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Dated
Tests of Components for models RBM, RBM-1 and RBM-2
Receiving Equipments

NAVY DEPARTMENT

Report of

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D. C.

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Prepared by: Maury I. Hull, Contract Employee

Reviewed by: Warren B. Burgess, Senior Radio Engineer
Head, Measurement & Direction Finder Section

A. Hoyt Taylor, Chief Physicist
Superintendent, Radio Division

W. B. Goulett, Lt. Comdr. USN

Approved by: H. G. Bowen, Rear Admiral, USN, Director

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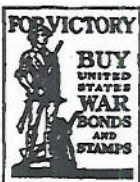
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From: Director
To: Bureau of Ships
Subject: NRL Report No. R-1951 "Tests of Components
for models RBM, RBM-1 and RBM-2 Receiving
Equipments" dated 17 October 1942.
Enclosure: Ten copies of subject report.

1. The subject report is forwarded herewith.

W. B. Goulett

W. B. Goulett
By direction



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AUTHORIZATION

1. These tests were authorized by references (a) and (b). Reference (c) to (h) inclusive are also pertinent.

References:

- (a) BuEng. ltr. F42-1(9-18-R6) of 19 Sept. 1939 to Director, NRL, Anacostia, D. C.
- (b) BuShips ltr. C-NOs-65690 (480-Da) of 11/8/41 to Director, NRL, Anacostia, D. C.
- (c) Specification RE 13A 372J.
- (d) Specification RE 13A 610B.
- (e) Specification RE 13A 488D.
- (f) Telephone conversation of 3/17/42 between BuShips and NRL discussing tests of RBM components.
- (g) Telephone conversation between NRL and BuShips of 7/14/42 giving preliminary report of test.
- (h) BuShips ltr. C-NOs-65690 (480 Da), NOs 72086, and NOs 95095 of 2/11/42 to RINM, WEM Co., Baltimore, Md.

OBJECT OF TEST

2. The objects of these tests were to determine the suitability of the capacitors, resistors, transformers and inductors for use in models RBM, RBM-1 and RBM-2 Receiving Equipments.

ABSTRACT OF TEST

3-1. Capacitors: The capacitors were tested in accordance with reference (e) to determine the following:

- (a) Ability to withstand a "flash" voltage of twice the d.c. working voltage.
- (b) Capacity.
- (c) Leakage resistance.
- (d) The efficacy of the container and seal to protect the condensers from humidity, as evidenced by a comparison of the capacities and leakage resistances before and after several cycles of hot and cold salt water baths.

3-2. Fixed Wire Wound Resistors: These resistors were tested according to their application in the subject receiving equipment as instructed by BuShips, reference (f). Tests were conducted to determine the following:

- (a) Hot spot temperature at operating conditions supplied by the Westinghouse Electric & Mfg. Co.
- (b) Resistance
- (c) Effect of thermal shock.
- (d) Effect of overloading.
- (e) Protection afforded against the effects of humidity.

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3-3. Composition Resistors: These resistors were submitted under reference (d) for preliminary model type test only. The following tests were made:

- (a) Resistance Tolerance.
- (b) Overload.
- (c) Thermal Shock.
- (d) Salt water immersion.

3-4 Laminated Iron Core Components - Audio: The laminated iron core transformers and inductors were given insulation breakdown and salt water immersion tests in accordance with reference (d).

3-5. Laminated Iron Core Components - Power Supply: The laminated iron core transformers and inductors were given insulation breakdown and salt water immersion tests in accordance with reference (d).

CONCLUSIONS

These conclusions apply only to the use of the components in the Models RBM, RBM-1, RBM-2 Receiving Equipments. In the case of all those components which passed the tests, either the material tested or the conditions of test were improper for general type approval.

It is concluded:

1. (a) That the capacitors comply with the requirements of the specification, reference (e), except as to markings and dimensions.
2. (a) That the wire wound fixed resistors are suitable for use in the models RBM, RBM-1 and RBM-2 receiving equipments.
3. (a) That the composition resistors comply with the requirements of reference (d) for preliminary model type approval.
(b) These resistors should not be used when worked up to their normal wattage rating, especially in the case of the one watt type.
4. (a) That the laminated iron core audio transformers and inductors fail to meet the requirements of the governing specification concerning hermetical seals.
(b) That these units are unsuitable for use in the models RBM, RBM-1 and RBM-2 receiving equipments.
5. (a) That the laminated iron core power supply transformers and filter inductors fail to meet the requirements of the governing specification concerning resistance to humidity.
(b) That these units are unsuitable for use in the models RBM, RBM-1 and RBM-2 receiving equipments.

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RECOMMENDATIONS

It is recommended:

1. (a) That these particular types of Aerovox foil paper capacitors be considered suitable for use in the Models RBM, RBM-1 and RBM-2 receiving equipments, provided they are marked in accordance with the governing specification, reference (e).

2. (a) That this particular type of MW-4 International Resistance Company wire wound fixed resistor be considered suitable for use in the models RBM, RBM-1 and RBM-2 receiving equipments.

3. (a) That these particular types of composition resistors be considered suitable for use in the Models RBM, RBM-1 and RBM-2 receiving equipments, provided their wattage dissipation and operating temperature characteristics offer no difficulties.

(b) That these resistors be not used near their normal rated wattage dissipation.

4. (a) That the container seal and terminal arrangements of the laminated iron core audio transformers and inductors be improved to afford adequate protection against the effects of humidity.

5. (a) That the container and terminal seals of the laminated iron core power supply units be improved to afford adequate protection against the effects of humidity.

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COMMENTS

Capacitors: It is noted that both 8 mfd. capacitors failed in the immersion test, whereas both 4 mfd. capacitors passed the immersion test. After the electrical test had been concluded, one of each of these two types of capacitors was opened and examined. There appeared to be no substantial difference in construction, and no evident reason for the fact noted above.

Composition Resistors: Some of the resistors when operated at a hot spot temperature of 65°C did not dissipate their rated wattage. See Tables III and IV.

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DESCRIPTION OF MATERIAL UNDER TEST

4-1. Capacitors: Seven foil-paper oil filled units of various capacities, dimensions and working voltages as shown below, manufactured by the Aerovox Mfg. Co. and submitted by the Westinghouse Electric and Manufacturing Co., were tested.

No. of Units Tested	Capacity MFD	Working Voltage	Dimension Inches
3	1.0	400	1-5/8 x 1/2 x 3-3/8
2	4.0	600	2-1/2 x 1-3/16 x 3-1/4
2	8.0	600	3-3/4 x 1-1/4 x 3-7/8

The capacitors were contained in sealed metal cases. Terminals were brought out through insulating fibre washers. None of the capacitors conformed to reference (e) in respect to marking. A general view of one of each type of unit tested is shown in Plate 1.

4-2. Wire Wound Fixed Resistors: The material under test consisted of six 10,000 ohm wire wound, fixed resistors manufactured by the International Resistance Company, manufacturer's style designation MW-4, and submitted by the Westinghouse Electric and Mfg. Co., Baltimore, Md. The resistance wire is wound upon a flat strip, permanently enclosed by molding in an asbestos-filled phenolic compound, and having an attached metal bracket with mounting feet. Terminals are of rolled edge, tinned strip steel, punched with hole to take No. 14 B & S gauge wire, and having side notches for wrapping connections. See Plate II, which shows, top to bottom; the complete unit, the resistance with mounting strip removed, and the mounting strip.

4-3. Composition Resistors: The material under test consisted of 38 composition resistors manufactured by the International Resistance Company and the Allen-Bradley Co., Inc. They have ratings as follows:

No. of Units Tested	Manufacturer	Resistance ohms	Tolerance	Wattage
4	I.R.C.	15.0	± 10%	1/2
3	I.R.C.	62.0	± 5%	1/2
4	I.R.C.	150.0	± 10%	1/2
2	A.B. Co.	390.0	± 10%	1/2
2	A.B. Co.	390.0	± 5%	1/2
2	A.B. Co.	10,000.	± 10%	1/2
2	A.B. Co.	10,000.	± 5%	1/2
15	A.B. Co.	20,000.	± 10%	1
2	A.B. Co.	2.2 meg	± 10%	1/2
2	A.B. Co.	2.2 meg	± 5%	1/2

These resistors consisted of a mixture of finely-divided, carbonaceous conducting material having wire leads, and covered with an

insulating compound. The resistors were color coded in accordance with the Standard RMA Color Code. For a general view of samples tested, see Plate III. The first and second units, top to bottom, are 1/2 watt, 2.2 megohms and 150 ohms respectively. The third resistor is a 1 watt, 20,000 ohm unit.

4-4. Laminated Iron Core Audio Components: The material under test consisted of four laminated iron core audio transformers, and four laminated iron core audio inductors suitable for use in wave filters, manufactured by the Westinghouse Electric and Mfg. Co., Baltimore, Md. These units are similar in general appearance and terminal construction to the power supply units shown in Plate IV. The audio transformers were 2-7/8" long and had a diameter of 2". The inductors were 1-7/8" long and 1-3/8" in diameter.

4-5. Laminated Iron Core Power Supply Components: The material under test consisted of eight laminated iron core inductors, suitable for use in power supply filters, manufactured by the Westinghouse Electric and Mfg. Co. and having inductances of 4, 5, and 10 henries; two 25 cycle and two 60 cycle filament transformers manufactured by the Westinghouse Electric and Mfg. Co.; and two 25 cycle and two 60 cycle power transformers each having filament and plate supply windings manufactured by the Raytheon Mfg. Co. Two Westinghouse units which failed in the tests are shown in Plate IV. A general view of the Raytheon transformers is shown in Plate V.

METHOD OF TEST

5-1. Capacitors.

- (a) Each capacitor was given a d.c. flash test of twice its working voltage for 15 seconds between terminals and between each terminal and case. The voltage was applied in series with a resistor of 750,000 ohms.
- (b) The capacity of the capacitors was measured with a 60 cycle capacity bridge.
- (c) The leakage resistance of the capacitors was measured by the use of a megohm bridge at a potential of 500 V. dc.
- (d) The test to determine the effect of humidity consisted in immersing the units in a saturated salt water solution at 65°C for two hours and then transferring them to a similar solution at 0°C for two hours. This procedure was repeated until five cycles had been completed. The capacitors were then immersed in a saturated salt water solution at 20°C for 24 hours after which they were removed, rinsed in clear water and allowed to dry for one hour. The capacity and leakage resistance were then remeasured, and the "flash" test of twice the working voltage repeated. After the electrical tests were completed, two of the capacitors were opened and examined to determine their terminal structure.

5-2.

Wire Wound Fixed Resistors

(a) The hot spot temperature of the resistors was determined under conditions simulating as closely as possible those actually encountered in the subject receiving equipments. The two units tested were firmly mounted in a horizontal position on a metal chassis contained within a cabinet having dimensions of 10" x 14" x 8", and containing a lamp dissipating 22.75 watts, providing an ambient temperature of 50.5°C. A potential of 275 volts d.c., the value actually used in the subject receiver equipment, was applied to the resistors, and the current and hot spot temperature recorded.

(b) The resistance was determined at 20°C by measurement with a wheatstone bridge.

(c) The thermal shock test was conducted under reference (c). Two units were suspended in free air at room temperature and sufficient voltage applied to bring their hot spot temperature to 100°C. The voltage and current were read to determine the watts input. The resistors were quickly plunged into fresh water at 0°C and allowed to cool for fifteen minutes. They were then removed and dried, and their resistance measured by the bridge method.

(d) In the overload test, two units were placed in a 40°C oven and allowed to remain for one-half hour. A voltage was applied to the resistors equal to that required for application of two percent of normal load. The voltage and current were measured, after which the voltage was increased to 335 volts, at which value the resistors carried 150% of their normal load. This voltage was applied continuously for 100 hours. After its removal the resistors were remeasured.

(e) In the test for resistance to humidity, the resistors were placed in an oven at 40°C, and operated for one hour at full load. At the end of this period the voltage and current were read and the resistors were immersed in saturated salt water at 100°C for two hours, then transferred to a saturated salt water solution at 0°C for two hours. They were then removed from the salt water bath, rinsed in clear water, dried and placed in the oven at rated load for two hours, after which period the voltage and current were read and the resistors returned to the 100°C salt bath to start the second cycle. This was continued night and day until 11 cycles were completed.

(f) After the humidity test was completed, the resistances of all units were remeasured.

5-3.

Composition Resistors

(a) The resistance of each unit was measured at 20°C on a wheatstone bridge to determine whether it was within tolerance.

(b) The overload test consisted in applying 150% of normal load continuously for 100 hours, at an ambient temperature of 40°C. Prior to this test, the resistances were measured at

2% of normal load after being placed in an ambient temperature of 40°C at no load for one-half hour. The resistance was remeasured in the same manner at the end of the 100 hour overload test.

(c) In the thermal shock test, sufficient potential was applied to the resistors to raise their hot spot temperature to 65°C. The voltage and current were measured at this point. The resistors were then plunged into fresh water at 0°C. After the units were completely cooled, they were removed, wiped dry, allowed to reach room temperature, and remeasured.

(d) The salt water immersion test was begun by operating the resistors at rated load in an ambient temperature of 40°C for one hour, at the end of which period the voltage and current were measured. The resistors were then transferred to a saturated salt water solution at 100°C, where they remained for two hours. From this 100°C salt bath they were moved to a similar bath at 0°C for two hours. Upon removal from the 0°C bath they were washed in clear water, dried, and operated at full load for two hours. A second cycle was then begun. This process was continued until all units had withstood an average of more than 10 cycles.

5-4.

Laminated Iron Core Audio Components

(a) The insulation breakdown test was conducted by applying a fifteen second "flash" test of 1500 volts r-m-s, 60 cycle a.c. between windings and between each winding and case. This voltage was applied in three steps of 500 volts each, with six seconds time lapse between steps.

(b) Winding resistances, and leakage resistances between windings and between each winding and case, were measured. The transformers and inductors were then submerged in a saturated salt water solution at 65°C for two hours. From this bath they were transferred to a similar solution at 0°C for two hours. After removal they were immersed in a 20°C saturated salt water solution for 24 hours. The units under test were then washed in clear water, dried and operated at rated voltage and current for two hours. The transformers under test had a current of ten milliamperes d.c. flowing in their primaries, and the potential difference between the "high" terminal and case was 130 volts. A 1000 cycles per second alternating current of ten r-m-s volts was also applied across the primaries. The secondaries were open circuited. The inductors were operated at a current of 0.9 milliamperes d.c. with a 100 volt d.c. potential difference between "high" terminal and case while a 1000 cycle alternating current was also applied to the inductors. The winding and leakage resistances were remeasured after removal of these potentials, and after sufficient time had elapsed for the units to return to the original reference temperature. Five cycles of baths and test runs, under rated voltage and current, were completed.

5-5. Laminated Iron Core Power Supply Components

(a) The insulation breakdown test was conducted by applying a fifteen second "flash" test of 1500 r-m-s a.c. volts, 60 cycles, between windings and between each winding and case. This voltage was applied in three steps of 500 volts each, with six seconds time lapse between steps.

(b) Winding resistances, and leakage resistances between windings and between each winding and case, were measured. The transformers and inductors were then submerged in a saturated salt water solution at 65°C for two hours. From this bath they were transferred to a similar solution at 0° for two hours. After removal they were immersed in a 20°C saturated salt water solution for 24 hours. The units under test were then washed in clear water, dried, and operated at rated voltage and current for two hours. The inductors were operated as follows:

	4-Henry Unit	5 Henry Unit	10 Henry Unit
Current (m.a.)	90	100	100
Voltage between high terminal and case	235	230	230

The Westinghouse filament transformers had 115 r-m-s volts, 25 or 60 cycles, applied to their primaries, and a current of .74 ampere taken from their secondaries. The Raytheon power transformers had the same voltage applied to their primaries, and current was taken from their secondaries as follows: 12 volt secondary 2.15 amperes; 5 volt secondary, 3 amperes; high voltage secondary, 50 milliamperes.

The winding and leakage resistances were remeasured upon completion of the two hour load test, after a sufficient time had elapsed for the units to return to the original reference temperature.

Five cycles of baths and test runs under rated voltage and current were completed.

5-6. The following instruments were used for these measurements:

General Electric Kenotron Testing Set, No. 6, 641, 485
 General Radio Co. Megohm Bridge, Type 544-B, Ser. No. 246
 Leeds and Northrup Wheatstone Bridge Model 5300, No. 374, 910
 Weston D.C. Millivoltmeter and Shunts, Model 1, Ser. No. 19864
 Weston D.C. Milliammeter, Model 45, Ser. No. 45107
 Weston A.C.-D.C. Ammeter, Model 370, Ser. No. 5302
 Weston A.C.-D.C. Voltmeter, Model 341, Ser. No. 9706
 Westinghouse A.C. Milliammeter Style WG 38167-1*

* This Westinghouse a.c. milliammeter was calibrated against Weston A.C.-D.C. milliammeter, Model 370, Ser. No. 5307, prior to its use in the subject test.

Simpson Electric Co. D.C. Voltmeter, Model 27 Ser. No. 4610**
 Leeds & Northrup Voltbox, Type 7591, No. 126, 359
 Leeds & Northrup Type K Potentiometer, Ser. No. 120078
 Weston D.C. Microammeter, Model 1, Ser. No. 42926
 Weston Rotary shunt, Model 8, Ser. No. 468
 Weston D.C. Voltmeter, Model 45, Ser. No. 41143
 Weston D.C. Voltmeter, Multipliers, Model 45, Ser. No. 42522
 Leeds & Northrup Standard Resistances 1; 10; 100; 1000; 10,000
 ohms, ser. nos. 121455; 53982; 53976; 47243; 341928 respectively.
 Lewis Eng. Co. Pyrometer - Potentiometer, Model 14 PO, Ser.
 No. 220.
 General Radio Company Capacity Bridge, Type 740, Ser. No. 289
 Ballantine Electronic Voltmeter, Model 300, Ser. No. 310

DATA RECORDED DURING TESTS

6. Certain data recorded during the tests are given in Results of Test; other data are presented in Tables I to XIII inclusive.

PROBABLE ERROR IN RESULTS

7. The error in the measurements is believed to be not greater than the following:

Measurement of d.c. voltages and currents	± 1%
Measurements of a.c. voltages	± 2%
Measurement of temperature	± 2°C
Measurement of winding resistance	± 1%
Measurement of capacity	± 1%
Measurement of leakage resistances	± 10%

The probable error in leakage resistance was not a contributing factor to the failures noted in the Results of Test, since those units which failed to meet the requirements for leakage resistance, after immersion, did so by large margins.

Inconsistencies in the leakage resistance measurements may be accounted for in part by the effects of electrolysis.

7-3. Some error was introduced into the measurement of the hot spot temperature of the composition resistors because of the necessity for attaching the thermocouples to the resistors. Thermocouples were attached to all the 1/2 watt resistors by means of a strip of Scotch tape. These strips reduce the dissipation of the resistors somewhat for a given hot spot temperature. In the case of all of the 1 watt resistors the thermocouples were attached with two turns of small cotton thread. The thermocouples were rel-

** This Simpson DC voltmeter was calibrated against Weston Laboratory Standard Voltmeter No. 1508 prior to its use in the subject tests.

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atively loosely attached, and hence the error introduced tended to increase the wattage dissipation for a given hot spot temperature.

RESULTS OF TEST

8-1. Capacitors

- (a) All of the capacitors, prior to immersion, satisfactorily withstood a "flash" test of twice the d.c. working voltage applied for 15 seconds between terminals and between each terminal and case.
- (b) The measured capacities of all units before immersion were within the tolerance limit set in reference (e). See table I.
- (c) The leakage between terminals before the salt water immersion test was within the required limits. See Table I.
- (d) Leakage resistance and capacity after immersion are shown in Table I. Both 8 mfd units failed the "flash" test after immersion; all other capacitors passed.

8-2. Wire Wound Fixed Resistors

- (a) In the test to determine the hot spot temperature under operating conditions, the temperature of 100°C which developed is well below the allowable temperature.
- (b) All resistances were well within the $\pm 5\%$ tolerance allowed. See Table II.
- (c) Both units tested passed the thermal shock test. See Table II.
- (d) Both units passed the 100 hour 150% overload test. See Table II.
- (e) All units passed the humidity test. See Table II.

8-3. Composition Resistors

- (a) The resistance of all units was within the specified tolerance. See Tables III, IV and V.
- (b) All units passed the overload test. See Tables III, IV and V.
- (c) All units passed the thermal shock test. See Tables III, IV and V.
- (d) Both types of resistors passed the salt water immersion test by averaging more than 10 cycles. See Tables III, IV and V.
- (e) Some of the resistors of both types when operated at a hot spot temperature of 65°C did not dissipate their rated wattage. See Tables III, IV and V.

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8-4. Laminated Iron Core Audio Components

- (a) All units successfully withstood the 1500 volt insulation breakdown test prior to immersion.
- (b) One transformer failed in the first cycle when the winding resistance changed more than 5% and the leakage resistance between one winding and case fell to less than 500 megohms. This unit continued to deteriorate in subsequent cycles. See Table VI.
- (c) One inductor failed in the third cycle when the leakage resistance fell to less than 500 megohms. See Table VII.

8-5. Laminated Iron Core Power Supply Components

- (a) All units successfully withstood the 1500 volt insulation breakdown test prior to immersion.
- (b) Westinghouse Inductors: One unit failed in the second cycle when its leakage resistance fell to less than the tolerated value and the resistance of one winding changed more than the allowable percent. One unit failed in the fifth cycle, by reduction of leakage resistance. See Table VIII. The right hand figure of Plate 4, taken several days after the conclusion of the tests, shows the salt deposit on a unit which failed.
- (c) Westinghouse filament transformers: One 25 cycle unit failed in the fourth cycle because of lowered leakage resistance. See Table IX. Both 60 cycle transformers completed five cycles satisfactorily. The left hand figure of Plate 4 shows a unit on which the sealing gasket had become loosened during the cycle of baths.
- (d) Raytheon power transformers: The leakage resistance of all units prior to immersion met the specification, but both 60 cycle units failed in the first cycle because of lowered leakage resistance. See Table X. One 25 cycle unit failed in the first cycle and one in the second cycle because of leakage resistance. See Table XII.

CONCLUSIONS

These conclusions apply only to the use of the components in the Models RBM, RBM-1 and RBM-2 Receiving Equipments. In the case of all those components which passed the tests, either the material tested or the conditions of test were improper for general type approval.

It is concluded:

- 1. (a) That the capacitors comply with the requirements of the specification, reference (e), except as to markings and dimensions.
- 2. (a) That the wire wound fixed resistors are suitable for use in the models RBM, RBM-1 and RBM-2 receiving equipments.
- 3. (a) That the composition resistors comply with the requirements of reference (d) for preliminary model type approval.

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- (b) These resistors should not be used when worked up to their normal wattage rating, especially in the case of the one watt type.
4. (a) That the laminated iron core audio transformers and inductors fail to meet the requirements of the governing specification concerning hermetical seals.
(b) That these units are unsuitable for use in the models RBM, RBM-1 and RBM-2 receiving equipments.
5. (a) That the laminated iron core power supply transformers and filter inductors fail to meet the requirements of the governing specification concerning resistance to humidity.
(b) That these units are unsuitable for use in the models RBM, RBM-1 and RBM-2 receiving equipments.

TABLE I
MEASURED CAPACITY AND LEAKAGE RESISTANCE OF AEROVOX FOIL PAPER CAPACITORS

Sample No.	Capacity (microfarads)	Measured Capacity		Between Terminals		Leakage Resistance (Megohms)		Left Terminal to Case		Right Terminal to Case	
		Before Immersion	After Immersion	Before Immersion	After Immersion	Before Immersion	After Immersion	Before Immersion	After Immersion	Before Immersion	After Immersion
1	1.0	.998	1.005	950.0	825.0	5,400	6,550.	6,100	6,150		
2	1.0	1.005	1.02	800.0	630.0	4,200	5,000.	20,000	5,300		
3	1.0	1.018	1.03	650.0	600.0	3,100	5,400.	4,600	5,300		
4	4.0	3.925	3.955	500.0	420.0	7,000	5,100.	6,500	5,100		
5	4.0	3.95	3.98	350.0	390.0	15,000	14,000.	15,000	7,300		
6	8.0	7.88	7.82	180.0	0.16	5,000	0.032	2,500	0.147		
7	8.0	7.82	*	120.0	0.025	5,000	1.200	2,000	1.200		

* No measurement obtainable

TABLE II

International Resistance Co.,
MW-4 Wire Wound Fixed Resistors

	Unit #1	Unit #2	Unit #3	Unit #4	Unit #5	Unit #6
Measured R prior to all tests(ohms)	9930	10,120	9960	10,200	10,060	10,050
R after Thermal Shock			9970	10,200		
R after Overload Test	9430	10,070				
I.m.s. (at 275.0 V)						
Preheat	29.2	27.15	27.5	26.95	27.35	27.4
Cycle 1	29.5	27.5	27.7	27.0	27.5	27.4
Cycle 2	29.75	27.5	27.8	27.0	27.5	27.5
Cycle 3	29.5	27.2	27.2	26.8	27.3	27.5
Cycle 4	29.75	27.5	27.5	27.0	27.5	27.5
Cycle 5	30.0	27.8	27.8	27.3	27.85	28.0
Cycle 6	30.0	27.8	27.5	27.2	27.8	27.9
Cycle 7	29.8	27.5	27.5	27.0	27.3	27.4
Cycle 8	29.8	27.6	27.5	27.2	27.3	27.4
Cycle 9	30.0	27.8	27.8	27.2	28.0	27.8
Cycle 10	29.5	27.5	27.5	27.0	27.4	27.5
Cycle 11	29.7	27.5	27.5	27.1	27.4	27.5

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TABLE III

SUMMATION OF MEASUREMENTS; ALLEN BRADLEY 20,000 OHM,
1 WATT RESISTORS

OVERLOAD TEST

	Unit #1	Unit #2	Unit #3	Unit #4	Unit #5
R before tests (bridge method)	19,400	19,800	19,080	20,310	19,600
R at 2% Load) Before	19,348	19,720	19,118	20,260	19,560
E * I) After	18,770	19,202	18,450	19,770	19,100

THERMAL SHOCK TEST

	Unit #6	Unit #7	Unit #8	Unit #9	Unit #10
R before tests (bridge method)	19,130.	19,080.	18,660.	19,150.	19,300.
W. at 65°C hot spot	.6357	.636	.654	.636	.630
R after shock (bridge method)	19,280.	19,200.	18,800.	19,300.	19,450.

SALT WATER IMMERSION TEST

	Unit #11	Unit #12	Unit #13	Unit #14	Unit #15
E (volts)	141.4	141.4	141.4	141.4	141.4
I (m.a.) Preheat	7.35	7.04	7.46	7.45	7.43
Cycle 1	7.34	7.03	7.45	7.44	7.44
Cycle 2	7.32	7.05	7.50	7.49	7.49
Cycle 3	7.40	7.06	7.47	7.48	7.44
Cycle 4	7.38	7.05	7.47	7.48	7.47
Cycle 5	7.35	7.03	7.47	7.49	7.48
Cycle 6	7.37	7.07	7.49	7.48	7.47
Cycle 7	7.36	7.03	7.45	7.45	7.44
Cycle 8	7.35	7.05	7.46	7.47	7.43
Cycle 9	7.38	7.05	7.49	7.48	7.47
Cycle 10	7.35	7.04	7.46	7.49	7.47

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TABLE IV

SUMMATION OF MEASUREMENTS; ALLEN BRADLEY 1/2 WATT RESISTORS

OVERLOAD TEST

	Unit #1	Unit #2	Unit #3	Unit #4	Unit #5	Unit #6
Rated R (ohms)	390.0	390.0	10,000	10,000	2.2 meg	2.2 meg
Measured R before tests (bridge)	387.3	390.4	10,430	10,320	2.25 meg	2.25 meg
R at 2% load) Before	386.47	389.35	10,369	10,265	2.434 meg	2.427 meg
E ÷ I) After	376.6	377.2	10,017	9,974	2.37 meg	2.35 meg

THERMAL SHOCK TEST

	Unit #7	Unit #8	Unit #9	Unit #10	Unit #11	Unit #12
Rated R (ohms)	390.0	390.0	10,000.	10,000.	2.2 meg	2.2 meg
Measured R before tests (bridge)	395.8	385.1	9,910.	10,420.	2.23 meg	2.2 meg
W at 65°C hot spot	.4973	.5116	.4192	.3955	.4371	.4427
R after shock (bridge method)	398.2	387.6	9,995	10,510	2.27 meg	2.25 meg

SALT WATER IMMERSION TEST

	Unit #7	Unit #8	Unit #9	Unit #10	Unit #11	Unit #12
E (volts)	13.97	13.97	70.7	70.7	1050.0	1050.0
I (m.a.) Preheat	34.2	35.2	7.25	6.88	.525	.535
Cycle 1	34.4	35.3	7.33	6.93	.519	.530
Cycle 2	34.3	35.3	7.27	6.88	.515	.527
Cycle 3	34.3	35.2	7.32	6.93	.510	.522
Cycle 4	34.0	35.0	7.32	6.91	.508	.522
Cycle 5	34.0	35.0	7.27	6.87	.507	.518
Cycle 6	33.9	35.0	7.25	6.83	.500	.514
Cycle 7	33.8	34.9	7.25	6.85	.496	.510
Cycle 8	33.8	34.9	7.25	6.87	.495	.510
Cycle 9	33.8	34.8	7.27	6.82	.493	.510
Cycle 10	33.7	34.8	7.20	6.78	.488	.510
Cycle 11	33.8	34.9	7.20	6.83	.485	.5035

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TABLE V

SUMMATION OF MEASUREMENTS: I. R. C. 1/2 WATT RESISTORS

OVERLOAD TEST

	Unit #1	Unit #2	Unit #3	Unit #4	Unit #5
Rated R (ohms)	15.0	15.0	62.0	150.0	150.0
R before tests (bridge method)	15.10	14.78	60.69	142.6	151.0
R at 2% load) Before	15.24	14.95	60.78	142.22	150.43
E + I) After	15.23	15.29	61.05	142.22	150.52

THERMAL SHOCK TEST

	Unit #6	Unit #7	Unit #8	Unit #9	Unit #10	Unit #11
Rated R (ohms)	15.0	15.0	62.0	62.0	150.0	150.0
R before tests (bridge method)	14.34	15.13	60.38	59.99	152.8	159.7
W at 65°C hotspot	.519	.498	.521	.526	.418	.401
R after shock (bridge method)	14.42	15.15	60.43	59.96	153.4	160.1

SALT WATER IMMERSION TESTS

	Unit #6	Unit #7	Unit #8	Unit #9	Unit #10	Unit #11
E (volts)	2.74	2.74	5.57	5.57	8.66	8.66
I (m.a.) Preheat	175.3	169.0	84.0	84.8	53.1	51.0
Cycle 1	174.5	169.3	88.0	80.5	53.2	51.2
Cycle 2	172.5	166.0	90.0	.016	53.2	51.2
Cycle 3	176.0	165.9	90.5	.016	53.0	50.8
Cycle 4	177.0	165.5	89.7	.008	52.9	50.8
Cycle 5	176.8	164.1	90.0	.007	52.7	50.4
Cycle 6	176.0	165.0	89.9	.005	52.9	50.5
Cycle 7	175.0	165.2	90.0	.002	52.7	49.9
Cycle 8	174.5	165.0	89.1	.003	52.7	49.6
Cycle 9	175.3	164.0	89.0	.003	52.5	49.0
Cycle 10	175.5	164.5	90.0	.003	52.3	48.8
Cycle 11	174.0	164.0	89.3	.003	52.4	48.8

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TABLE VI

SUMMATION OF MEASUREMENTS: WESTINGHOUSE LAMINATED IRON CORE AUDIO TRANSFORMERS

LEAKAGE RESISTANCES (megohms)

	Unit #1	Unit #2	Unit #3	Unit #4	
Prior to test	(Pri to case	120,000.	58,000.	200,000.	190,000.
	(Sec to case	160,000.	52,000.	57,000.	101,000.
	(Pri to Sec	180,000.	54,500.	150,000.	150,000.
End of Cycle 1	(Pri to case	85,000.	160,000.	180,000.	23,000.
	(Sec to case	85,000.	120,000.	70,000.	21,000.
	(Pri to Sec	170,000.	180,000.	110,000.	120,000.
End of Cycle 2	(Pri to case	440.	75,000.	180,000.	50,000.
	(Sec to case	70,000.	75,000.	190,000.	90,000.
	(Pri to Sec	200,000.	900,000.	100,000.	75,000.
End of Cycle 3	(Pri to case	32.	200,000.	190,000.	200,000.
	(Sec to case	10,000.	200,000.	100,000.	110,000.
	(Pri to Sec	10,000.	1,000,000.	1,000,000.	1,000,000.
End of Cycle 4	(Pri to case	.008	110,000.	190,000.	130,000.
	(Sec to case	3.0	190,000.	120,000.	100,000.
	(Pri to Sec	8.0	1,000,000.	1,000,000.	1,000,000.
End of Cycle 5	(Pri to case	.027	1,800.	7,500.	4,400.
	(Sec to case	1.0	3,100.	7,500.	11,000.
	(Pri to Sec	0.75	3,600.	10,000.	15,000.

WINDING RESISTANCES (ohms)

Prior to Test	(Primary	550.0	557.5	595.0	594.0
	(Secondary	18.24	18.53	20.1	19.53
End of Cycle 1	(Primary	560.6	567.2	600.5	604.4
	(Secondary	19.58	18.84	20.30	19.87
End of Cycle 2	(Primary	552.6	560.0	592.4	594.8
	(Secondary	18.31	18.59	20.04	19.57
End of Cycle 3	(Primary	548.5	556.0	587.7	590.9
	(Secondary	18.18	18.47	19.89	19.44
End of Cycle 4	(Primary	551.0	558.1	589.5	593.1
	(Secondary	18.24	18.50	19.92	19.49
End of Cycle 5	(Primary	548.5	555.5	587.8	591.2
	(Secondary	18.20	18.45	19.88	19.42

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TABLE VII

SUMMATION OF MEASUREMENTS: WESTINGHOUSE LAMINATED IRON CORE AUDIO FILTER INDUCTORS

LEAKAGE RESISTANCE (megohms)

	Unit #1	Unit #2	Unit #3	Unit #4
Prior to test	14,000	7,000	2,100	75,000
End of cycle 1	1,780	40,000	5,500	190,000
End of cycle 2	950	37,000	602	100,000
End of cycle 3	*	38,000	10,000	150,000
End of cycle 4	130	20,000	10,000	19,000
End of cycle 5	100	1,700	5,000	16,000

WINDING RESISTANCE (ohms)

Prior to test	2384	2515	2625	2199
End of cycle 1	2386	2515	2626	2199
End of cycle 2	2357	2486	2597	2174
End of cycle 3	2339	2466	2574	2154
End of cycle 4	2346	2476	2584	2165
End of cycle 5	2336	2466	2571	2155

* Below .08 megohm, lower limit of General Radio Megohm Bridge



TABLE VIII

SUMMATION OF MEASUREMENTS: WESTINGHOUSE LAMINATED IRON CORE FILTER REACTORS

LEAKAGE RESISTANCES (Megohms)

	Unit #1	Unit #2	Unit #3	Unit #4	Unit #5	Unit #6	Unit #7	Unit #8
Inductance (Henries)	4.0	4.0	4.0	4.0	5.0	5.0	10.0	10.0
Before tests	200,000.	200,000.	300,000.	300,000.	1,000,000.	1,000,000.	1,000,000.	1,000,000.
End of cycle 1	300,000.	300,000.	490,000.	200,000.	200,000.	200,000.	300,000.	300,000.
End of cycle 2	190,000.	110,000.	200,000.	100,000.	190,000.	160,000.	180,000.	*
End of cycle 3	500,000.	200,000.	500,000.	400,000.	1,000,000.	1,000,000.	25,000.	--
End of cycle 4	240,000.	190,000.	240,000.	220,000.	210,000.	240,000.	5,800.	--
End of cycle 5	20,000.	22,000.	48,000.	27,000.	15,000.	149,000.	.13	--

* Below .08 megohms

WINDING RESISTANCES (ohms)

Before tests	301.6	299.9	301.6	298.5	101.2	95.9	141.6	131.4
End of cycle 1	297.5	295.8	297.6	294.4	100.0	94.8	140.1	130.0
End of cycle 2	298.6	296.8	298.5	295.3	100.3	95.4	140.6	**
End of cycle 3	296.6	294.6	296.6	293.0	99.6	94.3	139.5	
End of cycle 4	297.1	295.1	297.1	293.9	99.9	94.8	139.8	
End of cycle 5	296.0	294.2	296.0	292.8	99.4	94.2	139.7	

** Open circuited

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TABLE IX

SUMMATION OF MEASUREMENTS; WESTINGHOUSE FILAMENT TRANSFORMERS

LEAKAGE RESISTANCES (megohms)

	60 cycles		25 cycles	
	Unit #1	Unit #2	Unit #1	Unit #2
Prior to test (Pri to case)	100,000.	200,000.	200,000.	3,000.
Prior to test (Sec to case)	100,000.	200,000.	200,000.	6,000.
Prior to test (Pri to sec)	200,000.	190,000.	100,000.	10,000.
End of cycle 1 (Pri to case)	600.	3,300.	1,000,000.	3,000.
End of cycle 1 (Sec to case)	5,200.	7,800.	1,000,000.	7,000.
End of cycle 1 (Pri to sec)	5,500.	8,200.	200,000.	7,500.
End of cycle 2 (Pri to case)	1,400.	1,850.	500,000.	2,300.
End of cycle 2 (Sec to case)	100,000.	100,000.	500,000.	2,300.
End of cycle 2 (Pri to sec)	20,000.	100,000.	200,000.	2,400.
End of cycle 3 (Pri to case)	22,000.	650,000.	200,000.	1,600.
End of cycle 3 (Sec to case)	41,000.	800,000.	200,000.	1,300.
End of cycle 3 (Pri to sec)	200,000.	100,000.	100,000.	1,400.
End of cycle 4 (Pri to case)	46,000.	45,000.	3,600.	700.
End of cycle 4 (Sec to case)	59,000.	52,000.	2,100.	430.
End of cycle 4 (Pri to sec)	200,000.	24,000.	2,400.	550.
End of cycle 5 (Pri to case)	48,000.	610.	150,000.	385.
End of cycle 5 (Sec to case)	110,000.	2,900.	150,000.	280.
End of cycle 5 (Pri to sec)	400,000.	3,000.	150,000.	290.

WINDING RESISTANCES (ohms)

Prior to test (Pri)	68.60	66.60	85.5	85.4
Prior to test (Sec)	.869	.880	1.297	1.337
End of cycle 1 (Pri)	68.35	66.31	85.4	85.4
End of cycle 1 (Sec)	.866	.876	1.294	1.337
End of cycle 2 (Pri)	68.00	65.89	85.6	85.75
End of cycle 2 (Sec)	.866	.877	1.298	1.344
End of cycle 3 (Pri)	68.31	66.17	84.92	85.0
End of cycle 3 (Sec)	.866	.876	1.288	1.333
End of cycle 4 (Pri)	68.47	66.35	85.08	85.22
End of cycle 4 (Sec)	.866	.876	1.291	1.336
End of cycle 5 (Pri)	68.13	65.99	85.84	85.99
End of cycle 5 (Sec)	.866	.875	1.302	1.349

TABLE X

RAYTHEON 60 CYCLE POWER TRANSFORMERS

LEAKAGE RESISTANCE IN MEGOHMS
HUMIDITY TEST

	1st Cycle	2nd Cycle
	Sample 1	
Pri to Case	65,000.	50,000.
12 V. Sec. to Case	65,000.	35,000.
5 V. Sec. to Case	630.	2.5
H. V. Sec. to Case	.48	.016
H. V. Sec. to Pri.	65,000.	40,000.
H. V. Sec. to 5 V. Sec.	700.	.6
H. V. Sec. to 12 V. Sec.	75,000.	40,000.
5 V. Sec. to 12 V. Sec.	80,000.	30,000.
5 V. Sec. to Pri.	65,000.	30,000.
12 V. Sec. to Pri.	150,000.	180,000.
	Sample 2	
Pri to Case	7,500.	37,000.
12 V. Sec. to Case	17.	11.
5 V. Sec. to Case	100.	.073
H. V. Sec. to Case	10,000.	.012
H. V. Sec. to Pri.	40,000.	16,000.
H. V. Sec. to 5 V. Sec.	11,000.	.2
H. V. Sec. to 12 V. Sec.	11,000.	12.
5 V. Sec. to 12 V. Sec.	100.	11.
5 V. Sec. to Pri.	10,000.	20,000.
12 V. Sec. to Pri.	6,500.	25,000.

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TABLE XI

RAYTHEON 60 CYCLE POWER TRANSFORMERS

WINDING RESISTANCES

Sample #1

	Prior to Test	1st Cycle	2nd Cycle
Primary	1.733	1.716	1.732
12 V. Sec.	.129	.128	.130
5 V. Sec.	.0525	.0520	.0533
High V. Sec.	86.1	85.27	86.0

Sample #2

Primary	1.751	1.714	1.729
12 V. Sec.	.131	.128	.130
5 V. Sec.	.0533	.052	.053
High V. Sec.	87.3	85.4	86.09

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TABLE XII

RAYTHEON 25 CYCLE POWER TRANSFORMERS

LEAKAGE RESISTANCE IN MEGOHMS
HUMIDITY TEST

	1st Cycle	2nd Cycle	3rd Cycle
		Sample #1	
Pri. to Case	40,000.	50,000	25,000.
12 V. Sec. to Case	4,000.	1,600	130.
5 V. Sec. to Case	3,400.	46	7.
H. V. Sec. to Case	4,000.	1,800	90.
H. V. Sec. to Pri.	40,000.	45,000	1,400.
H. V. Sec. to 5 V. Sec.	5,300.	1,800	100.
H. V. Sec. to 12 V. Sec.	9,000.	3,100	220.
5 V. Sec. to 12 V. Sec.	4,800.	1,600	140.
5 V. Sec. to Pri.	35,000.	40,000	17,000.
12 V. Sec. to Pri.	50,000.	75,000	22,000.
		Sample #2	
Pri. to Case	2,500.	1,000	40.0
12 V. Sec. to Case	24.5	3	.7
5 V. Sec. to Case	15,000.	50,000	1,008.
H. V. Sec. to Case	2,800.	680	410.
H. V. Sec. to Pri.	6,000.	2,800	420.
H. V. Sec. to 5 V. Sec.	23,000.	75,000	2,000.
H. V. Sec. to 12 V. Sec.	2,000.	1,000	400.
5 V. Sec. to 12 V. Sec.	23,000.	28,000	3,300.
5 V. Sec. to Pri.	32,000.	40,000	3,000.
12 V. Sec. to Pri.	1,900.	850	75.

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TABLE XIII

RAYTHEON 25 CYCLE POWER TRANSFORMERS

WINDING RESISTANCES

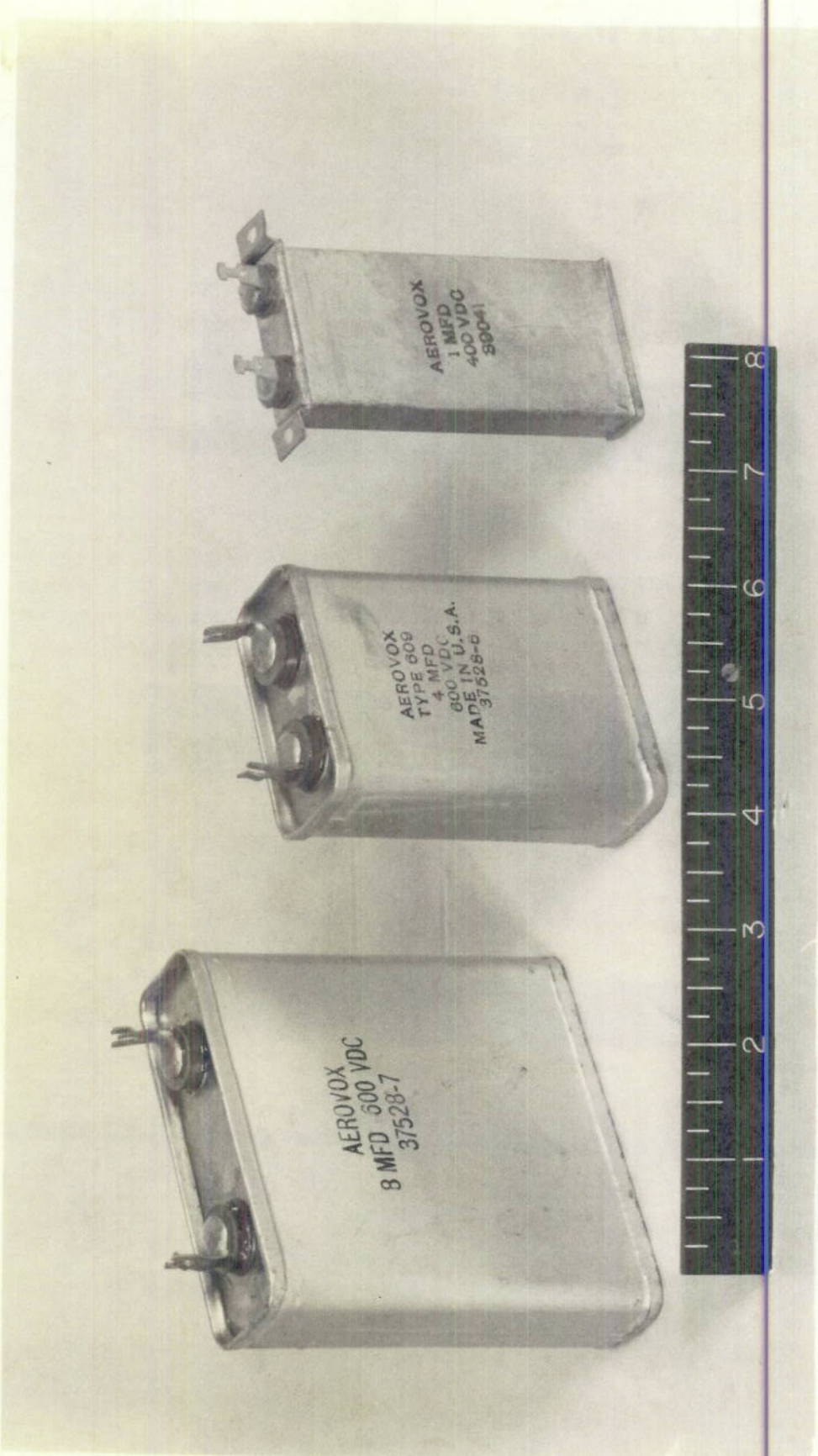
Sample #1

	Prior to test	1st Cycle	2nd Cycle	3rd Cycle
Primary	2.426	2.409	2.410	2.420
12 V. Sec.	.176	.1750	.1755	.176
5 V. Sec.	.0645	.0640	.0645	.065
High V. Sec.	94.8	94.01	94.2	94.50

Sample #2

Primary	2.400	2.352	2.356	2.369
12 V. Sec.	.1732	.1695	.1705	.171
5 V. Sec.	.0658	.0643	.065	.0650
High V. Sec.	93.7	91.9	91.91	92.47

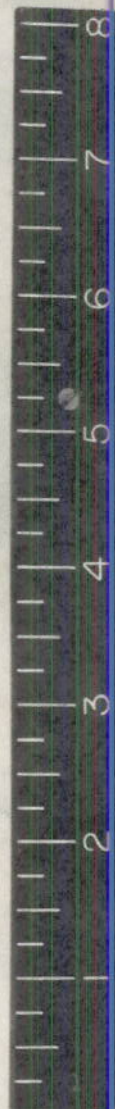
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AEROVOX
1 MFD
400 VDC
50041

AEROVOX
TYPE 609
4 MFD
600 VDC
MADE IN U.S.A.
37528-6

AEROVOX
8 MFD 500 VDC
37528-7



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PLATE I

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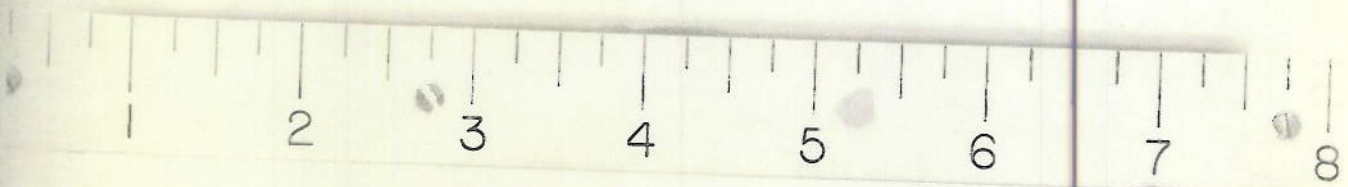
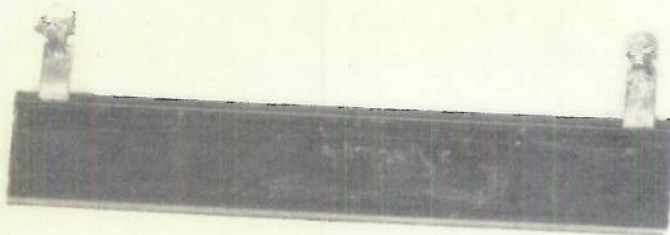
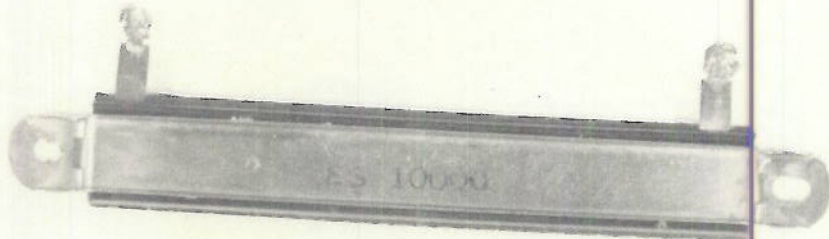


PLATE 2

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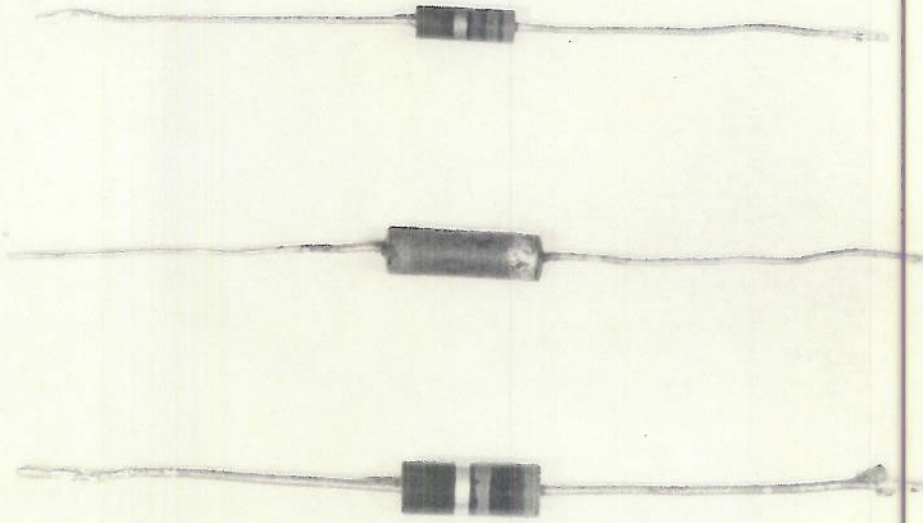
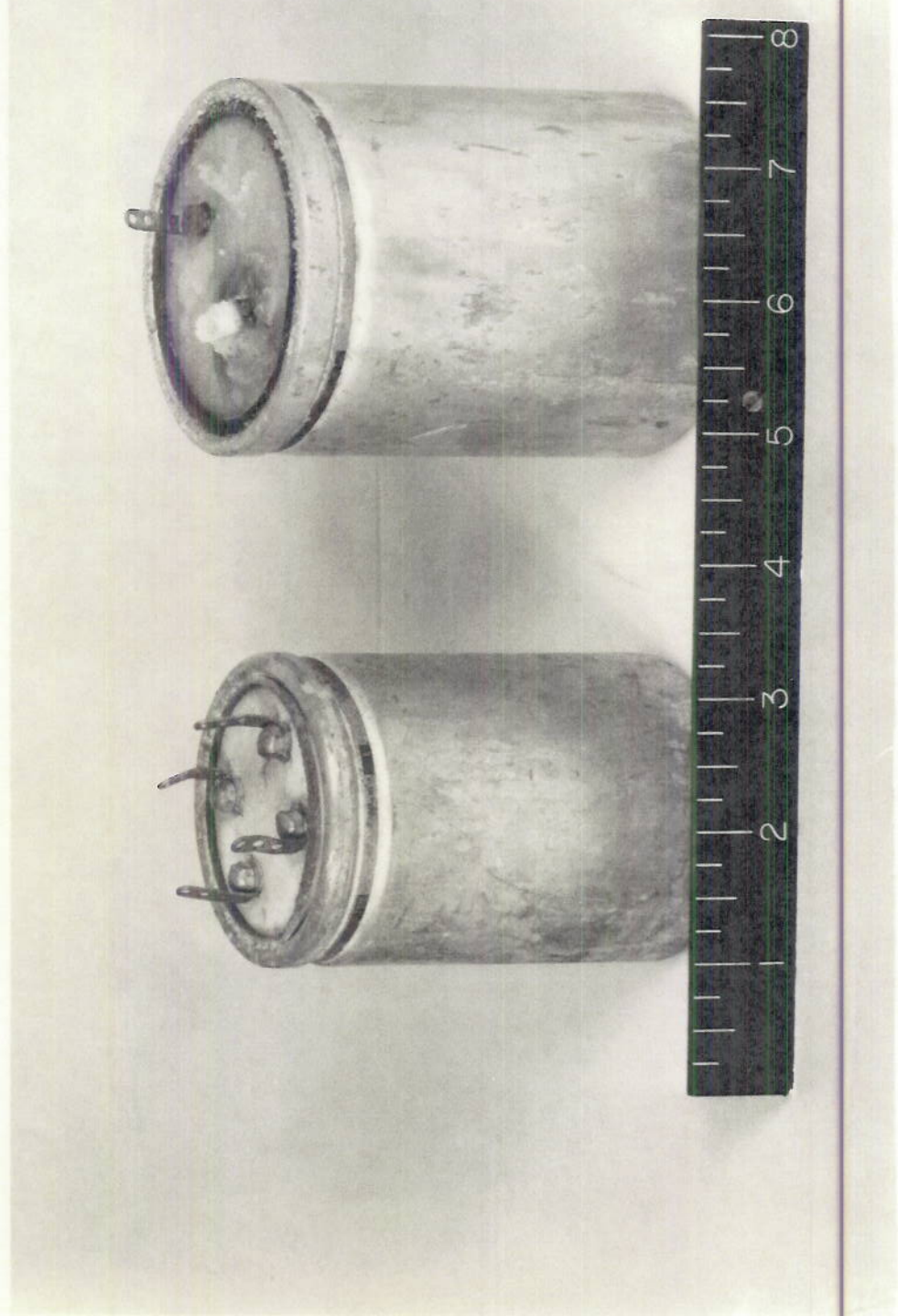


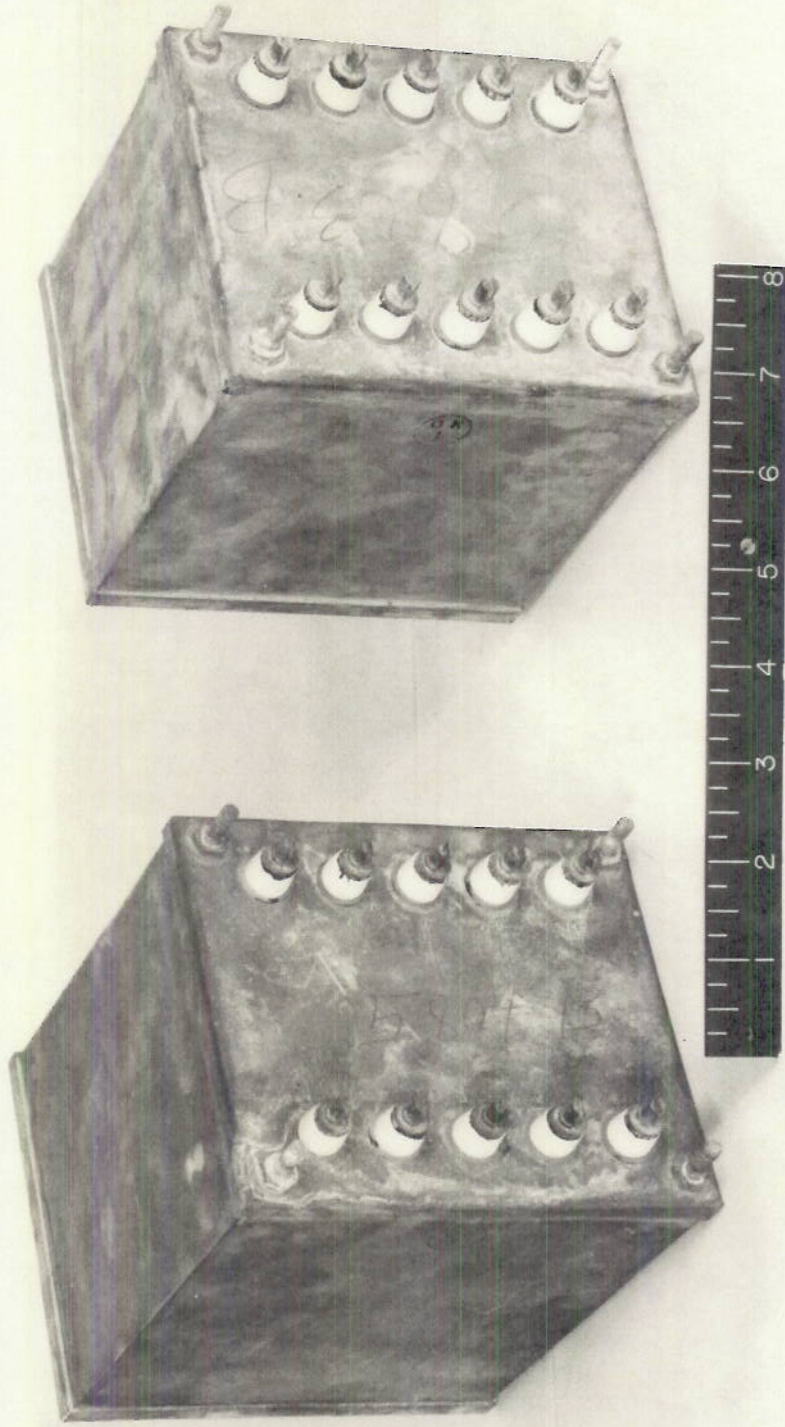
PLATE 3

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PLATE 4



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PLATE 5