

INCH-POUND

MIL-R-18546E

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SUPERSEDING

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MILITARY SPECIFICATION

RESISTORS, FIXED, WIRE-WOUND
(POWER TYPE, CHASSIS MOUNTED),
GENERAL SPECIFICATION FOR

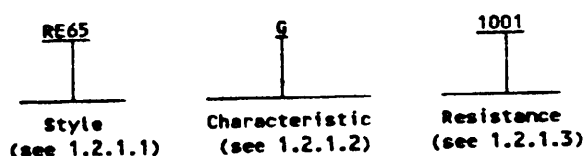
This specification is approved for use by all
Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the general requirements for power type, wire-wound, fixed resistors which utilize the principal of heat dissipation through a metal mounting surface. The resistors have an initial resistance tolerance of ± 1 percent and a resistance-temperature characteristic range from 30 ppm per $^{\circ}\text{C}$ to 200 ppm per $^{\circ}\text{C}$ depending upon the resistance value. They are not suitable for application when the alternating current (ac) characteristics are of critical importance; however, provisions have been made to minimize the inductance.

1.2 Classification.

1.2.1 Part or Identifying Number (PIN). The PIN shall be in the following form, and as specified (see 3.1 and 6.3).



1.2.1.1 Style. The style is identified by the two-letter symbol "RE" followed by a two digit number; the letters identify chassis-mounted, power type, wire-wound, fixed resistor, and the number identifies the size and power rating of the resistor.

1.2.1.2 Characteristic. The characteristic is identified by a single letter which identifies the maximum continuous operating temperature, and inductive (G) or noninductive (N) method of winding in accordance with table I.

TABLE I. Characteristic.

Symbol	Method of winding	Maximum continuous operating temperature
G	Inductive	$+250^{\circ}\text{C}$
N	Noninductive	$+250^{\circ}\text{C}$

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Defense Electronics Supply Center, ATTN: DESC-ES, 1507 Wilmington Pike, Dayton, OH 45444-5274, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

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FSC 5905

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1.2.1.3 **Resistance.** The nominal resistance value expressed in ohms is identified by a four digit number; the first three represent significant figures, and the last digit specifies the number of zeros to follow. Where fractional values of an ohm, and values of less than 100 ohms are required, the letter "R" is substituted for one of the significant digits to represent the decimal point. When the letter "R" is used, the succeeding digits become significant. The following are examples of symbols for resistance values:

OR05	=	0.05 ohm
OR10	=	0.10 ohm
1R00	=	1.00 ohm
10R0	=	10.0 ohms
1000	=	100 ohms
1001	=	1,000 ohms
1002	=	10,000 ohms

Minimum and maximum nominal resistance values shall be as specified (see 3.1). The standard resistance values for every decade shall follow the sequence demonstrated for the "1 to 10" decade (see table II).

TABLE II. Standard resistance values for the 1 to 10 decade. 1/

1.00	1.50	2.26	3.40	5.00	7.15
1.02	1.54	2.32	3.48	5.11	7.32
1.05	1.58	2.37	3.57	5.23	7.50
1.07	1.62	2.43	3.65	5.36	7.68
1.10	1.65	2.49	3.74	5.49	7.87
1.13	1.69	2.55	3.83	5.62	8.00
1.15	1.74	2.61	3.92	5.76	8.06
1.18	1.78	2.67	4.02	5.90	8.25
1.21	1.82	2.74	4.12	6.00	8.45
1.24	1.87	2.80	4.22	6.04	8.66
1.27	1.91	2.87	4.32	6.19	8.87
1.30	1.96	2.94	4.42	6.34	9.09
1.33	2.00	3.01	4.53	6.49	9.31
1.37	2.05	3.09	4.64	6.65	9.53
1.40	2.10	3.16	4.75	6.81	9.76
1.43	2.15	3.24	4.87	6.98	9.90
1.47	2.21	3.32	4.99	7.00	

1/ Resistors having resistance values not listed herein, or in any other decade, shall be considered as not conforming to the specification.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.1).

SPECIFICATIONS

MILITARY

- MIL-R-39009 - Resistors, Fixed, Wire-wound (Power Type, Chassis, Mounted), Established Reliability, General Specification for.
- MIL-R-39032 - Resistors, Packaging of.

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STANDARDS

MILITARY

- MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts.
- MIL-STD-1276 - Leads for Electronic Component Parts.
- MIL-STD-1285 - Marking of Electrical and Electronic Parts.

(Unless otherwise indicated, copies of the federal and military specifications, standards, and handbooks are available from the Defense Printing Service Detachment Office, Building 4D (Customer Service), 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.1.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

NATIONAL BUREAU OF STANDARDS

Handbook M28 - Screw-Thread Standards for Federal Services.

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington, DC 20402)

(Copies of specifications, standards, and other Government documents required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related associated detail specifications or specification sheets), the text of this document shall take precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS.

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

3.2 Qualification. Resistors furnished under this specification shall be products which are authorized by the qualifying activity for listing on the applicable qualified products list at the time of award of contract (see 4.4 and 6.2).

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). Resistors shall be wound with a single layer of resistance wire (round or flat-wound ribbon), except as otherwise required for characteristic "WM". In order to minimize inductance for characteristic "WM", resistors shall be wound by one of the following methods:

- a. Ayrton-Perry.
- b. Bifilar.

3.4.1 Windings.

3.4.1.1 Wire. 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 the end terminals. In no case shall the nominal diameter be less than .001 inch (0.03 mm) and the absolute minimum diameter be less than .0009 inch (0.023 mm) (see 3.1).

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3.4.1.2 Pitch. For round wire, the average winding pitch shall not exceed 325 percent, nor be less than 200 percent of the wire diameter, except that for resistance values less than 1 ohm, a minimum pitch of 150 percent is permitted.

3.4.1.3 Effective wire coverage. Effective wire coverage is the winding length on the tube between points of departure from the nominal winding pitch. The effective wire coverage shall be such that not more than 20 percent of the overall body length shall remain uncovered (by wire).

3.4.2 Protective coating or enclosure. The resistance element and caps shall be protected by a coating or an enclosure which shall completely cover the exterior of the resistance element and caps. The enclosure shall be free from holes, fissures, chips, and other faults. Small cracks and molding flaws which do not adversely affect the units ability to meet all environmental requirements of this specification will not be considered as cause for rejection. The exposed end of the enclosure shall prevent the entrapment of moisture.

3.4.3 Housing. The housing shall be made from an aluminum alloy and shall be protected against corrosion. All fasteners shall be suitably plated. Unplated copper bearing metals shall not be used in contact with aluminum.

3.4.4 Terminals. Connection of resistor windings to terminals shall result in a joint that is electrically stable and mechanically strong. When applicable, terminals shall be suitably treated to facilitate soldering. The terminals shall be firmly secured and shall not be solely dependent on the protective coating or enclosure for mechanical anchorage.

3.4.4.1 Solder dip (retinning) leads. Only the manufacturer or his authorized MIL-R-39009 category B or C distributor who has previously been approved may solder dip/retin the leads of product supplied to this specification provided the solder dip/retin process has been approved by the qualifying activity.

3.4.4.2 Qualifying activity approval. Approval of the solder dip/retin process will be based on one of the following options:

- a. When the original lead finish qualified was hot solder dip lead finish 52 of MIL-STD-1276 (Note: The 200-microinch maximum thickness is not applicable.), the manufacturer shall use the same solder dip process for retinning as is used in the original manufacture of the product.
- b. When the lead originally qualified was not hot solder dip lead finish 52 of MIL-STD-1276 as prescribed in 3.4.4.2a, approval for the process to be used for solder dip shall be based on the following test procedure:
 - (1) Thirty samples of any resistance value for each style and lead finish are subjected to the manufacturer's solder dip process. Following the solder dip process, the resistors are subjected to the dc resistance test and other group A electricals. No defects are allowed.
 - (2) Ten of the 30 samples are then subjected to the solderability test. No defects are allowed.
 - (3) The remaining 20 samples are subjected to the resistance to solder heat test followed by the moisture resistance test.

3.4.4.3 Solder dip/retinning options. The manufacturer may solder dip/retin as follows:

- a. After the group A tests and following the solder dip/retinning process, the electrical measurements required in group A, subgroup 1 shall be repeated on the lot. The group A, subgroup 1, lot rejection criteria shall be used. Following this test, the manufacturer shall submit the lot to the group A solderability test as specified in 4.6.3.
- b. As a corrective action if the lot fails the group A solderability test.

3.4.5 Threaded parts. All threaded parts shall be in accordance with Handbook H28.

3.4.6 Weight. Resistors shall not exceed the maximum weight specified (see 3.1).

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3.5 Voltage rating. Resistors shall have a rated direct current (dc) continuous working voltage, or an approximate sine wave root mean square (rms) continuous working voltage at commercial line frequency and waveform corresponding to the power rating, as determined from the following formula:

$$E = \sqrt{PR}$$

Where: E = rated dc or rms continuous working voltage
P = power rating (see 3.1)
R = nominal resistance

3.6 DC resistance. When resistors are tested as specified in 4.6.1, the dc resistance shall be within 1 percent of the nominal resistance (see 1.2.1.3 and 3.1).

3.7 Solderability (as applicable) (see 3.1). When resistors are tested as specified in 4.6.3, the flat portion of the terminal shall be considered as the solderable area, and must be completely solderable.

3.8 Terminal strength. 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 $\pm(0.2 \text{ percent} + 0.05 \text{ ohm})$.

3.9 Resistance-temperature characteristic. When resistors are tested as specified in 4.6.5, the resistance-temperature characteristic shall not exceed ± 0.0030 percent per $^{\circ}\text{C}$ (30 ppm per $^{\circ}\text{C}$) for resistance values of 20 ohms and higher, ± 0.0050 percent per $^{\circ}\text{C}$ (50 ppm per $^{\circ}\text{C}$) for resistance values from 1 ohm to 19.6 ohms, ± 0.01 percent per $^{\circ}\text{C}$ (100 ppm per $^{\circ}\text{C}$) for resistance values from 0.1 ohm to 0.976 ohm, and ± 0.02 percent per $^{\circ}\text{C}$ (200 ppm per $^{\circ}\text{C}$) for resistance values from .05 ohm to .09 ohm.

3.10 Temperature. When resistors are tested as specified in 4.6.6, there shall be no evidence of mechanical damage. Softening of the solder during test, except where it used solely as a tinning agent, shall be considered a basis for failure. The change in resistance shall not exceed $\pm(0.5 \text{ percent} + 0.05 \text{ ohm})$.

3.11 Dielectric withstanding voltage. When resistors are tested as specified in 4.6.7, resistors shall not flashover, show any evidence of damage, arcing, or insulation breakdown, nor a change in resistance in excess of $\pm(0.2 \text{ percent} + 0.05 \text{ ohm})$, as applicable.

3.12 Insulation resistance. When resistors are tested as specified in 4.6.8, the insulation resistance shall not be less than 10,000 megohms.

3.13 Thermal shock. When resistors are tested as specified in 4.6.9, the change in resistance shall not exceed $\pm(0.5 \text{ percent} + 0.05 \text{ ohm})$ nor shall there be any evidence of mechanical damage which will result in degradation of performance.

3.14 Momentary overload. When resistors are tested as specified in 4.6.10, the change in resistance shall not exceed $\pm(0.5 \text{ percent} + 0.05 \text{ ohm})$, and there shall be no evidence of arcing, burning, or charring.

3.15 Moisture resistance. When resistors are tested as specified in 4.6.11, the change in resistance shall not exceed $\pm(1 \text{ percent} + 0.05 \text{ ohm})$. The insulation resistance shall not be less than 1,000 megohms. There shall be no evidence of breaking, cracking, loosening of terminals, or corrosion.

3.16 Life. When tested as specified in 4.6.12, resistors shall dissipate not less than the rated power input (see 3.1) without exceeding a change in resistance in excess of $\pm(1 \text{ percent} + 0.05 \text{ ohm})$ between the initial measurement and any succeeding measurement. The insulation resistance shall be not less than 10,000 megohms, and there shall be no evidence of mechanical damage.

3.17 Shock, (specified pulse). When resistors are tested as specified in 4.6.13, there shall be no electrical discontinuity during the test, the change in resistance shall not exceed $\pm(0.2 \text{ percent} + 0.05 \text{ ohm})$, and there shall be no evidence of mechanical damage. Resistors shall meet the dielectric withstanding voltage requirements specified in 3.11.

3.18 Vibration, high frequency. When resistors are tested as specified in 4.6.14, there shall be no electrical discontinuity during the test, the change in resistance shall not exceed $\pm(0.2 \text{ percent} + 0.05 \text{ ohm})$, and there shall be no evidence of mechanical damage. Resistors shall meet the dielectric withstanding voltage requirements specified in 3.11.

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3.19 Marking. Resistors shall be marked with the type designation and the manufacturer's name, trademark, or code symbol. All markings may appear on one flat at the manufacturer's option; however, all markings must be visible after mounting. There shall be no space between the symbols which comprise the type designation. Markings shall remain legible at the end of all tests.

3.20 Workmanship. Resistors shall be processed in such a manner as to be uniform in quality and shall be free from corrosion, holes, fissures, chips, and other defects that may affect life, serviceability, or appearance.

3.20.1 Soldering. Where soldering is employed, only noncorrosive fluxes shall be used, unless it can be shown that corrosive elements have been satisfactorily removed after soldering. Solder shall not be used for obtaining mechanical strength. Electrical connections shall be mechanically secure before soldering and electrically continuous after soldering. Except for solder used to coat the terminals, the solder used shall in no case start to melt at a temperature less than +300°C.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in this specification where such inspections are deemed necessary to ensure supplies and service conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.1.2 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 inspection requirements specified herein are 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. Unless otherwise specified herein, all inspections shall be made at room ambient temperature, relative humidity, and pressure.

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 to this specification. The sample shall be taken from a production run and shall be produced with equipment and procedures normally used in production.

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4.4.2 Test routine. Sample units shall be subjected to the qualification inspection specified in table III, in the order shown. All sample units except those listed under group IA shall be subjected to the inspection of group I. The 18 sample units shall then be divided equally into 3 groups of 6 sample units each, for groups II to IV inclusive, and subjected to the inspection for their particular group. The uncoated or enclosed sample units shall be subjected to the inspection of group V.

4.4.3 Defectives. Failures in excess of those allowed in table III 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 inspections. Delivery of products which have passed the groups A and B inspections shall not be delayed pending the results of group C inspection.

4.5.1.1 Inspection lot. An inspection lot, as far as practical, shall consist of all resistors of the same style, produced under essentially the same conditions, and offered for inspection at one time. Two or more resistance values may be grouped together in one lot provided they are otherwise alike.

4.5.1.1.1 Production lot. A production lot shall consist of all resistors of the same style, nominal resistance value, and termination type.

4.5.1.2 Group A inspection. Group A inspection shall consist of the inspection specified in table IV, and shall be made on the same set of sample units, in the order shown.

4.5.1.2.1 Sampling plan (group A).

4.5.1.2.1.1 Subgroup 1. A sample of parts from each inspection lot shall be randomly selected in accordance with table V. If one or more defects are found, the lot shall be rescreened and defects removed. After screening and removal of defects, a new sample of parts shall be randomly selected in accordance with table V. If one or more defects are found in the second sample, the lot shall be rejected and shall not be supplied to this specification. Resistance values in the samples shall be representative, and where possible, in proportion to the resistors in the inspection lot.

4.5.1.2.1.2 Subgroup 2. A sample of parts from each inspection lot shall be randomly selected in accordance with table V. If one or more defects are found, the lot shall be rescreened and defects removed. After screening and removal of defects, a new sample of parts shall be randomly selected in accordance with table V. If one or more defects are found in the second sample, the lot shall be rejected and shall not be supplied to this specification.

4.5.1.2.1.3 Subgroup 3 (solderability).

4.5.1.2.1.3.1 Sampling plan (subgroup 3). Five samples shall be selected randomly from each inspection lot and subjected to the subgroup 3 solderability test. If there are one or more defects, the lot shall be considered to have failed.

4.5.1.2.1.3.2 Rejected lots. In the event of one or more defects, the inspection lot is rejected. The manufacturer may use one of the following options to rework the lot:

- a. Each production lot that was used to form the failed inspection lot shall be individually submitted to the solderability test as required in 4.6.3. Production lots that pass the solderability test are available for shipment. Production lots failing the solderability test can be reworked only if submitted to the solder dip procedure in 4.5.1.2.1.3.2b.
- b. The manufacturer submits the failed lot to a 100 percent solder dip using an approved solder dip process in accordance with 3.4.4.1. Following the solder dip, the electrical measurements required in group A, subgroup 2 tests shall be repeated on 100 percent of the lot. The Percent Defective Allowable (PDA) for the electrical measurements shall be as for the subgroup 1 tests. Thirteen additional samples shall then be selected and subjected to the solderability test with zero defects allowed. If the lot fails this solderability test, the lot shall be reworked a second time and retested. If the lot fails the second rework, the lot shall be considered rejected and shall not be furnished against the requirements of this specification.

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TABLE III. Qualification inspection.

Inspection	Requirement paragraph	Method paragraph	Number of defectives allowed ^{1/}
<u>Group I (18 coated or enclosed sample units)</u>			
DC resistance ^{2/}	3.6	4.6.1	0
Visual and mechanical inspections ^{3/}	3.1, 3.3, to 3.4.5 incl, and 3.19 to 3.20.1 incl	4.6.2	
<u>Group IA (4 coated or enclosed sample units) ^{4/}</u>			
Solderability ^{5/}	3.7	4.6.3	1
Terminal strength	3.8	4.6.4	
<u>Group II (6 coated or enclosed sample units)</u>			
Resistance-temperature characteristic ^{2/}	3.9	4.6.5	1
Temperature	3.10	4.6.6	
Dielectric withstanding voltage	3.11	4.6.7	
Insulation resistance	3.12	4.6.8	
Thermal shock	3.13	4.6.9	
Momentary overload	3.14	4.6.10	
Moisture resistance	3.15	4.6.11	
<u>Group III (6 coated or enclosed sample units)</u>			
Life	3.16	4.6.12	1
<u>Group IV (6 coated or enclosed sample units)</u>			
Shock, (specified pulse)	3.17	4.6.13	1
Vibration, high frequency	3.18	4.6.14	
<u>Group V (4 uncoated or unenclosed sample units)</u>			
Visual and mechanical inspections	3.1, 3.3 to 3.4.1.3 incl, 3.4.4, and 3.20 to 3.20.1 incl	4.6.2	0

^{1/} Failure of a resistor in one or more tests of a group shall be charged as a single defect.

^{2/} Nondestructive tests.

^{3/} Marking shall be considered defective only if marking on any portion thereof is illegible. Marking shall remain legible at the end of all tests.

^{4/} These sample units are subjected to group IA only.

^{5/} As applicable (see 3.1).

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TABLE IV. Group A inspection.

Inspection	Requirement paragraph	Method paragraph	Number of samples
<u>Subgroup 1</u>			
DC resistance	3.6	4.6.1	4.5.1.2.1.1
<u>Subgroup 2</u>			
Visual and mechanical inspections	---	4.6.2	4.5.1.2.1.2
Material	3.3 and 3.4.3	---	"
Dimensions	3.4 to 3.4.1.3 incl	---	"
Design and construction (other than dimensions)	3.4.2 to 3.4.5 incl	---	"
Marking	3.19	---	"
Workmanship	3.20	---	"
Soldering	3.20.1	---	"
<u>Subgroup 3</u>			
Solderability	3.7	4.6.3	4.5.1.2.1.3

TABLE V. Group A sampling plan.

Lot size	Subgroup 1 sample size	Subgroup 2 sample size
2 to 13	100 percent	100 percent
14 to 125	100 percent	13
126 to 150	125	13
151 to 280	125	20
281 to 500	125	29
501 to 1200	125	34
1201 to 3200	125	42
3201 to 10000	192	50
10001 to 35000	294	60
35001 to 150000	294	74
150001 to 500000	345	90
500001 and over	435	102

4.5.1.2.1.3.3 Disposition of samples. The solderability test is considered a destructive test and samples submitted to the solderability test shall not be supplied on the contract.

4.5.1.3 Group B inspection. Group B inspection shall consist of the tests specified in table VI, in the order shown. They shall be performed on sample units that have been subjected to and have passed the group A inspection, unless the Government considers it more practical to select a sample from the lot for group B inspection.

4.5.1.3.1 Sampling plan (group B). A sample of parts shall be randomly selected in accordance with table VII. If one or more defects are found, the lot shall be rescreened and defects removed. After screening and removal of defects, a new sample of parts shall be randomly selected in accordance with table VII. If one or more defects are found in the second sample, the lot shall be rejected and shall not be supplied to this specification.

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TABLE VI. Group B inspection.

Test	Requirement paragraph	Method paragraph
Resistance temperature characteristic	3.9	4.6.5
Temperature	3.10	4.6.6
Dielectric withstanding voltage	3.11	4.6.7
Insulation resistance	3.12	4.6.8
Thermal shock	3.13	4.6.9
Momentary overload	3.14	4.6.10

TABLE VII. Group B sampling plan.

Lot size	Sample size
2 to 5	100 percent
6 to 50	5
51 to 90	7
91 to 150	11
151 to 280	13
281 to 500	16
501 to 1,200	19
1,201 to 3,200	23
3,201 to 10,000	29
10,001 to 35,000	35
35,001 to 150,000	40
150,001 to 500,000	40
500,001 and over	40

4.5.1.3.2 Disposition of sample units. Sample units which have been subjected to group B inspection shall not be delivered on the contract or purchase order.

4.5.1.4 Group C inspection. Group C inspection shall consist of the tests specified in table VIII, in the order shown. Characteristic "N" sample units manufactured in the preceding period shall be tested in proportion to the characteristic "G" sample units subjected to these tests.

4.5.1.4.1 Sampling plan (group C).

4.5.1.4.1.1 Quarterly. Ten sample units of the same style shall be inspected quarterly. Four sample units of any resistance value shall be subjected to the tests of subgroup I. Six sample units of the same style and highest resistance value shall be subjected to the tests of subgroup II. If the number of defectives exceeds those allowed in table VIII, the sample shall be considered to have failed.

4.5.1.4.1.2 Semiannually. Twelve sample units, 6 for each of the subgroups, of the highest resistance value and in the same style shall be inspected semiannually. If the number of defectives exceeds those allowed in table VIII, the sample shall be considered to have failed.

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TABLE VIII. Group C inspection.

Test	Requirement paragraph	Method paragraph	Number of defects allowed ^{1/}
<u>Quarterly (10 sample units)</u>			
<u>Subgroup I (4 sample units)</u>			
Terminal strength ^{2/}	3.8	4.6.4	1
<u>Subgroup II (6 sample units)</u>			
Resistance-temperature characteristic	3.9	4.6.5	
Temperature	3.10	4.6.6	
Dielectric withstanding voltage	3.11	4.6.7	
Insulation resistance	3.12	4.6.8	
Thermal shock	3.13	4.6.9	
Momentary overload	3.14	4.6.10	
Moisture resistance	3.15	4.6.11	
<u>Semiannually (12 sample units)</u>			
<u>Subgroup I (6 sample units)</u>			
Life	3.16	4.6.12	1
<u>Subgroup II (6 sample units)</u>			
Shock, (specified pulse)	3.17	4.6.13	1
Vibration, high frequency	3.18	4.6.14	

^{1/} Failure of a resistor in one or more tests of an inspection period or subgroup shall be charged as a single defective.

^{2/} As applicable (see 3.1).

4.5.1.4.2 Disposition of sample units. Sample units which have been subjected to group C inspection shall not be delivered on the contract or order.

4.5.1.4.3 Noncompliance. If a sample fails to pass group C inspection, the manufacturer shall immediately notify the qualifying activity and the cognizant inspection activity of such failure and take corrective action on the materials or processes, or both, as warranted, and on all units or product which can be corrected and which were manufactured under essentially the same materials and processes, and which are considered subject to the same failure. Acceptance and shipment of the product shall be discontinued until corrective action, acceptable to the qualifying activity has been taken. After 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 qualifying activity). Groups A and B inspections may be reinstituted; however, final acceptance and shipment 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 shall be furnished to the cognizant inspection activity and the qualifying activity.

4.5.2 Inspection of packaging. The sample and inspection of the packaging, preservation, and container marking shall be in accordance with the requirements of MIL-R-39032.

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4.5.3 Retention of qualification. In order to retain qualification, the supplier shall forward a report at 6-month intervals, to the activity responsible for qualification. The qualifying activity shall establish the initial reporting date. The report shall consist of:

- a. A summary of the results of the tests performed for inspection of product for delivery (groups A and B), indicating as a minimum the number of lots that have failed. The results of tests of all reworked lots shall be identified and accounted for.
- b. A summary of the results of tests performed for qualification verification inspection (group C), including the number and mode of failures. The summary shall include results of all qualification verification inspection tests performed and completed during the 6-month period. If the summary of the test results indicates nonconformance with specification requirements, and corrective action acceptable to the qualifying activity has not been taken, action may be taken to remove the failing product from the qualified products list.

Failure to submit the report within 30 days after the end of each 6-month period may result in loss of qualification for the 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 this specification.

In the event that no production occurred during the reporting period, a report shall be submitted certifying that the company still has the capabilities and facilities necessary to produce the item. If during two consecutive reporting periods there has been no production, the manufacturer may be required, at the discretion of the qualifying activity, to submit his qualified products to testing in accordance with the qualification inspection requirements.

4.5.4 Alternate inspection. For the purpose of retention of qualification and quality conformance inspection (see 4.5 and 4.5.3), test data on identical items covered by MIL-R-39009 may be used.

4.6 Methods of inspections.

4.6.1 DC resistance (see 3.6). Resistors shall be tested in accordance with method 303 of MIL-STD-202. The following details and exceptions shall apply:

- a. The same measuring apparatus shall be used for any one test, but not necessarily for all tests.
- b. Test voltage: The test voltage shall not exceed 1 percent of rated dc voltage (see 3.1). The voltage used for initial measurement shall be used for all subsequent measurements.

4.6.2 Visual and mechanical inspections. Resistors shall be inspected 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 3.4.5 inclusive, and 3.19 to 3.20.1 inclusive).

4.6.3 Solderability (see 3.7). Resistors shall be tested in accordance with method 208 of MIL-STD-202. The following details shall apply:

- a. Both terminals of each sample shall be tested.
- b. Terminals shall be immersed sufficiently to cover the flat portion.

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4.6.4 Terminal strength (see 3.1 and 3.8). 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 E (pull test and torque test, respectively): Test condition A for all terminal types, and test condition E for screw-thread terminals.
- b. Method of holding:
 - (1) Test condition A: The resistor body shall be firmly mounted and the specified direct pull (see 3.1) applied to the hole or nut of each terminal, as applicable, for at least 30 seconds, one terminal at a time.
 - (2) Test condition E: The resistor body shall be firmly mounted and the specified torque (see 3.1) shall be applied to each terminal, one at a time.
- c. Measurement before and after test: DC resistance shall be measured as specified in 4.6.1.
- d. Inspection after test: Resistors shall be inspected for evidence of mechanical damage.

4.6.5 Resistance-temperature characteristic (see 3.9). Resistors shall be tested in accordance with method 304 of MIL-STD-202. The following detail shall apply: Test temperature shall be in accordance with table IX.

4.6.6 Temperature (see 3.10). Following a resistance measurement (see 4.6.1), resistors shall be placed in an oven at room temperature. The temperature of the oven shall then be elevated gradually to +250°C +0°C, -5°C. The transition period from room temperature to +250°C +0°C, -5°C shall be accomplished in not more than 45 minutes. For product acceptance inspection, at the option of the supplier, resistors may be placed in an oven whose temperature has already been brought up to +250°C +0°C, -5°C. The resistors shall be conditioned at this temperature for a period of 2 hours. They shall then be allowed to cool gradually to room temperature, after which they shall be visually inspected for evidence of mechanical damage, and the resistance shall be measured as specified in 4.6.1 (see 3.10).

4.6.7 Dielectric withstanding voltage (see 3.11).

4.6.7.1 Atmospheric pressure. Resistors shall be tested in accordance with method 301 of MIL-STD-202. The following details shall apply:

- a. Special preparations: Resistors shall be mounted firmly on a metal plate by means of the normal mounting hardware. The plate shall be of sufficient size to extend beyond the resistor extremities.
- b. Magnitude of test voltage: As specified in 3.1.
- c. Nature of potential: An ac supply at commercial-line frequency and waveform.
- d. Points of application of test voltage: Between the terminals tied together and mounting plate, making certain that there is good electrical contact between the metal of the mounting tab, if any, and mounting plate.
- e. Measurements and inspection: Resistance (see 4.6.1) shall be measured before the test. At the conclusion of the test, resistors shall be inspected for evidence of damage, arcing, flashover, and insulation breakdown.

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

Sequence	Temperature °C	
	For qualification inspection	For quality conformance inspection 2/
1	+25 1/	+25 1/
2	-55	-55
3	+25 1/	+25 1/
4	+125	---
5	+200	---
6	+250	+250

1/ This temperature shall be considered the reference temperature for each of succeeding temperatures.

2/ At the option of the manufacturer, the reverse sequence may be as follows:

Sequence 1: +25°C 1/
Sequence 2: +250°C
Sequence 3: +25°C 1/
Sequence 4: -55°C

4.6.7.2 At reduced barometric pressure. Following the test specified in 4.6.7.1, resistors shall be tested in accordance with method 105 of MIL-STD-202. The following details shall apply:

- a. Method of mounting: As specified in 4.6.7.1a.
- b. Test condition C.
- c. Magnitude of test voltage: As specified in 3.1.
- d. Nature of potential: As specified in 4.6.7.1c.
- e. Points of application of test voltage: As specified in 4.6.7.1d.
- f. Measurements and inspection: At the conclusion of the test, resistance shall be measured (see 4.6.1). Resistors shall also be inspected for evidence of damage, arcing, flashover, and insulation breakdown.

4.6.8 Insulation resistance (see 3.12). Resistors shall be tested in accordance with method 302 of MIL-STD-202. The following details shall apply:

- a. Test condition A.
- b. Special preparations: As specified in 4.6.7.1a.
- c. Points of measurement: As specified in 4.6.7.1d.

4.6.9 Thermal shock (see 3.13). Resistors shall be mounted as specified in 4.6.12.1. Following a measurement of resistance (see 4.6.1), rated voltage from an ac supply at commercial-line frequency and waveform (see 3.5) shall be applied until thermal stability has been reached. The potential shall then be removed and within 8 to 12 seconds, the resistors shall be subjected to an air temperature of -55°C +0°C, -5°C for a period of not less than 15 minutes nor more than 30 minutes. Resistance (see 4.6.1) shall again be measured not less than 2 hours after final exposure. Resistors shall then be inspected for evidence of mechanical damage (see 3.13).

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4.6.10 Momentary overload (see 3.14). Resistors shall be mounted as specified in 4.6.12.1. One of the resistor terminals shall be grounded to the resistor housing during the test. Following a measurement of resistance (see 4.6.1), a test potential from an ac supply at commercial-line frequency and waveform which will result in five times the rated wattage (see 3.1), but not to exceed the specified voltage used for the dielectric-withstanding voltage test (atmospheric pressure) (see 3.1), shall be applied to the resistors for 5 seconds. Resistors (see 4.6.1) shall be measured after the resistors have stabilized at room temperature. Resistors shall then be inspected for evidence of arcing, burning, and charring (see 3.14).

4.6.11 Moisture resistance (see 3.15). Resistors shall be tested in accordance with method 106 of MIL-STD-202. The following details and exceptions shall apply:

- a. Mounting: Resistors under load shall be mounted as specified in 4.6.12.1. Resistors under polarization shall be mounted as specified in 4.6.7.1a.
- b. Initial measurements: Resistors shall be measured as specified in 4.6.1.
- c. Load and polarization: One-half of the resistors shall be subjected to load and the remaining half to polarization.
 - (1) Load: During the first 2 hours of each of steps 1 and 4, the rated dc continuous working voltage (see 3.5), derated in accordance with figure 1 to the temperature attained at the end of the two-hour period, shall be applied to the resistors. The negative terminals shall be electrically grounded to the mounting surface.
 - (2) Polarization: During steps 1 to 6 inclusive, a potential of 100 volts dc shall be applied with the positive side connected to the terminals tied together, and the negative side connected to the mounting plate.
- d. Final measurements and inspection: At the end of the final cycle, the resistors shall be removed from the chamber, conditioned at room ambient conditions, and the dc resistance and insulation resistance shall be measured as specified in 4.6.1 and 4.6.8, respectively, within 30 \pm 15 minutes of removal from the chamber. The resistors shall not be wiped or forced air dried prior to these measurements. Resistors shall then be inspected for evidence of breaking, cracking, loosening of terminals and corrosion. (The subsequent 4- to 24-hour conditioning period and measurements do not apply).

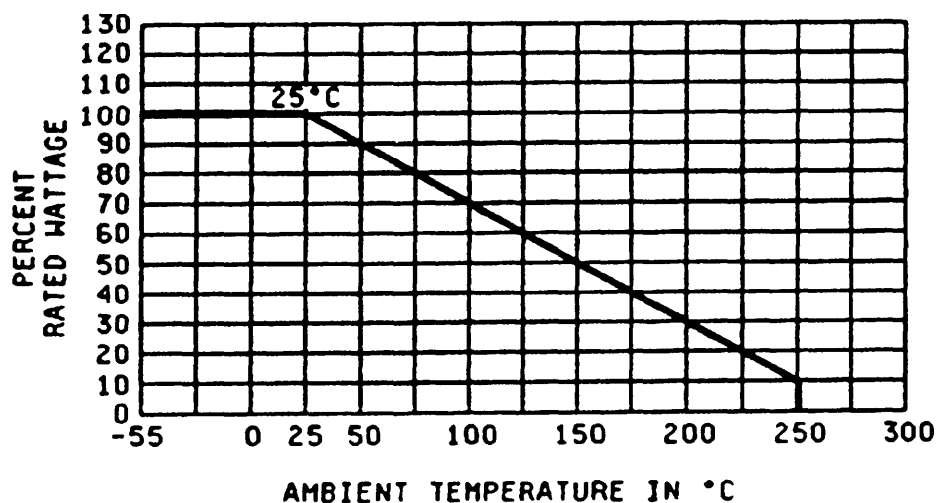


FIGURE 1. Derating curves for high ambient temperatures.

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4.6.12 Life (see 3.16).

4.6.12.1 Test conditions. Life test shall be conducted at an ambient temperature of $+25^{\circ}\text{C} \pm 2^{\circ}\text{C}$. The resistor shall be centrally mounted by normal mounting means on an aluminum chassis of the dimensions specified (see 3.1). The resistor shall be mounted with the longitudinal axis of the resistor parallel to the longitudinal axis of the chassis. The chassis shall be horizontally-supported by a material having a low thermal conductivity. 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. The voltage used shall be the rated continuous working voltage (see 3.5) from an ac supply at commercial-line frequency and waveform, and adequate precaution shall be taken to maintain constant voltage on resistors under test.

4.6.12.2 Procedure. Following a measurement of resistance (see 4.6.1), the test potential shall be applied intermittently, 1 hour 30 minutes on, and 30 minutes off, for a total of $1,000 \pm 12$ hours. Resistance measurements (see 4.6.1) shall be made at the end of the 30-minute off periods after the following hours have elapsed:

250 ± 72 , -24 hours;
 500 ± 72 , -24 hours;
 750 ± 72 , -24 hours;
 1,000 ± 72 , -24 hours

Resistance and insulation resistance as specified in 4.6.1 and 4.6.8, respectively, shall be measured. Resistors shall then be inspected for evidence of mechanical damage.

4.6.13 Shock (specified pulse) (see 3.17). Resistors shall be tested in accordance with method 213, condition I, of MIL-STD-202. The following details shall apply:

- a. Mounting: Resistors shall be mounted by their normal mounting means as specified in 4.6.12.1 on an appropriate mounting fixture. The mounting fixture shall be constructed in such a manner as to insure that the mounting supports remain in a static condition with reference to the shock table. Resistors shall be mounted in such a manner that the stress applied is in the direction which would be considered most detrimental.
- b. Test condition C.
- c. Measurement before shock: Resistance, as specified in 4.6.1.
- d. 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 discontinuity having a duration of 0.1 millisecond as well as those of greater duration.
- e. Measurement, inspection, and test after shock: Resistance (see 4.6.1) shall be measured, and the resistors inspected for evidence of mechanical damage. Resistors shall then be subjected to the dielectric withstanding voltage test (at atmospheric pressure) as specified in 4.6.7.1.

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4.6.14 Vibration, high frequency (see 3.18). Resistors shall be tested in accordance with method 204 of MIL-STD-202. The following details shall apply:

- a. Mounting: Resistors shall be mounted by their normal mounting means as specified in 4.6.12.1 on a vibration test jig. The jig shall be so constructed so as to preclude any resonances within the test range. 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.
- b. Test condition B.
- c. Measurement before vibration: Resistance, as specified in 4.6.1.
- d. Measurement during vibration: 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 discontinuity having a duration of 0.1 millisecond or less, as well as those of greater duration.
- e. Measurement, inspection, and test after vibration: Resistance (see 4.6.1) shall be measured, and the resistors inspected for evidence of mechanical damage. Resistors shall then be subjected to the dielectric withstanding voltage test (atmospheric pressure) as specified in 4.6.7.1.

5. PACKAGING

5.1 Packaging requirements. The requirements for packaging shall be in accordance with MIL-R-39032.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of this specification.
- b. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1)
- c. Title, number, and date of the applicable detail specification, and the complete PIN (see 1.2.1 and 3.1).
- d. Levels of preservation and packaging and packing, and applicable marking (see section 5).

6.2 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified 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 contractors is called to these requirements, 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 purchase orders for the products covered by this specification. The activity responsible for the qualified products list is the Space and Naval Warfare Systems Command and information pertaining to qualification of products may be obtained from the Defense Electronics Supply Center (DESC-ELS), 1507 Wilmington Pike, Dayton, OH 45444-5764.

6.3 Part or Identifying Number (PIN). PIN is a new term encompassing previous terms used in specifications such as part number, type designator, identification number, etc. (see 1.2.1).

6.4 Retinning leads. If retinning (hot solder dip) of the leads is required (see 3.4.4.1).

6.5 Subject term (key word) listing.

Resistor, fixed
Resistor, power type
Resistor, wirewound
Resistor, chassis mount

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6.6 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

CONCLUDING MATERIAL

Custodians:

Army - ER

Navy - EC

Air Force - 85

Review activities:

Army - AR, MI

Navy - MC

Air Force - 17, 99

Preparing activity:

DLA - ES

(Project 5905-1292)

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APPENDIX

PROCEDURE FOR QUALIFICATION INSPECTION

10. SCOPE

10.1 Scope. This appendix details the procedure for submission of samples, with related 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. This appendix is a mandatory part of the specification. The information contained herein is intended for compliance only.

20. APPLICABLE DOCUMENTS. This section is not applicable to this appendix.

30. SUBMISSION

30.1 Sample. A sample consisting of 18 coated or enclosed and 4 uncoated or unenclosed sample units, of the highest resistance value, and in addition, a sample consisting of 4 coated or enclosed sample units of any resistance value, shall be submitted for each style and characteristic for which qualification is sought. If the same coating or enclosure is not used, a separate sample shall be submitted for each coating and enclosure for which qualification is sought. Samples shall be representative of the supplier's normal production. Extension of qualification between characteristics shall be as specified in 30.2.

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

30.3 Description of items. The manufacturer shall submit a detailed description of the resistors being submitted for qualification, including wire used for the resistance element, the type of coating or enclosure, and the material used for the housing and terminals.

40. EXTENSION OF QUALIFICATION

40.1 Extent of qualification. Qualification of a particular style and resistance value will qualify a range of resistance values from the smallest value manufactured in that style to the resistance value qualified.

40.2 Characteristics W and G. Qualification of characteristic "W" resistors will also qualify corresponding characteristic "G" resistors. Qualification of maximum resistance value in characteristic "W" will also qualify highest resistance value in characteristic "G".

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:

1. DOCUMENT NUMBER
MIL-R-18546

2. DOCUMENT DATE (YYMMDD)

3. DOCUMENT TITLE

RESISTORS, FIXED, WIRE-WOUND (POWER TYPE, CHASIS MOUNTED), GENERAL SPECIFICATION FOR

4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle Initial)

b. ORGANIZATION

c. ADDRESS (Include Zip Code)

d. TELEPHONE (Include Area Code)

e. DATE SUBMITTED (YYMMDD)

(1) Commercial

(2) AUTOVON
(If applicable)

8. PREPARING ACTIVITY

a. NAME
COMMANDER, DEFENSE ELECTRONICS SUPPLY
CENTER

b. TELEPHONE (Include Area Code)
(1) Commercial 513-296-6063

(2) AUTOVON
986-6063

c. ADDRESS (Include Zip Code)
ATTN: DESC-ES,
1507 WILMINGTON PIKE, DAYTON, OH
45444-5274

IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT:
Defense Quality and Standardization Office
5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466
Telephone (703) 756-2340 AUTOVON 289-2340