MIL-R-93D
28 December 1965
SUPERSEDING
MIL-R-93C
12 June 1961
MIL-R-14262(SigC)
28 February 1956
MIL-R-9444A(USAF)
20 July 1959

MILITARY SPECIFICATION

RESISTORS, FIXED, WIRE-WOUND (ACCURATE), GENERAL SPECIFICATION FOR

This specification is mandatory for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the general requirements for accurate, wire-wound, fixed resistors having a maximum resistance tolerance of 1 percent, with the windings suitably protected against high humidity. The resistors are suitable for continuous full-load operation at any ambient temperature up to 125° C, and derated up to 145° C (see figure 3). They are not suitable for application where alternating current (ac) characteristics are of critical importance. A table which provides a summary of performance characteristics for this type of resistor is included in supplement 1.

1.2 Classification.

1.2.1 Type designation. The type designation shall be in the following form, and as specified (see 3.1 and 6.1):

RB08	C	E	12701	D
Style (1.2.1.1.)	Characteristic and terminal (1.2.1.2)	Resistance-temperature characteristic (1.2.1.3)	Resistance (1.2.1.4)	Resistance tolerance (1.2.1.5)

1.2.1.1 Style. The style is identified by the two-letter symbol RB followed by a two-digit number; the letters identify accurate, wire-wound, fixed resistors, and the number identifies the size and power rating of the resistor.

1.2.1.2 Characteristic and terminal. The characteristic and terminal are identified by a single letter in accordance with table I.

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TABLE I. Temperature characteristic and terminal.

Symbol	Terminal	Maximum ambient temperature at rated wattage (see fig. 3)	Maximum ambient temperature (at zero percent rated wattage dissipation) (see fig. 3)
C	Solderable 1/	125° C	145° C
W	Weldable	125° C	145° C

1/ Applicable to both lug type and axial wire lead terminals.

1.2.1.3 Resistance-temperature characteristic. The resistance-temperature characteristic is identified by a single letter in accordance with table II (see 6.9.2).

TABLE II. Resistance-temperature characteristic (in parts per million per °C (PPM/°C) (referred to an ambient of 25° C).

Symbol	Below 1 ohm	1 ohm to 10 ohms—(excluding 10 ohms)	10 ohms and above
E - - - - -	±90 PPM	±50 PPM	±20 PPM

1.2.1.4 Resistance. The nominal resistance expressed in absolute ohms (1 absolute ohm = 0.99951 international ohm) is identified by five digits; the first four digits represent significant figures and the last digit specifies the number of zeroes to follow. When the values of resistance is less than 1,000 ohms, or when fractional values of an ohm are required, the letter R is substituted for one of the significant digits to represent the decimal point. When the letter R is used, succeeding digits of the group represent significant figures. The resistance-value designations are shown in tables III and IV, as applicable. Minimum and maximum resistance values shall be as specified (see 3.1). The standard resistance values for every decade shall follow the sequence demonstrated for 10 to 100 decade in table V. The resistance values for the .05 percent and 0.1 percent resistance tolerances may be of any value (within limits of this specification (see 3.1)), however, it is preferred that the values be chosen from the 192 series decade specified for resistance tolerance D. Except as noted herein, and in 1.2.1.4.1, resistance values not listed in table V shall be considered as not conforming to the specification.

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TABLE III. Designation of resistance values. 1/

Designation	Resistance value			
	Ohms			
R1000 to R9880, incl	0.100	to	0.9880,	incl
1R000 to 9R880, incl	1.000	to	9.880,	incl
10R00 to 98R80, incl	10.00	to	98.80,	incl
100R0 to 988R0, incl	100.0	to	988.0,	incl
10000 to 98800, incl	1,000	to	9,880,	incl
10001 to 98801, incl	10,000	to	98,800,	incl
10002 to 98802, incl	100,000	to	988,000,	incl
10003 to maximum	1,000,000	to	maximum	

1/See applicable detail specification for minimum and maximum values.

1.2.1.4.1 Replacement or maintenance (not applicable to .05 percent tolerance). It is preferred that resistance values be selected as specified in table V. However, if it is impracticable to do so, then any value (within specification limits) may be specified and these values shall be considered as conforming to the specification (see table IV.)

TABLE IV. Designation of resistance values. 1/

Designation	Resistance value			
	Ohms			
R1000 to R9999, incl	2/ 0.100		0.9999,	incl
1R000 to 9R999, incl	1.000	to	9.999,	incl
10R00 to 99R99, incl	2/ 10.00	to	99.99,	incl
100R0 to 999R9, incl	100.0	to	999.9,	incl
10000 to 99990, incl	1,000	to	9,999,	incl
10001 to 99991, incl	10,000	to	99,999,	incl
10002 to 99992, incl	100,000	to	999,999,	incl
10003 to maximum	1,000,000	to	maximum	

1/Applicable to 0.1-percent resistance tolerance and for replacement and maintenance, as required (see 1.2.1.4.1).

2/See applicable detail specification for applicable minimum and maximum values .

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TABLE V. Standard resistance values for the 10 to 100 decade.

Resistance tolerance

D (0.5)	F (1.0)	D (0.5)	F (1.0)	D (0.5)	F (1.0)	D (0.5)	F (1.0)	D (0.5)	F (1.0)	D (0.5)	F (1.0)
10.00	10.00	14.70	14.70	21.50	21.50	31.60	31.60	46.40	46.40	68.10	68.10
10.10	.....	14.90	.....	21.80	.....	32.00	.....	47.00	.....	69.00	.....
10.20	10.20	15.00	15.00	22.10	22.10	32.40	32.40	47.50	47.50	69.80	69.80
10.40	.....	15.20	.....	22.30	.....	32.80	.....	48.10	.....	70.60	.....
10.50	10.50	15.40	15.40	22.60	22.60	33.20	33.20	48.70	48.70	71.50	71.50
10.60	.....	15.60	.....	22.90	.....	33.60	.....	49.30	.....	72.30	.....
10.70	10.70	15.80	15.80	23.20	23.20	34.00	34.00	49.90	49.90	73.20	73.20
10.90	.....	16.00	.....	23.40	.....	34.40	.....	50.50	.....	74.10	.....
11.00	11.00	16.20	16.20	23.70	23.70	34.80	34.80	51.10	51.10	75.00	75.00
11.10	.....	16.40	.....	24.00	.....	35.20	.....	51.70	.....	75.90	.....
11.30	11.30	16.50	16.50	24.30	24.30	35.70	35.70	52.30	52.30	76.80	76.80
11.40	.....	16.70	.....	24.60	.....	36.10	.....	53.00	.....	77.70	.....
11.50	11.50	16.90	16.90	24.90	24.90	36.50	36.50	53.60	53.60	78.70	78.70
11.70	.....	17.20	.....	25.20	.....	37.00	.....	54.20	.....	79.60	.....
11.80	11.80	17.40	17.40	25.50	25.50	37.40	37.40	54.90	54.90	80.60	80.60
12.00	.....	17.60	.....	25.80	.....	37.90	.....	55.60	.....	81.60	.....
12.10	12.10	17.80	17.80	26.10	26.10	38.30	38.30	56.20	56.20	82.50	82.50
12.30	.....	18.00	.....	26.40	.....	38.80	.....	56.90	.....	83.50	.....
12.40	12.40	18.20	18.20	26.70	26.70	39.20	39.20	57.60	57.60	84.50	84.50
12.60	.....	18.40	.....	27.10	.....	39.70	.....	58.30	.....	85.60	.....
12.70	12.70	18.70	18.70	27.40	27.40	40.20	40.20	59.00	59.00	86.60	86.60
12.90	.....	18.90	.....	27.70	.....	40.70	.....	59.70	.....	87.60	.....
13.00	13.00	19.10	19.10	28.00	28.00	41.20	41.20	60.40	60.40	88.70	88.70
13.20	.....	19.30	.....	28.40	.....	41.70	.....	61.20	.....	89.80	.....
13.30	13.30	19.60	19.60	28.70	28.70	42.20	42.20	61.90	61.90	90.90	90.90
13.50	.....	19.80	.....	29.10	.....	42.70	.....	62.60	.....	92.00	.....
13.70	13.70	20.00	20.00	29.40	29.40	43.20	43.20	63.40	63.40	93.10	93.10
13.80	.....	20.30	.....	29.80	.....	43.70	.....	64.20	.....	94.20	.....
14.00	14.00	20.50	20.50	30.10	30.10	44.20	44.20	64.90	64.90	95.30	95.30
14.20	.....	20.80	.....	30.50	.....	44.80	.....	65.70	.....	96.50	.....
14.30	14.30	21.00	21.00	30.90	30.90	45.30	45.30	66.50	66.50	97.60	97.60
14.50	.....	21.30	.....	31.20	.....	45.90	.....	67.30	.....	98.80	.....

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1.2.1.5 Initial-resistance tolerance. The initial-resistance tolerance is identified by a single letter in accordance with table VI. For applicable minimum resistance values see 3.1.

TABLE VI. Initial-resistance tolerance.

Symbol	Initial-resistance tolerance
	Percent (±)
A	0.05
B	0.10
D	0.50
F	1.00

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

P-D-680 - Dry Cleaning Solvent.
TT-I-735 - Isopropyl Alcohol.
PPP-B-566 - Boxes, Folding, Paperboard.
PPP-B-636 - Box, Fiberboard.
PPP-B-676 - Boxes, Setup
PPP-T-60 - Tape: Pressure-Sensitive Adhesive, Waterproof, for Packaging.
PPP-T-76 - Tape, Pressure-Sensitive Adhesive, Paper (for Carton Sealing).

MILITARY

MIL-P-116 - Preservation, Methods of.

(See supplement 1 for applicable detail specifications.)

STANDARDS

MILITARY

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-129 - Marking for Shipment and Storage.
MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts.

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MIL-STD-810(USAF) - Enviornmental Test Methods for Aerospace and Ground Equipment.
MIL-STD-1276 - Leads, Weldable, for Electronic Component Parts.

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 Detail requirements for individual resistor types. The individual part requirements shall be as specified herein and in accordance with the applicable detail specifications. In the event of any conflict between requirements of this specification and the detail specifications, the latter shall govern (see 6.1).

3.2 Qualification. Resistors furnished under this specification shall be a product which has been tested, and passed the qualification tests specified in 4.4, and has been listed on or approved for listing on the applicable qualified products list (see 6.2). In addition, the periodic submission of groups A, B, and C data to the qualifying activity, is required in order to retain qualification (see 4.5.3).

3.3 Material. The material shall be as specified herein. However, when a definite material is not specified, a material shall be used which will enable the resistors to meet the performance requirements of this specification. Acceptance or approval of any constituent material shall not be construed as a guaranty of the acceptance of the finished product.

3.4 Design and construction. Resistors shall be of the design, construction, and physical dimensions specified (see 3.1). The resistor assembly shall be protected by a coating or enclosure of moisture-resistant insulating material which will withstand exposure to the humidity and temperature conditions specified herein. Unless otherwise specified (see 3.1), in order to minimize inductance, resistors shall be wound by one of the following methods:

(a) Reverse pi-winding.
(b) Bifilar.
(c) Ayrton-Perry.

3.4.1 Terminals.

3.4.1.1 Lug terminals. Lug terminals shall be designed to permit the secure crimping or hooking of 0.064-inch diameter (No. 14 AWG) wire and shall not depend upon soldering for mechanical strength.

3.4.1.2 Wire lead terminals. Wire lead terminals shall be made of a solid conductor of the length and diameter specified. The termination of element to terminal shall not depend on solder or welding alone to attain mechanical strength.

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3.4.1.2.1 Solderable terminals. Solderable leads shall be suitably treated to meet the requirements of solderability (see 3.8). When a tin lead solder coating is used, the tin content shall range between 40 and 70 percent.

3.4.1.2.2 Weldable wire leads (not applicable to lug type). Weldable leads shall be type N-1 of MIL-STD-1276. The supplier shall verify by certification that the weldable leads meet all requirements of type N-1 of MIL-STD-1276.

3.4.2 Windings. Each resistor shall be wound with a conductor having no joints, welds, or bonds within each terminated resistance element, except for a splice at the midpoint of any bifilar winding and at end terminals.

3.4.2.1 Resistance wire. Resistance wire shall possess a substantially uniform cross section of conductor and insulation. The wire shall be as free as practicable from particles of impurity or other factors contributing to spot weakness. The cross-sectional area of the wire shall be the maximum consistent with other requirements of this specification. The supplier shall verify by certification that the conductor nominal diameter shall in no case be smaller than 0.001 inch nominal (0.0009 inch absolute minimum diameter). Wire abrasion is not permitted where the resistance wire is less than 0.002 inch nominal (0.0018 absolute) diameter.

3.4.3 Protective coating or enclosure. Resistor assemblies shall be protected by a coating or enclosure of moisture-resistant insulating material which shall completely cover the exterior of the resistance element including connections or terminations of the resistance element. This material shall afford adequate protection against the effects of prolonged exposure to high humidities. The protective coating or enclosure shall be such as to minimize the establishment of leakage paths between the terminals, resulting from collection of moisture film on the exterior surface of the resistor.

3.4.4 Impregnation. The impregnating compound shall not drip, run, or form globules at any temperature up to and including 145° C, regardless of the mounting position of the resistor (see 4.6.13).

3.5 DC resistance. When resistors are tested as specified in 4.6.1, the dc resistance shall be expressed in absolute ohms (see 1.2.1.4) and shall be within the specified initial resistance tolerance of the nominal resistance (see 1.2.1.5).

3.6 Short-time overload. When resistors are tested as specified in 4.6.3, there shall be no evidence of arcing, burning, or charring. The change in resistance shall not exceed the initial resistance tolerance specified in the type designation (see 1.2.1.5) or ±(0.1 percent +0.05 ohm), whichever is smaller.

3.7 Temperature cycling. When resistors are tested as specified in 4.6.4, there shall be no evidence of mechanical damage. The change in resistance shall not exceed ±(0.2 percent +0.05 ohm).

3.8 Solderability (not applicable to terminal type W). When resistors are tested as specified in 4.6.5, they shall meet the applicable criteria for terminal evaluation in the referenced test method.

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3.9 Resistance to solvents. When resistors are tested as specified in 4.6.6, there shall be no evidence of mechanical damage and the marking shall remain legible.

3.10 Insulation resistance. When resistors are tested as specified in 4.6.7, the insulation resistance shall be not less than 1,000 megohms.

3.11 Moisture resistance. When resistors are tested as specified in 4.6.8, there shall be no evidence of breaking, cracking, spalling, or loosening of terminals or mounting hardware. The final insulation resistance shall be not less than 100 megohms. The change in resistance between the initial and final resistance measurements shall not exceed ±(1.0 percent +0.05 ohm) for styles RB70 and RB71, and ±(0.25 percent +0.05 ohm) for all other styles.

3.12 Dielectric withstanding voltage. When resistors are tested as specified 4.6.9, there shall be no evidence of flashover, mechanical damage, arcing, or insulation breakdown. The change in resistance shall not exceed ±(0.05 percent +0.05 ohm).

3.13 Terminal strength.

3.13.1 Lug-terminal resistors. When resistors are tested as specified in 4.6.10, the terminals shall remain securely fastened to the form resisting the specified pull without damage; the resistance element shall remain securely connected mechanically and electrically to the terminals in such a manner that the normal movement of the terminals shall not result in strain, wear, or damage to the element, coating, or enclosure. The change in resistance shall not exceed ±(0.05 percent +0.05 ohm).

3.13.2 Wire-lead-terminal resistors. When resistors are tested as specified in 4.6.10, there shall be no break in the wire-lead terminals; the resistance element shall remain securely connected mechanically and electrically to the terminals in such a manner that the normal movement of the terminals shall not result in strain, wear, or damage to the element, coating, or enclosure. The change in resistance shall not exceed ±(0.05 percent +0.05 ohm).

3.14 Salt-water-immersion cycling. When resistors are tested as specified in 4.6.11, they shall withstand the five cycles of immersion without visible damage to the coating, enclosure, or other parts of the resistor. The change in resistance between the initial resistance measurement and any of the succeeding measurements made at the end of each cycle shall not exceed ±(0.25 percent +0.05 ohm).

3.15 Life. When resistors are tested as specified in 4.6.12, there shall be no evidence of mechanical damage to the resistance element, coating, or enclosure. The change in resistance between the initial resistance measurement and any succeeding measurement shall not exceed ±(0.5 percent +0.05 ohm).

3.16 Resistance-temperature characteristic. When resistors are tested as specified in 4.6.13, the resistance-temperature characteristic referred to an ambient temperature of 25° C shall not exceed the value specified in table II.

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3.17 Low-temperature storage. When resistors are tested as specified in 4.6.14, there shall be no evidence of mechanical damage. The change in resistance between the initial and final resistance measurements at 25° ± 5° C shall not exceed ±(0.2 percent +0.05 ohm).

3.18 Low-temperature operation. When resistors are tested as specified in 4.6.15, there shall be no evidence of mechanical damage. The change in resistance between the initial and final resistance measurements at 25°±5° C shall not exceed ±(0.25 percent +0.05 ohm).

3.19 High-temperature exposure. When resistors are tested as specified in 4.6.16, there shall be no damage or loosening under a mounting bolt, where applicable. The change in resistance shall not exceed ±(0.5 percent +0.05 ohm).

3.20 Shock, medium impact. When resistors are tested as specified in 4.6.17, there shall be no evidence of mechanical or electrical damage. The change in resistance shall not exceed ±(0.1 percent +0.05 ohm). There shall be no electrical discontinuity during the test.

3.21 Vibration, high frequency. When resistors are tested as specified in 4.6.18, there shall be no evidence of mechanical or electrical damage. The change in resistance shall not exceed ±(0.1 percent +0.05 ohm). There shall be no electrical discontinuity during the test.

3.22 Fungus. All external materials shall be non-nutrient to fungus growth or shall be suitably treated to retard fungus growth. ~~The supplier shall verify~~ by certification that all external materials are fungus resistant or shall test the resistors as specified in 4.6.19. There shall be no evidence of fungus growth.

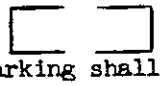
3.23 Marking. Resistors shall be marked with the type designation (see 6.1), and the manufacturer's name, trademark, or code symbol. If space permits, the resistance value in absolute ohms, the initial resistance tolerance, the rated or maximum voltage or the power rating, as applicable, shall also be marked. There shall be no space between the symbols which comprise the type designation. If lack of space requires it, the type designation shall be divided between the resistance-temperature characteristic letter and the first digit of the resistance value, as shown in the following example:

RB08CE
12701D

Marking shall remain legible at the end of all tests (see 3.9).

3.23.1 Designation marking of resistance values for .05 percent resistance tolerances. The designation of resistance values for resistance tolerances of .05 percent, when used with nondecade resistance values shall be as follows:

RB52CE- - - - - A



The nominal ohmic values shall be marked below the broken line. If two lines are used, the marking shall be below the bottom line.

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3.24 Workmanship. Resistors shall be processed in such a manner as to be uniform in quality and shall meet the requirements of 3.3 to 3.4.4, incl, 3.21, and 3.23.1 to 3.23.2, incl, as applicable, and shall be free from other defects that will affect life, serviceability, or appearance.

3.24.1 Soldering. When soldering is employed, only substantially noncorrosive fluxes shall be used, unless it can be shown that corrosive elements have been satisfactorily removed after soldering. Solder shall not be used primarily for obtaining mechanical strength. Electrical connections shall be mechanically secure before and electrically continuous after soldering. In no case shall the solder used, start to melt at a temperature less than 180° C.

3.24.2 Welding and brazing. When welding or brazing is employed, the electrical connections shall be mechanically secure and electrically continuous after welding or brazing. When brazing is employed, only substantially noncorrosive fluxes shall be used, unless it can be shown that corrosive elements have been satisfactorily removed after brazing.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection.

4.1.1 Supplier. The supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own or any other inspection facilities and services acceptable to the Government. Inspection records of the examination and tests shall be kept complete and available to the Government as specified in the contract or order. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1.1 Test equipment and inspection facilities. Test equipment and inspection facilities shall be of sufficient accuracy, quality, and quantity to permit performance of the required inspection. The supplier shall establish calibration of inspection equipment to the satisfaction of the Government.

4.2 Classification of inspection. The examination and testing of resistors shall be classified as follows:

(a) Qualification inspection (see 4.4).
(b) Quality conformance inspection (see 4.5).
    1. Inspection of product for delivery (see 4.5.1).
    2. Inspection of preparation for delivery (see 4.5.2).

4.3 Inspection conditions and precautions.

4.3.1 Conditions. Unless otherwise specified herein, all inspection shall be in accordance with the general requirements of MIL-STD-202.

4.3.2 Methods and precautions. Adequate precautions shall be taken during inspection to prevent condensation of moisture on resistors, except during the rated moisture-resistance test. The theoretically calculated rated continuous working voltage or the voltage equivalent to power rating (rated wattage) shall be

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determined from the following formula:

$$E = \sqrt{PR}$$

where E = Rated dc, or root mean square (rms) ac continuous working voltage at commercial line frequency and waveform.
P = Power rating (see 3.1).
R = Nominal total resistance.

In no case shall the rated dc or rms (ac) continuous working voltage be greater than the applicable maximum value (see 3.1).

4.4 Qualification inspection. Qualification inspection shall be performed at a laboratory acceptable to the Government (see 6.2).

4.4.1 Sample. The number of sample units comprising a sample of resistors to be submitted for qualification inspection shall be as specified in the appendix of this specification.

4.4.2 Test routine. Sample units shall be subjected to the qualification inspection specified in table VII, in the order shown. All coated or enclosed sample units with exception of group IA samples shall be subjected to the inspection of group I. The remaining 30 coated or enclosed sample units shall then be divided as specified in table XV, for groups II to VI, inclusive, and subjected to the inspection for their particular group. The 2 uncoated or unenclosed sample units shall be subjected to the visual and mechanical examination of group VII only.

4.4.3 Defectives. Defectives in excess of those allowed in table VII, shall be cause for refusal to grant qualification.

4.5 Quality conformance inspection.

4.5.1 Inspection of product for delivery. Inspection of product for delivery shall consist of groups A, B, and C.

4.5.1.1 Inspection lot. An inspection lot, shall be as specified in MIL-STD-105 as far as practicable and shall consist of all the resistors of the same style, produced under essentially the same conditions and offered for inspection at one time.

4.5.1.2 Rejected lots. If an inspection lot is rejected, the supplier may withdraw the lot, rework it to correct the defects, or screen out the defective units, as applicable, and reinspect. Such lots shall be separate from new lots and shall be clearly identified as reinspected lots. Rejected lots shall be inspected using tightened inspection.

4.5.1.3 Group A inspection. Group A inspection shall consist of the examinations and test specified in table VIII, and shall be made on the same set of sample units, in the order shown.

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TABLE VII. Qualification inspection.

Examination or test	Requirement paragraph	Method paragraph	Number of defectives allowed 1/
Certification requirements			
Wire diameter	3.4.2.1	---	---
Fungus	3.22	4.6.19	---
Group I			
DC resistance 2/	3.5	4.6.1	1
Visual and mechanical examination 2/, 3/	3.1, 3.3 to 3.4.4, inclusive, and 3.23 to 3.24.2, inclusive	4.6.2	
Short-time overload 2/	3.6	4.6.3	
Temperature cycling 2/	3.7	4.6.4	
Group IA			
Solderability 5/	3.8	4.6.5	1
Resistance to solvents	3.9	4.6.6	
Group II			
Insulation resistance	3.10	4.6.7	1
Moisture resistance	3.11	4.6.8	
Dielectric withstanding voltage	3.12	4.6.9	
Terminal strength	3.13	4.6.10	
Group III			
Salt-water-immersion cycling	3.14	4.6.11	1
Dielectric withstanding voltage 4/	3.12	4.6.9	
Terminal strength	3.13	4.6.10	
Group IV			
Life	3.15	4.6.12	1
Group V			
Resistance-temperature characteristic 2/	3.16	4.6.13	1
Low-temperature storage	3.17	4.6.14	
Low-temperature operation	3.18	4.6.15	
High-temperature exposure	3.19	4.6.16	
Group VI			
Shock, medium impact	3.20	4.6.17	0
Vibration, high frequency	3.21	4.6.18	
Group VII			
Visual and mechanical examination	3.1, 3.3 to 3.4.4, incl, and 3.23 to 3.24.2, incl.	4.6.2	0

1/ Failure of a resistor in one or more tests of a group shall be charged as a single defective.
2/ Nondestructive tests.
3/ Marking shall be considered defective only if the marking is illegible.
4/ This test shall be performed not less than 10 minutes nor more than 30 minutes after the preceding test.
5/ Not applicable to terminal type W.

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4.5.1.3.1 Sampling plan. Statistical sampling and inspection shall be in accordance with MIL-STD-105. The acceptable quality levels (AQL) shall be as specified in table VIII. Major and minor defects shall be as defined in MIL-STD-105. Resistance values in the samples shall be representative, and where possible, in proportion to the resistors in the inspection lot.

TABLE VIII. Group A inspection.

Examination or test	Requirement paragraph	Method paragraph	AQL (percent defective)	
			Major	Minor
DC resistance	3.5	4.6.1	1.0	
Visual and mechanical examination:	------	4.6.2		
Body and mounting dimensions	3.1 and 3.4	--------	1.0	4.0
Lug terminals	3.1 and 3.4.1.1	--------		
Marking	3.23	--------		
Workmanship	3.24 to 3.24.2 incl	--------		

4.5.1.4 Group B inspection. Group B inspection shall consist of the tests specified in table IX, in the order shown.

TABLE IX. Group B inspection.

Test	Requirement paragraph	Method paragraph
Short-time overload	3.6	4.6.3
Temperature cycling	3.7	4.6.4

4.5.1.4.1 Sampling plan. The sampling plan shall be in accordance with MIL-STD-105 for small-sample inspection. Unless otherwise specified herein, S-4 inspection shall be used. The AQL shall be 4.0 (percent defective).

4.5.1.4.2 Disposition of sample units. Sample units which have passed all the group B inspection and which are still within the initial resistance tolerance may be delivered on the contract or order, at the option of the supplier, if the lot is accepted.

4.5.1.5 Group C inspection. Group C inspection shall consist of the examinations and tests specified in table XI, in the order shown.

4.5.1.5.1 Sampling plan.

4.5.1.5.1.1 Monthly. The following number of sample units shall be selected during the 2-week period prior to the monthly testing specified in table XI, from any one style listed in each group in table X which contains a style produced

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during the month. The style selected shall have had a production greater than 1,000 units; if less than 1,000 units were produced, the style with the highest production shall then be selected. In subsequent monthly testing, preference in the selection of the resistor style shall be given to the style not tested during the previous month:

Sample units in the same style	Resistance value
6 - - - - - - - - - - -	In any high resistance value and made with the smallest diameter wire.
6 - - - - - - - - - - -	In any resistance value nearest 10,000 ohms in any diameter wire but of the same type wire as for that of the highest resistance value.
6 - - - - - - - - - - -	In any resistance value below 40.2 ohms.

TABLE X. Style groupings for monthly and quarterly testing.

Style grouping			
RB52	RB54	RB08	RB70
RB53	RB55	RB16	RB71
RB57	RB56	RB17	
RB58	....	RB18	
RB59	....	RB19	
		RB72	
		RB73	

4.5.1.5.1.2 Quarterly. The following number of sample units shall be selected in accordance with the method specified in 4.5.1.5.1.1, during the month prior to the quarterly testing specified in table XI:

Sample units in the same style	Resistance value
42 - - - - - - - - - - -	In any high resistance value and made with the smallest diameter wire.
6 - - - - - - - - - - -	In 10,000 ohms or the value nearest to 10,000 ohms.
6 - - - - - - - - - - -	In the lowest resistance value.

In addition, an additional 10 sample units of any resistance value shall be subjected to subgroup 4 tests.

4.5.1.5.1.3 Semiannually. The following sample units shall be selected during the month prior to the semiannual testing specified in table XI.

4.5.1.5.2 Disposition of sample units. Sample units which have been subjected to group C inspection shall not be delivered on the contract or order, except that the sample units which have been subjected to and have passed the monthly tests may be delivered on the contract or order, at the option of the supplier.

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TABLE XI. Group C inspection.

Examination or test	Requirement paragraph	Method paragraph	Number of failures allowed
Monthly - 18 sample units			
DC resistance 1/	3.5	4.6.1	1
Visual and mechanical examination 1/	3.1, 3.3 to 3.4.4, incl, and 3.23 to 3.24.2, incl	4.6.2	
Short-time overload 1/	3.6	4.6.3	
Temperature cycling 1/	3.7	4.6.4	
Resistance-temperature characteristic	3.16	4.6.13	
Low-temperature storage	3.17	4.6.14	
Low-temperature operation	3.18	4.6.15	
High-temperature exposure	3.19	4.6.16	
Quarterly - 64 sample units			
Subgroup 1 - 18 sample units of highest resistance value			
DC resistance 1/	3.5	4.6.1	1
Visual and mechanical examination 1/	3.1, 3.3 to 3.4.4, incl, and 3.23 to 3.24.2, incl	4.6.2	
Short-time overload 1/	3.6	4.6.3	
Temperature cycling 1/	3.7	4.6.4	
Insulation resistance	3.10	4.6.7	
Moisture resistance	3.11	4.6.8	
Dielectric withstanding voltage	3.12	4.6.9	
Terminal strength	3.13	4.6.10	
Subgroup 2 - 18 sample units of highest resistance value			
DC resistance 1/	3.5	4.6.1	1
Visual and mechanical examination 1/	3.1, 3.3 to 3.4.4, incl, and 3.19 to 3.20.2, incl	4.6.2	
Short-time overload 1/	3.6	4.6.3	
Temperature cycling 2/	3.7	4.6.4	
Salt-water-immersion cycling	3.14	4.6.11	
Dielectric withstanding voltage	3.12	4.6.9	
Terminal strength	3.13	4.6.10	
Subgroup 3 - 18 sample units (6-highest, 6-10,000 ohm or nearest to 10,000 ohm, 6-lowest value)			
DC resistance 1/	3.5	4.6.1	1
Visual and mechanical examination 1/	3.1, 3.3 to 3.4.4, incl, and 3.23 to 3.24.2, incl	4.6.2	
Short-time overload 1/	3.6	4.6.3	
Temperature cycling 1/	3.7	4.6.4	
Life	3.15	4.6.12	
Subgroup 4 - 10 sample units (any value)			
Solderability	3.8	4.6.5	1
Resistance to solvents	3.9	4.6.6	
Semiannually - 6 sample units			
DC resistance 1/	3.5	4.6.1	0 2/
Visual and mechanical examination 1/	3.1, 3.3 to 3.4.4, incl, and 3.23 to 3.24.2, incl	4.6.2	
Short-time overload 1/	3.6	4.6.3	
Temperature cycling 1/	3.7	4.6.4	
Shock, medium impact	3.20	4.6.17	
Vibration, high frequency	3.21	4.6.18	

1/ This test applicable only if the sample units have not been subjected to groups A and B inspection.

2/ If one failure occurs, an additional six sample units may be tested with no failures allowed.

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4.5.1.5.3 Noncompliance. If a sample fails to pass group C inspection, the supplier shall take corrective action on the materials or processes, or both, as warranted, and on all units of product which can be corrected and which were manufactured under essentially the same conditions, with essentially the same materials, processes, etc, and which are considered subject to the same failure. Acceptance of the product shall be discontinued until corrective action, acceptable to the Government, has been taken. After the corrective action has been taken, group C inspection shall be repeated on additional sample units (all inspection, or the inspection which the original sample failed, at the option of the Government). Groups A and B inspection may be reinstituted; however, final acceptance shall be withheld until the group C reinspection has shown that the corrective action was successful. In the event of failure after reinspection, information concerning the failure and the corrective action taken shall be furnished to the contracting officer.

4.5.2 Inspection of preparation for delivery. Sample items and packs shall be selected and inspected in accordance with MIL-P-116, table III, including rough handling tests, to verify conformance with requirements in section 5 of this specification.

4.5.3 Retention of qualification. In order to retain qualification, the supplier shall forward via the government inspector at 6-month intervals, to the activity responsible for qualification, a summary of the results of groups A and B tests, indicating as a minimum the number of lots which passed and the number which failed, and a summary of the results of group C tests, including the number and type of any part failures. The summary shall include those tests performed during that 6-month period. If the summary of the test results indicates nonconformance with specification requirements, action will be taken to remove the failing product from the qualified products list. Failure to submit the summary will result in loss or qualification for that product. In addition to the periodic submission of inspection data, the supplier shall immediately notify the qualifying activity at any time during the 6-month period that the inspection data indicates failure of the qualified product to meet the requirements of the specification. In the event no product has been submitted under the specification during the 6-month period, a statement indicating the condition shall be forwarded to the qualifying activity in the manner indicated above.

4.6 Methods of examination and test.

4.6.1 DC resistance (see 3.5). Resistors shall be tested in accordance with method 303 of MIL-STD-202. The following details and exceptions shall apply:

(a) Measuring apparatus - Bridges.

(b) Limit of error of measuring apparatus - One-fourth of the specified initial-resistance tolerance or 0.1 percent, whichever is less, +0.002 ohm.

(c) Test voltage - Measurements of resistance shall be made by using the test voltages specified in table XII. The test voltage chosen, whether it is the maximum or a lower voltage which would still provide the sensitivity required, shall be applied across the terminals of the resistor. This same voltage shall be used whenever a subsequent resistance measurement is made.

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(d) Points of application of test voltage for initial-resistance-tolerance measurement:
  (1) Wire-lead-terminal resistors of 10 ohms and less - 3/8 ± 1/16 inch from the end of the body.
  (2) Lug-terminal resistors of 10 ohms and less - From the center of the hole of the lug terminal.

(e) Temperature-The dc resistance tests specified in group I of table VII, in table VIII, and in the monthly, quarterly, and semiannual groups of table XI shall be measured at 25° ± 2° C. For all other tests, unless otherwise specified herein, the temperature at which subsequent and final resistance measurements are made in each test shall be within 2° C of the temperature at which the first resistance measurement was made.

TABLE XII. DC resistance test voltages.

Resistance, nominal	1/2 watt and greater	Less than 1/2 watt
Ohms	Volts	Volts
Less than 1 ohm	0.1	0.05
1 to 9.999, incl	0.3	0.15
10 to 99.99, incl	1.0	1.0
100 to 999.9, incl	3.0	3.0
1,000 to 9,999, incl	10.0	3.0
10,000 to 99,999 incl	30.0	10.0
100,000 and higher	100.0	30.0

4.6.2 Visual and mechanical examination. Resistors shall be examined to verify that the materials, design, construction, physical dimensions, marking and workmanship are in accordance with the applicable requirements (see 3.1, 3.3 to 3.4.4, inclusive, and 3.23 to 3.24.2, inclusive).

4.6.3 Short-time overload. DC resistance shall be measured as specified in 4.6.1. Each resistor shall be subjected to a dc test potential equivalent to that calculated for twice the rated wattage, but not to exceed twice the maximum voltage specified (see 3.1), for 10 minutes under the following conditions:
  (a) In free space, predicated on horizontal mounting with no object closer than 3 inches to the protective coating, except the mounting base which will be not closer than 2 inches below the resistors.
  (b) In still air, with no circulation other than that created by the heat of the resistors being operated.

Thirty $^{+15}_{-0}$ minutes after removal of the test potential, the dc resistance shall again be measured as specified 4.6.1. Resistors shall then be examined for evidence of arcing, burning, and charring (see 3.6).

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4.6.4 Temperature cycling (see 3.7). Resistors shall be tested in accordance with method 102 of MIL-STD-202. The following details and exceptions shall apply:

(a) Mounting - In such a manner that there is at least 1 inch of free air space around each resistor, and in such a position with respect to the air stream that the mounting offers substantially no obstruction to the flow of air across and around the resistors.
(b) Measurement before cycling - DC resistance shall be measured as specified in 4.6.1.
(c) Test condition letter - C.
(d) Climate chamber - The rate of temperature change within the climate chamber shall be not less than 2° C per minute. The temperature shall be maintained at each of the extreme temperatures by means of circulating air. The air temperature shall be measured by a suitable method and as near the center of the group of resistors as possible.
(e) When two climate chambers are used - The resistors may be transferred from one chamber to another, in which case they shall be kept at room temperature for not less than 10 minutes and not more than 15 minutes between exposures to the extreme temperatures.
(f) Measurement after cycling - Not less than 1 hour, but within a 24-hour period after the last cycle, dc resistance shall be measured as specified in 4.6.1.
(g) Examination after test - Resistors shall be examined for evidence of mechanical damage.

4.6.5 Solderability (see 3.8). Resistors shall be tested in accordance with method 208 of MIL-STD-202. The following details shall apply: Both terminals shall be tested. The terminals shall be dipped within 1/16 inch of the body.

4.6.6 Resistance to solvents (see 3.9). The resistors shall be subjected to 3 immersions of 1 minute ± 10 seconds duration each, in the following solvent solution by volume at room ambient temperature.

1 part isopropyl alcohol (TT-I-735 grade A).
3 parts mineral spirit (P-D-680).

Immediately following each immersion and while wet, the resistors shall be brushed 10 strokes with a common hard bristle toothbrush. After the final immersion and brushing, resistors shall be allowed to dry. When dry, the resistors shall be examined for legibility of marking and mechanical damage.

4.6.7 Insulation resistance (see 3.10). Resistors shall be tested in accordance with method 302 of MIL-STD-202. The following details and exceptions shall apply:

(a) Special preparations - As specified in 4.6.9(a).
(b) Test condition letter - A or B, whichever is practicable.
(c) Points of measurement - Between the resistor terminals connected together and the mounting strap.

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4.6.8 Moisture resistance (see 3.11). Resistors shall be tested in accordance with method 106 of MIL-STD-202. The following details and exceptions shall apply:

(a) Mounting:
  (1) Lug-terminal resistors - Vertically with the usual mounting hardware.
  (2) Wire-lead-terminal resistors - Soldered by their leads to rigid mounts or terminal lugs. The spacing of the mounts or terminal lugs shall be such that the length of each resistor lead is approximately 3/8 inch when measured from the edge of the supporting terminal to the resistor body. One-half of the specimens shall be covered with a V-shaped metal strap whose width is such that the resistor shall not extend more than 1/32 inch beyond the edge of the strap. The strap shall be made of a corrosion-resistant metal and shall be kept in contact with the resistor body by supporting the body as indicated on figure 1, with a non-conducting, noncorrosive support whose width is less than that of the body and which will not act as a moisture tray. The mounting straps may be individual for each resistor or continuous for all resistors.

(b) Initial measurements - Immediately following the initial drying period, the dc resistance shall be measured as specified in 4.6.1. The insulation resistance shall then be measured between the resistor terminals connected together and the mounting hardware, using a dc potential of approximately 100 volts with the positive side connected to the terminals.

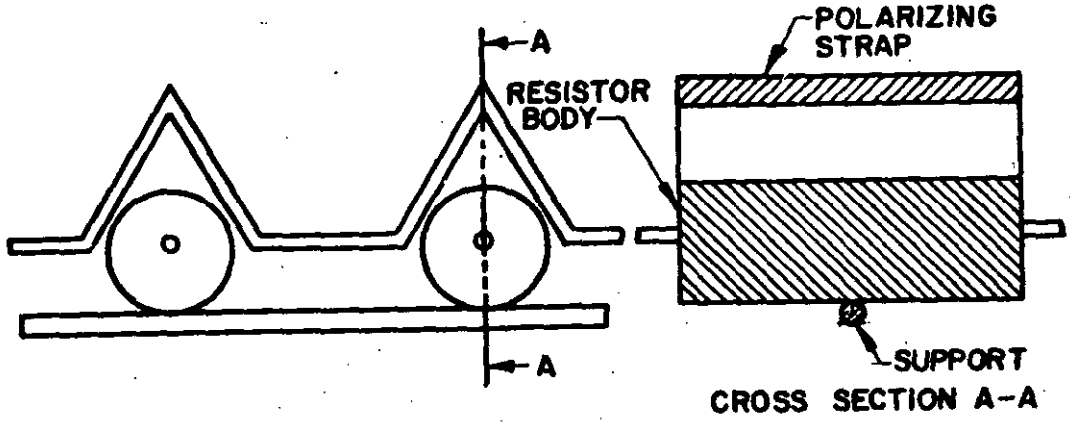

FIGURE 1. Mounting strap for wire-lead-terminal resistors.

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(c) Polarization and loading voltage - The resistors shall be divided into two equal groups; one group shall be subjected to polarization and the other group to load.
  (1) Polarization - During steps 1 to 6, inclusive, a 100-volt dc potential shall be applied with the positive lead connected to the resistor terminals tied together, and the negative lead connected to the mounting hardware or polarizing straps, as applicable.
  (2) Loading voltage - During the first 2 hours of steps 1 and 4, a dc test potential equivalent to 100-percent rated wattage but not exceeding the maximum rated voltage shall be applied to the resistors. Where potential to ground is over 250 volts, supplementary insulation shall be provided (see 20.1.3).
(d) Final measurements - Upon completion of step 6 of the final cycle, the resistors shall be conditioned at a temperature of 25°±2° C and at a relative humidity of 90 to 95 percent for a period of 1-1/2 to 3-1/2 hours. After conditioning, the resistors shall be removed from the chamber and within 1/2 hour, the dc resistance and insulation resistance shall be measured as specified in 4.6.1 and 4.6.7 respectively. Wiping and forced air drying prior to measurement is not allowed. The subsequent 4- to 24-hour conditioning period and measurements do not apply.
(e) Examinations after test - Resistors shall be examined for evidence of breaking, cracking, spalling, and loosening of terminals and mounting hardware.

4.6.9 Dielectric withstanding voltage (see 3.12). This test shall be performed not less than 10 minutes, nor more than 30 minutes, after the preceding test. Resistors shall be tested in accordance with method 301 of MIL-STD-202. The following details and exceptions shall apply:
(a) Special preparations:
  (1) Lug-terminal resistors - Resistors shall be mounted, without supplementary insulation, between two metal plates normal to the horizontal axis of the resistor, one plate at each end held firmly against the end of the resistor core by a throughbolt. The plates shall be of sufficient size to extend beyond the resistor terminal extremities.
  (2) Wire-lead-terminal resistors - Resistors shall be clamped in the trough of a 90° metallic V-block of such size that the body of the resistor does not extend beyond the extremities of the block. The resistor leads shall be so positioned that one of the points of contact of the periphery of the resistor with the V-block is the point at which the distance from the surface of the resistor leads to the periphery of the resistor body is a minimum. The minimum distance to the periphery of the resistor body shall be measured from the point of emergence of the resistor lead.

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(b) Initial measurement - dc resistance shall be measured as specified in 4.6.1.
(c) Magnitude of test voltage - 500 volts rms.
(d) Nature of potential - An ac supply at commercial-line frequency and waveform.
(e) Duration of application of test voltage - 1 minute.
(f) Rate of application of test voltage - The test voltage shall be raised from zero to 500 volts rms, as uniformly as practicable, at a rate of approximately 100 volts rms per second.
(g) Points of application of test voltage - Between the resistor terminals connected together and the mounting hardware, or the V-block, as applicable.
(h) Measurement after test - DC resistance shall be measured as specified in 4.6.9(g).
(i) Examinations after test - Resistors shall be examined for evidence of flashover, mechanical damage, arcing, and insulation breakdown.

4.6.9.1 Barometric pressure (reduced). Resistors shall be tested in accordance with method 105 of MIL-STD-202. The following details and exceptions shall apply:

(a) Method of mounting - As specified in 4.6.9.(a).
(b) Initial measurement - DC resistance shall be measured as specified in 4.6.1.
(c) Test condition letter - D.
(d) Test voltages during subjection to reduced pressure - 200 volts.
(e) Nature of potential - As specified in 4.6.9(d).
(f) Duration of application of test voltage - 5 seconds.
(g) Rate of application - 100 volts per second.
(h) Points of application of test voltage - As specified in 4.6.9(g).
(i) Measurement after test - DC resistance shall be measured as specified in 4.6.1.
(j) Examinations after test - As specified in 4.6.9(i).

4.6.10 Terminal strength (see 3.13). Resistors shall be tested in accordance with method 211 of MIL-STD-202. The following details and exceptions shall apply:

(a) Test condition letters - A and D. (Pull test and twist test, respectively.) Applied force (A) - 4-1/2 pounds. Resistor clamped by 1 lead and force applied to other lead.
(b) Measurement before and after test - DC resistance shall be measured as specified in 4.6.1.

4.6.11 Salt-water-immersion cycling (3.14).

4.6.11.1 Salt water bath. The salt water baths specified herein shall contain common table salt. The baths shall be of sufficient volume to maintain relatively constant temperature for the duration of the tests.

4.6.11.2 First day's cycling. Resistors shall be placed in a dry oven maintained at a temperature of 85°±2° C. The rated or maximum dc voltage, whichever is smaller, shall be applied for 1 hour. Within 1/2 hour or as soon

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as the resistors have stabilized after removal of this voltage, the dc resistance shall be measured as specified in 4.6.1 while the resistors are in the oven. Upon completion of this measurement, the rated or maximum dc voltage shall again be applied to the resistors for 1 hour while they are in the oven maintained at a temperature of 85°±2°C. Within 5 seconds after removal of this voltage, resistors shall be taken from the oven and immersed for a period of 1 hour in a saturated salt water bath maintained at a temperature of 85°±2° C. Within 5 seconds after removal from this bath, resistors shall be immersed for a period of 1 hour in another saturated salt water bath maintained at a temperature of $0° \begin{smallmatrix}+2° \\ -0°\end{smallmatrix}$ C. Resistors shall then be thoroughly and quickly washed in tap water and all surfaces wiped or air blasted clean and dry. The resistors shall again be placed in the oven maintained at a temperature of 85°±2° C and operated at the rated or maximum dc voltage for 1 hour. Within 1/2 hour or as soon as the resistors have stabilized after removal of this voltage, the dc resistance shall be measured as specified in 4.6.1 while the resistors are in the oven.

4.6.11.3 Conditioning between daily cycles. After each day's final cycle, resistors shall be left overnight in the oven maintained at a temperature of 85°±2° C with no voltage applied. In no case shall this conditioning period exceed 24 hours.

4.6.11.4 Subsequent cycling. The rated or maximum dc voltage shall be applied to the resistors for 1 hour while they are in the oven maintained at a temperature of 85°±2° C. Within 5 seconds after removal of this voltage, resistors shall be taken from the oven and immersed for a period of 1 hour in a saturated salt water bath maintained at a temperature of 85°±2° C. Within 5 seconds after removal from this bath, resistors shall be immersed for a period of 1 hour in another saturated salt water bath maintained at a temperature of $0° \begin{smallmatrix}+2° \\ -0°\end{smallmatrix}$ C. Resistors shall then be thoroughly and quickly washed in tap water and all surfaces wiped or air blasted clean and dry. The resistors shall again be placed in the oven maintained at a temperature of 85°±2°C. and operated at the rated or maximum dc voltage for 1 hour. Within 1/2 hour or as soon as the resistors have stabilized after removal of this voltage, the dc resistance shall be measured as specified in 4.6.1 while the resistors are in the oven. This cycle shall be repeated to a total of five cycles. Resistors shall then be examined for evidence of damage.

4.6.12 Life (see 3.15). Resistors shall be tested in accordance with method 108 of MIL-STD-202. The following details and exceptions shall apply:

(a) Method of mounting:

(1) Lug-terminal resistors - Supported by wire leads, each approximately 1 inch in length.

(2) Wire-lead-terminal resistors - Supported by their terminals: axial-lead resistors at a point 1 inch from the resistor body; printed-circuit resistors at a point 3/4 inch from the resistor body. Resistors shall be so arranged that the temperature of any one resistor shall not appreciably influence the temperature of any other resistor. There shall be no undue draft over the resistors.

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(b) Test temperature and tolerance - 125°±5° C.
(c) Initial measurement - DC resistance shall be measured at a temperature of 125°±5° C after temperature stabilization and within 8 hours of exposure of the resistors to this temperature
(d) Operating conditions - Rated or maximum dc continuous working voltage shall be applied intermittently, 1-1/2 hours on and 1/2 hours off for 1,500 hours, at the test temperature. Each resistor shall dissipate rated wattage but shall not exceed maximum voltage. Adequate precaution shall be taken to maintain constant voltage on the resistor.
(e) Test condition letter - E.
(f) Measurements during test - While the resistors are still in the oven, the dc resistance shall be measured as specified in 4.6.1, at the end of the 1/2-hour off periods, after 50±4, 100±8, 250±12, 500 $^{+48}_{-0}$, 750 $^{+48}_{-0}$, 1,000 $^{+48}_{-0}$, 1,250 $^{+48}_{-0}$ and 1,500 $^{+48}_{-0}$ hours have elapsed.
(g) Examination after test - Resistors shall be examined for evidence of mechanical damage.

4.6.13 Resistance-temperature characteristic (see 3.16). Resistors shall be tested in accordance with method 304 of MIL-STD-202. The following details and exceptions shall apply:
Test temperature - In accordance with table XIII.

TABLE XIII. Temperature for resistance-temperature-characteristic test.

Sequence	Temperature
	°C
1	1/25
2	2/ 0
3	2/15
4	-55
5	-65
6	1/25
7	50
8	75
9	2/105
10	145

1/This temperature shall be considered the reference temperature for each of the succeeding temperatures.
2/Not applicable to quality conformance inspection.

4.6.14 Low-temperature storage (see 3.17).

4.6.14.1 Mounting. Resistors shall be mounted by their normal mounting means and in such a manner that there is at least 1 inch of free air space around each

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resistor, and in such a position with respect to the air stream that the mounting offers substantially no obstruction to the flow of air across and around the resistors.

4.6.14.2 Procedure. DC resistance shall be measured as specified in 4.6.1. Within 1 hour after this measurement, the resistors shall be placed in a cold chamber at room temperature. The temperature shall then be gradually decreased to -63° $^{+0}_{-2}$° C within a period of not less than 3 hours. For quality conformance inspection only, and at the option of the supplier, the resistors may be placed in the cold chamber when the chamber is already at the extreme low temperature. Twenty-four hours after the resistors have reached this temperature, the temperature shall be gradually increased to room temperature within a period of not more than 8 hours. The resistors shall be removed from the chamber and maintained at a temperature of 25° ± 5° C for a period of approximately 24 hours; the dc resistance shall again be measured as specified in 4.6.1. Resistors shall then be examined for evidence of mechanical damage.

4.6.15 Low-temperature operation (see 3.18). Following the final dc resistance measurement specified in 4.6.14.2, the resistors, mounted as specified in 4.6.14.1, shall again be placed in a cold chamber at room temperature. The temperature shall be gradually decreased to -55° $^{+0}_{-2}$° C, within a period of not less than 1-1/2 hours. For quality conformance inspection only, and at the option of the supplier, the resistors may be placed in the cold chamber when the chamber is already at the extreme low temperature. After 1 hour of stabilization at this temperature, full rated continuous working voltage as specified in 4.3.2 shall be applied for 45 minutes. The resistors may be loaded individually or in parallel. Fifteen $^{+5}_{-0}$ minutes after the removal of voltage, the temperature in the chamber shall be gradually increased to room temperature within a period of not more than 8 hours. The resistors shall then be removed from the chamber and maintained at a temperature of 25° ± 5° C for a period of approximately 24 hours; the dc resistance shall again be measured as specified in 4.6.1. Resistors shall then be examined for evidence of mechanical damage.

4.6.16 High-temperature exposure (see 3.19).

4.6.16.1 Mounting. Resistors shall be mounted by their normal mounting means and no soldering shall be used.

4.6.16.2 Procedure. DC resistance shall be measured as specified in 4.6.1 at room ambient temperature. Resistors shall then be exposed to an ambient temperature of 145° $^{+5}_{-0}$° C for a period of 24±4 hours. Not less than 2 hours after the end of the exposure period, the dc resistance shall again be measured as specified in 4.6.1 at room ambient temperature.

4.6.17 Shock, medium impact (see 3.20). Resistors shall be tested in accordance with method 205 of MIL-STD-202. The following details and exceptions shall apply:

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(a) Special mounting means - Resistors shall be mounted in relation to the test equipment in such a manner that the stress applied is in the direction which would be considered most detrimental.

(1) Lug-terminal resistors - Resistors shall be mounted in a normal manner with the proper throughbolt on appropriate jig fixtures. A suggested mounting fixture is shown on figure 2. These fixtures shall be constructed in a manner to insure that the points of the resistor-mounting supports will remain in a static condition with reference to the shock table.

(2) Wire-lead-terminal resistors - Resistors shall be rigidly mounted on appropriate jig fixtures with their bodies restrained from movement and their leads supported at a distance of 1/4 inch from the resistor body. These fixtures shall be constructed in a manner to insure that the points of the resistor-mounting supports will remain in a static condition with reference to the shock table.

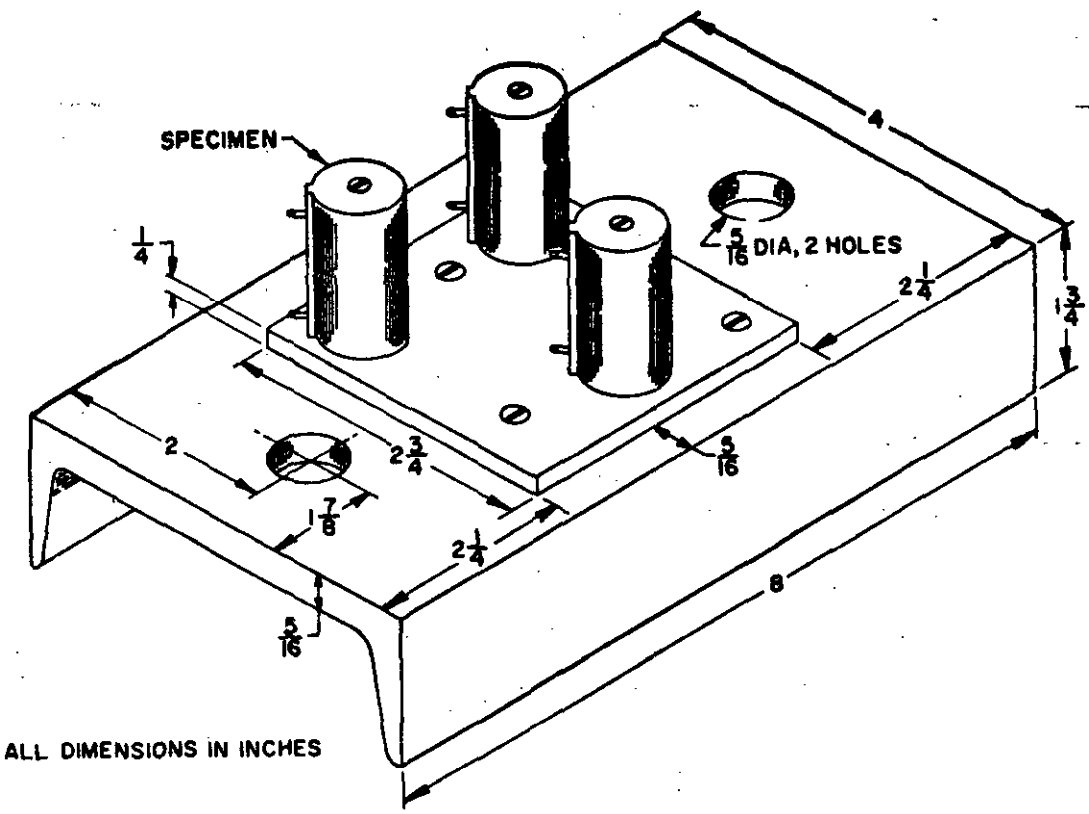

FIGURE 2. Suggested mounting fixture for lug-terminal resistors for shock and high-frequency-vibration tests.

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(b) Test leads - Test leads used during this test shall be no larger than AWG size 22 stranded wire, so that the influence of the test lead on the resistor will be held to a minimum. The test-lead length shall be no longer than necessary.
(c) Measurement before shock - DC resistance shall be measured as specified in 4.6.1.
(d) Test condition letter - C.
(e) Number and direction of applied shocks motion - The resistors shall be subjected to 5 shocks (total of 15 shocks) in each of 3 mutually perpendicular planes. The initial plane shall pass through the resistor axis and terminals and the other two planes shall be mutually perpendicular.
(f) Measurement during shock - Each resistor shall be monitored to determine electrical discontinuity by a method which shall at least be sensitive enough to monitor or register, automatically, any electrical discontinuity of 0.1 millisecond or greater duration.
(g) Measurement after shock - DC resistance shall be measured as specified in 4.6.1.
(h) Examination after test - Resistors shall be examined for evidence of mechanical and electrical damage.

4.6.18 Vibration, high frequency (see 3.21). Resistors shall be tested in accordance with method 204 of MIL-STD-202. The following details and exceptions shall apply:
(a) Mounting of specimens - Resistors shall be mounted in relation to the test equipment in such a manner that the stress applied is in the direction which would be considered most detrimental.
(1) Lug-terminal resistors - Resistors shall be mounted in a normal manner with the proper throughbolt on appropriate jig fixtures. A suggested mounting fixture is shown on figure 2. These fixtures shall be constructed in a manner to insure that the points of the resistor-mounting supports will remain in a static condition with reference to the vibration table.
(2) Wire-lead-terminal resistors - Resistors shall be rigidly mounted on appropriate jig fixtures with their bodies restrained from movement and their leads supported at a distance of 1/4 inch from the resistor body. These fixtures shall be constructed in a manner to insure that the points of the resistor-mounting supports will remain in a static condition with reference to the vibration table.
(b) Test leads - Test leads used during this test shall be no larger than AWG size 22 stranded wire, so that the influence of the test lead on the resistor shall be held to a minimum. The test-lead length shall be no longer than necessary. A shielded cable, which may be necessary because of the field surrounding the vibration table, shall be clamped to the resistor mounting jig.

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(c) Measurement before vibration - DC resistance shall be measured as specified in 4.6.1.
(d) Test condition letter - D.
(e) Motion - In each of three mutually perpendicular planes; the initial plane shall pass through the resistor axis and terminals, and the other two planes shall be mutually perpendicular.
(f) Measurements during vibration - Each resistor shall be monitored to determine electrical discontinuity by a method that shall at least be sensitive enough to monitor or register, automatically, any electrical discontinuty of 0.1 millisecond or greater duration.
(g) Measurement after vibration - DC resistance shall be measured as specified in 4.6.1.
(h) Examination after test - Resistors shall be examined for evidence of mechanical and electrical damage.

4.6.19 Fungus (see 3.22). Unless certification is provided, resistors shall be tested in accordance with method 508, procedure II, of MIL-STD-810. Resistors shall be examined for evidence of fungus growth.

5. PREPARATION FOR DELIVERY

5.1 Preservation and packaging. Preservation and packaging shall be level A or C, as specified (see 6.1).

5.1.1 Level A.

5.1.1.1 Cleaning. Resistors shall be cleaned in accordance with MIL-P-116, process C-1.

5.1.1.2 Drying. Resistors shall be dried in accordance with one or more of the procedures listed in MIL-P-116. The procedure used shall not be injurious to the item.

5.1.1.3 Preservative application. None required.

5.1.1.4 Unit packaging. Unless otherwise specified, resistors shall be adequately cushioned and individually packaged in accordance with MIL-P-116 method IA8, insuring compliance with the general (3.5.1) and physical protection (3.6) requirements.

5.1.1.5 Intermediate packaging. Resistors, packaged as described in 5.1.1.4, shall be placed in intermediate containers conforming to PPP-B-566 or PPP-B-676. Intermediate containers shall be uniform in size and shape, shall be of minimum cube and tare, and shall contain multiples of five unit packages, not to exceed 100 packages or ten pounds. No intermediate packaging is required when the total quantity shipped to a single destination is less than 100 units.

5.1.2 Level C. Resistors shall be preserved and packaged in a manner that will afford adequate protection against corrosion, deterioration, and physical

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damage during shipment from supply source to the first receiving activity for immediate use. This package may conform to the supplier's commercial practice for retail distribution when such meets the requirements of this level.

5.2 Packing. Packing shall be level A, B, or C, as specified (see 6.1).

5.2.1 Level A. The packaged item(s) shall be packed in fiberboard containers conforming to PPP-B-636, weather resistant, style optional, special requirement. In lieu of the closure and waterproof requirements in the appendix of PPP-B-636, closures and waterproofing shall be accomplished by sealing the center seams, ends, edges, and manufacturer's joints with waterproof tape, 2 inches wide, conforming to PPP-T-60, Class 1 or PPP-T-76. Banding (reinforcement requirements) shall be applied in accordance with the appendix to PPP-B-636, using nonmetallic or tape banding only.

5.2.2 Level B. The packaged item(s) shall be packed in fiberboard containers conforming to PPP-B-636, class domestic, style and use requirements optional. Closures shall be in accordance with the appendix, thereto.

5.2.3 Level C. The packaged item(s) shall be packed in a manner that will afford adequate protection against damage during direct shipment from the supply source to the first receiving activity for immediate use. This pack shall conform to the applicable carrier rules and regulations and may be the supplier's commercial practice when such conforms to the requirements of this level.

5.3 Marking (see 6.1). In addition to any special marking required by the contract or order, each unit package, intermediate and exterior containers shall be marked in accordance with MIL-STD-129.

5.4 General. Exterior containers shall be of a minimum tare and cube consistent with the protection required and shall contain equal quantities of identical items to the greatest extent possible.

6. NOTES

6.1 Ordering data. Procurement documents should specify the following:
(a) Title, number, and date of this specification.
(b) Title, number, and date of the applicable detail specification, and the complete type designation (see 1.2.1, 2.1, and 3.1).
(c) Levels of preservation and packaging and packing, and applicable marking (see section 5).
(d) Methods of preservation and packaging of MIL-P-116, if other than method IA8 (see 5.1.1.4).
(e) Number of unit packages or type of container, if other than that specified in 5.2.

6.1.1 Indirect shipments. The packaging, packing, and marking specified in section 5 are for only to direct purchases by or direct shipments to the Government and are not intended to apply to contracts or orders between the supplier and prime contractor.

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6.2 Qualification. With respect to products requiring qualification, awards will be made only for such products as have, prior to the time set for opening of bids, been tested and approved for inclusion in the applicable qualified products list whether or not such products have actually been so listed by that date. The attention of the suppliers is called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government, tested for qualification, in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the qualified products list is U.S. Army Electronics Command; however, information pertaining to qualification of products may be obtained from the Defense Electronics Supply Center, Directorate of Engineering Standardization (DESC-E), 1507 Wilmington Pike, Dayton, Ohio 45401.

6.3 Derating. The intention of this specification in covering temperature rise is to limit the final resistor hotspot temperature to 145° C. However, if it is desired to operate these resistors at an ambient temperature greater than 125° C the resistors should be derated in accordance with figure 3.

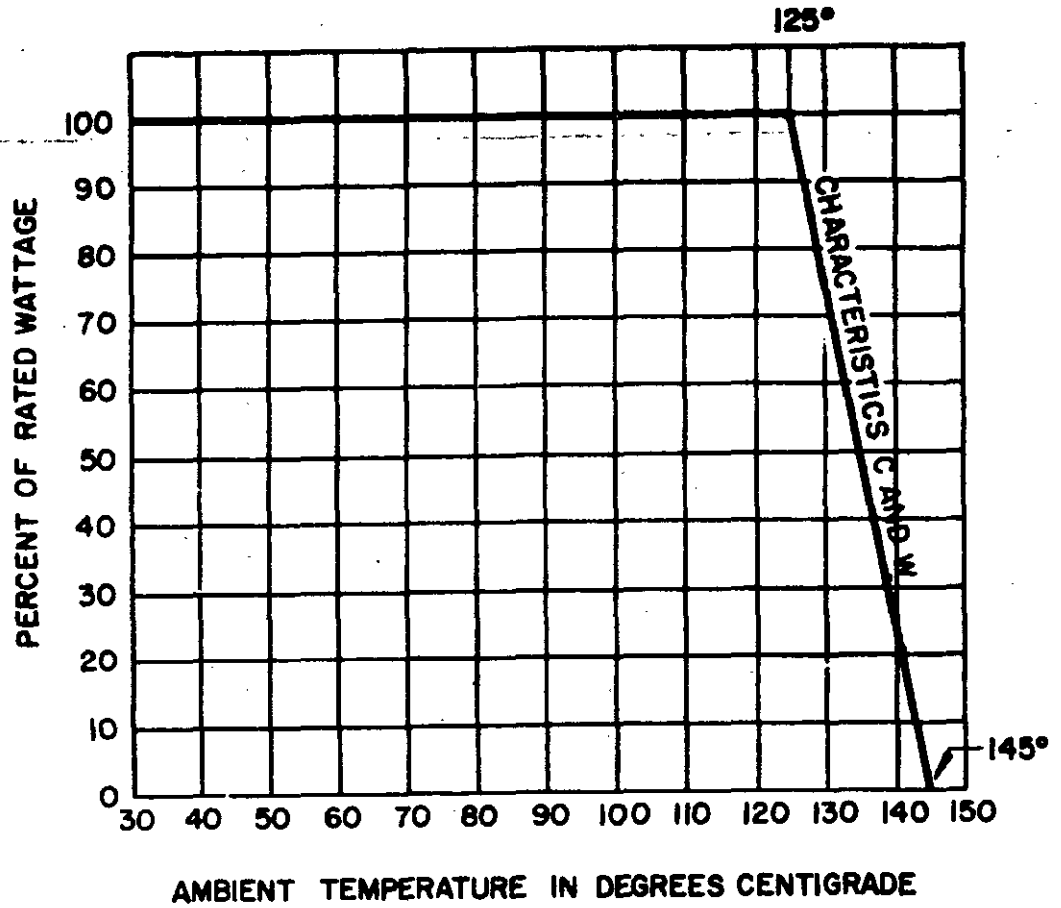

FIGURE 3. Derating curve for high-ambient temperature.

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6.4. High frequency. Resistors should not be used in circuits where their ac performance is of critical importance in the operation of such circuits, unless supplementary requirements are specified in the contract or order for controlling the ac properties of the resistors involved. If supplementary requirements are specified, no type designation should appear on the resistor (see 1.2.1 and 3.19).

6.5 Washers. All mounting washers used for insulating purposes should be of glazed ceramic material, conforming to grade L-241, or better, of MIL-I-10, "Insulating Materials, Electrical, Ceramic, Class L."

6.6 Mounting. It is suggested that wire-lead-terminal resistors be mounted by restraining their bodies from movement when shock or high-frequency vibration forces of the magnitudes, enumerated in this specification, are to be encountered.

6.7 Power rating. The power ratings of these resistors are conservative and are approximately 50 percent of the corresponding commercial ratings.

6.8 Selection and use information. Equipment designers should refer to MIL-STD-199, "Resistors, Selection and Use of," for a selection of standard resistor types and values for new equipment design. All application and use information concerning these resistors are also provided in MIL-STD-199,

6.9 Supersession data.

6.9.1 Resistance tolerance. Resistors identified under MIL-R-93C with an initial resistance tolerance of ±.025 percent (symbol C) may be replaced with resistors from this specification of ±0.1 percent, or ±0.05 percent tolerances.

6.9.2 Resistance temperature characterisitc. Resistors of characteristic "E" (although different in numerical value of resistance temperature characteristic are interchangeable with "E" characteristics resistors, under MIL-R-93C. In addition, characteristics E, L, and M are superseded by characteristic "E" of this specification.

6.9.3 Characteristics and terminal. Resistors identified by temperature characteristic and lead type symbol "C" of this specification, are interchangeable with resistors with characteristic "C" of MIL-R-93C. Temperature characteristic "C" of this specification supersedes characteristics "A" and "C" of MIL-R-93B and covers the temperature range of 125°C to 145° C specified in MIL-R-9444A(USAF).

6.9.4 Supersession of styles. The styles in this specification supersede the styles of superseded MIL-R-93C, 12 June 1961, "Resistors, Fixed, Wirewound (Accurate), General Specification for.", and MIL-R-9444A(USAF) 20 July 1959, "Resistors, Fixed, Wirewound, Precision High Temperature General Specification for." as listed in table XIV.

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TABLE XIV. Supersession of styles.

MIL-R-93D	MIL-R-93C 1/	MIL-R-93B	MIL-R-9444A(USAF)
	Style	Supersedes style	Supersedes style
RB56	RB56	RB56	- - - - - - - - -
RB55	RB55	RB55	AFRT 10
RB54	RB54	RB54	AFRT 11
RB53	RB53	RB53	AFRT 12
RB52	RB52	RB52	AFRT 13
RB57	RB57	- - - - - - - - -	AFRT 14
RB58	RB58	- - - - - - - - -	AFRT 15
RB59	RB59	- - - - - - - - -	AFRT 16
RB08	RB08	RB09, RB15	AFRT 17
RB16	RB16	RB16	AFRT 18
RB17	RB17	RB17	AFRT 19
RB18	RB18	RB18	- - - -
RB19	RB19	RB19	- - - -
RB70	RB70	- - -	- - - -
RB71	RB71	- - -	- - - -
RB72		- - - - - - - - -	AFRT 20
RB73		- - - - - - - - -	AFRT 21

1/ Resistors in this specification are mutually interchangeable with resistors of the same type designation under MIL-R-93B (see 6.9.3) and MIL-R-93C.

6.10 Changes from previous issue. Asterisks are not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes.

Custodians:
Army - EL
Navy - SH
Air Force - 11

Review activities:
Army, MI, MU, EL
Navy - SH, WP
Air Force - 11, 17, 85

User activities:
Army - MO
Navy - MC
Air Force - 14, 19

Preparing activity:
Army - EL

(Project 5905-0328)

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APPENDIX

PROCEDURE FOR QUALIFICATION INSPECTION

10. SCOPE

10.1 This appendix details the procedure for submission of samples, with releated data for qualification inspection of resistors covered by this specification. The procedure for extending qualification of the required sample to other resistors covered by this specification is also outlined herein.

20. SUBMISSION

20.1 Sample.

20.1.1 Single-type submission. When qualification is sought for a single resistance value, a sample consisting of 40 coated or enclosed sample units and 2 uncoated or unenclosed sample units in the same resistor style, and lead type, shall be submitted.

20.1.2 Multiple-type submission. When qualification is sought for a resistance range, a sample consisting of 40 coated or enclosed sample units and 2 uncoated or unenclosed sample units in the same resistor style, terminal type, and tightest tolerance for which qualification is sought, shall be submitted together with a statement indicating the lowest resistance value manufactured. The number of sample units in groups II to VII, inclusive, of table VII and the applicable resistance value shall be as specified in table XV. When axial terminal type "C" is submitted (as 40 samples above): Qualification for type "W" in the same style may be granted when an additional 6 samples of type "W" are subjected to groups I and II of table VII. In a similar manner, type "C" may be qualified where "W" is submitted (as 40 samples above), with the submission of 16 additional samples of type "C" resistors to groups I, IA and II of table VII.

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TABLE XV. Number of sample units and resistance value for multiple-type submission. (For single lead type) 1/

Group No. of table VII	Number of 2/ 3/ sample units	Resistance value
Coated or enclosed		
IA	10	Any value
II	6	Highest.
III	6	Highest.
IV	3	Highest.
	3	10,000 ohms or value nearest 10,000 ohms
V	2	Highest.
	2	10,000 ohms (wound with same type wire as highest resistance value).
	2	10 ohms 4/
VI	6	10,000 ohms or value nearest 10,000 ohms.
Uncoated or unenclosed		
VII	2	Highest.

1/ Qualification of both leads "C" and "W" is possible by a partial submission of additional samples under 20.1.2.

2/ One additional coated or enclosed sample unit of each resistance value shall be submitted to permit substitution for the defective allowed in group I of table VII.

3/ If the same coatings and materials are not used for all resistance values and tolerances within the same style, an additional submission shall be made for each coating and material. The term "material" in this specification does not apply to the resistance-wire element.

4/ 10 ohms or a higher value, if this higher value is the minimum value for which approval is sought.

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20.1.3 Supplementary insulation. Polytetrafluoroethylene washers 1/8 inch thick shall be furnished by the supplier as supplementary insulation.

20.2 Test data. When examinations and tests are to be performed at a Government laboratory, prior to submission, all sample units shall be subjected to all of the examinations and tests indicated as nondestructive in table VII. Each submission shall be accompanied by the test data obtained from these examinations and tests. The performance of the destructive tests by the supplier on a duplicate set of sample units is encouraged, although not required. All test data shall be submitted in duplicate.

20.3 Description of items. The supplier shall submit a detailed description of the resistors being submitted for inspection, including materials used for the protective coating or enclosure and the type wire used in the resistance element.

30. EXTENT OF QUALIFICATION

30.1 Single-type submission. Qualification shall be restricted to the resistance value in the style and resistance tolerance submitted.

30.2 Multiple-type submission. The resistance range included in the qualification of any one resistor style and terminal shall be between the highest resistance value tested and the lowest resistance value for which qualification is sought, provided the same materials are used within the range qualified. Qualification of resistors by initial resistance tolerance shall qualify resistors of the same style and resistance range in any of the other initial resistance tolerances as listed in table XVI provided the same coating, enclosure, and materials are used.

TABLE XVI. Extent of qualification by tolerance.

Symbol	Initial resistance tolerance	Will qualify resistance tolerance
A	0.05 percent	A, B, D, F
B	0.1 percent	B, D, F
D	0.5 percent	D, F
F	1.0 percent	F

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SPECIFICATION ANALYSIS SHEET

Form Approved Budget Bureau No. 119-R004

INSTRUCTIONS

This sheet is to be filled out by personnel either Government or contractor, involved in the use of the specification in procurement of products for ultimate use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured with a minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity.

SPECIFICATION

ORGANIZATION	CITY AND STATE

CONTRACT NO	QUANTITY OF ITEMS PROCURED	DOLLAR AMOUNT
		$

MATERIAL PROCURED UNDER A

☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?

   a. GIVE PARAGRAPH NUMBER AND WORDING

   b. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES

2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID

3. IS THE SPECIFICATION RESTRICTIVE?

   ☐ YES ☐ NO IF "YES", IN WHAT WAY?

4. REMARKS *(Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity)*

SUBMITTED BY *(Printed or typed name and activity)*	DATE

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