet the breakdown potential requirements of AN 9534 specifications.

(b) Samples A and B do not meet the requirement of Section D-3 of AN 9534 specification, (spacing between contacts); Samples C, D, E, F, G, H, I, J, K, L, M, N, P, Q and R meet these requirements. This is fully discussed under "Results of Tests."

(c) The square contact pins used in Samples A, B, C, and F are desirable (though not required by specifications). The only objectionable feature is that noted under (a) of "Conclusions."

(d) Dust and other foreign matter on the surface of insulation influences the breakdown potential.

(e) The operating voltage specified for a given voltage rating may be reduced if the voltage rating for the contact spacing may be increased.

TABLE I

MATERIAL UNDER TEST

Sample Designation	Shell Type	Shell Size	Insert	No. of Contacts	Size of Contacts	Service Rating	Minimum Spacing required between Terminals	Actual Spacing between Terminals	Maximum Operating D.C. Voltage Rating	Name of Manufacturer
A	AN3102	28	20	14	1 for #12 13 for #16	2kV	1/8"	1/16"	1500	Amphenol
B	AN3106	28	21	14	1 for #12 13 for #16	2kV	1/8"	1/16"	1500	Amphenol
C	AN3102	28	18	14	1 for #12 13 for #16	2kV	1/8"	1/8"	1500	Breeze
D	AN3106	28	18	14	1 for #12 13 for #16	2kV	1/8"	1/8"	1500	Breeze
E	AN3102	14	11S	4	#16	500V	1/2"	1/4"	1000	Amphenol
F	AN3106	22	11P	4	#16	500V	1/2"	1/4"	1000	Amphenol
G	AN3102	12	12	2	#20	1kV	1/16"	1/16"	750	Breeze
H	AN3106	16S	11	2	#20	1kV	1/16"	1/16"	750	Breeze
I	AN3102	16S	18	2	#20	1kV	1/16"	1/16"	750	Cannon
J	AN3106	16S	23	2	#20	1kV	1/16"	1/16"	750	Cannon
K	AN3102	28	21	14	1 for #12 13 for #16	2kV	1/8"	1/8"	1500	Cannon
L	AN3106	28	19	14	1 for #12 13 for #16	2kV	1/8"	1/8"	1500	Cannon
M	AN3102	24	16S	8	#16	1kV	1/4"	1/4"	2500	Cannon
N	AN3106	24	23S	8	#16	1kV	1/4"	1/4"	2500	Cannon
O	AN3102	16S	13	2	#12	1kV	1/16"	1/16"	750	Amphenol
P	AN3106	16S	19	2	#12	1kV	1/16"	1/16"	750	Amphenol
R	AN3102	22	23	4	1 for #12 3 for #16	1kV	1/8"	1/8"	1500	Amphenol
S	AN3106	22	14	4	1 for #12 3 for #16	1kV	1/8"	1/8"	1500	Amphenol

TABLE 2

BREAKDOWN VOLTAGE DATA

Reference Designation	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Service Designation	24V	24V	24V	24V	500V	500V	INST.	INST.	INST.	INST.	24V	24V	110V	110V	INST.	INST.	24V	24V
Altitude in Feet																		
0	5700	5700	5400	[illegible]	[illegible]	10,000	2500	2500	4200	[illegible]	[illegible]	5500	8500	8500	3500	3500	6100	6100
20,000	3650	3650	3275	3275	6700	6700	1650	1650	2900	2900	3500	3500	4800	4800	2600	2600	3900	3900
35,000	2800	2800	2600	2600	4200	4200	1075	1075	1900	1900	2200	2200	3100	3100	1900	1900	2400	2400
50,000	2000	2000	2000	2000	2400	2400	700	700	1350	1350	1500	1500	2400	2400	1700	1700	1700	1700

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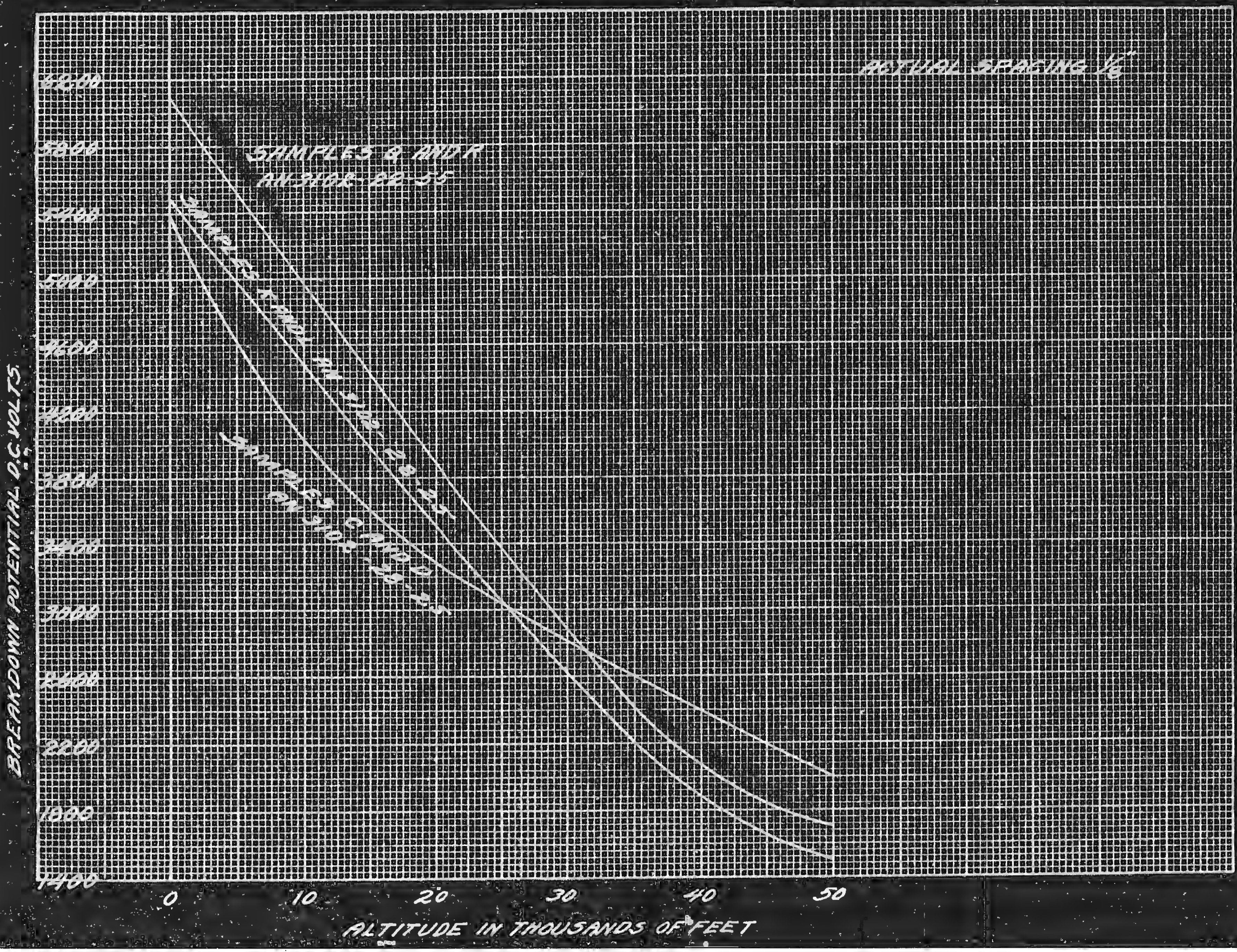

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TABLE 1

MATERIAL UNDER TEST

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A	AN3102	28	2S	14	2 for #12 12 for #16	24V	1/8"	1/16"	100	Amphenol
B	AN3106	28	2P	14	2 for #12 12 for #16	24V	1/8"	1/16"	100	Amphenol
C	AN3102	28	2S	14	2 for #12 12 for #16	24V	1/8"	1/8"	100	Breeze
D	AN3106	28	2P	14	2 for #12 12 for #16	24V	1/8"	1/8"	100	Breeze
E	AN3102	22	11S	2	#16	500V	1/4"	1/4"	1000	Amphenol
F	AN3106	22	11P	2	#16	500V	1/4"	1/4"	1000	Amphenol
G	AN3102	16S	1S	7	#20	Inst.	1/16"	1/16"	70	Breeze
H	AN3106	16S	1P	7	#20	Inst.	1/16"	1/16"	70	Breeze
I	AN3102	16S	1S	7	#20	Inst.	1/16"	1/16"	70	Cannon
J	AN3106	16S	1P	7	#20	Inst.	1/16"	1/16"	70	Cannon
K	AN3102	28	2S	14	2 for #12 12 for #16	24V	1/8"	1/8"	100	Cannon
L	AN3106	28	2P	14	2 for #12 12 for #16	24V	.1/8"	1/8"	100	Cannon
M	AN3102	22	10S	4	#16	110V	1/4"	1/4"	230	Cannon
N	AN3106	22	10P	4	#16	110V	1/4"	1/4"	230	Cannon
O	AN3102	16S	1S	7	#20	Inst.	1/16"	1/16"	70	Amphenol
P	AN3106	16S	1P	7	#20	Inst.	1/16"	1/16"	70	Amphenol
Q	AN3102	22	5S	6	2 for #12 4 for #16	24V	1/8"	1/8"	100	Amphenol
R	AN3106	22	5P	6	2 for #12 4 for #16	24V	1/8"	1/8"	100	Amphenol

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