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TABLE I. Characteristic.

Symbol	Temperature coefficient	Capacitance drift
	Parts/million/°C	
C	-200 to +200	±(0.5 percent +0.1 pF)
E	-20 to +100	±(0.1 percent +0.1 pF)
F	0 to +70	±(0.05 percent +0.1 pF)

1.2.1.3 Capacitance. The nominal capacitance value expressed in picofarads (pF) is identified by a three-digit number; the first two digits represent significant figures and the last digit specifies the number of zeros to follow. When the nominal value is less than 10 pF, the letter R shall be used to indicate the decimal point and the succeeding digit(s) of the group shall represent significant figure(s). For example 1R0 indicates 1.0 pF; R75 indicates 0.75 pF; and DR5 indicates 0.5 pF.

1.2.1.4 Capacitance tolerance. The capacitance tolerance in percent or pF, as applicable, is identified by a single letter in accordance with table II.

TABLE II. Capacitance tolerance.

Symbol	Capacitance tolerance
	(±)
D	0.5 pF
F	1 percent
G	2 percent
J	5 percent

1.2.1.5 Operating temperature range. The operating temperature range is identified by a single letter in accordance with table III.

TABLE III. Operating temperature range.

Symbol	Operating temperature range
	°C
O	-55 to +125
P	-55 to +150

1.2.1.6 Rated voltage. The rated voltage is identified by a single letter in accordance with table IV.

TABLE IV. Rated voltage.

Symbol	DC rated voltage
A	100
C	300
D	500
Y	50

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1.2.1.7 Failure rate level. The failure rate level in percent per 1,000 hours is identified by a single letter in accordance with table V, and is based on rated voltage at 125°C or 150°C, as applicable.

TABLE V. Failure rate level.

Symbol	Failure rate level (percent per 1,000 hours)
M	1.0
P	0.1
R	0.01
S	0.001

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 6.2).

SPECIFICATIONS

MILITARY

- MIL-C-5 - Capacitors, Fixed, Mica Dielectric, General Specification For.
- MIL-C-39001/5 - Capacitors, Fixed, Mica Dielectric, Established Reliability, Styles CMR03, CMR04, CMR05, CMR06, CMR07, and CMR08.
- MIL-C-39001/6 - Capacitors, Fixed, Mica Dielectric, Established Reliability, Style CMR16.
- MIL-C-39028 - Capacitors, Packaging of.

STANDARDS

MILITARY

- MIL-STD-202 - Test Methods for Electronic and Electrical Components Parts.
- MIL-STD-690 - Failure Rate Sampling Plans and Procedures.
- MIL-STD-790 - Reliability Assurance Program for Electronic Parts Specifications.
- MIL-STD-810 - Environmental Test Methods.
- MIL-STD-1276 - Leads for Electronic Component Parts.
- MIL-STD-1285 - Marking of Electrical and Electronic Parts.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2 Non-Government publications. The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

- EIA-554 - Assessment of Outgoing Nonconforming Levels in Parts Per Million (PPM).
- EIA-557 - Statistical Process Control Systems.

(Application for copies should be addressed to the Electronic Industries Association, 2001 Eye Street, NW, Washington, DC 20006).

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, specification sheets, or MS standards), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

### 3. REQUIREMENTS

3.1 Specification sheet. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheet. In the event of any conflict between the requirements of this specification and the specification sheet, the latter shall govern (see 6.2).

3.2 Qualification. Capacitors 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 6.4). In addition, the manufacturer shall obtain certification from the qualifying activity that the reliability assurance requirements of 4.1.1 have been met and are being maintained. Authorized distributors which are approved to MIL-STD-790 distributor requirements by the qualified products list (QPL) manufacturers are listed in the QPL.

### 3.3 Reliability and quality.

3.3.1 Reliability. Reliability of capacitors furnished under this specification shall be established and maintained in accordance with the procedures and requirements specified in MIL-STD-790 and MIL-STD-690 with details specified in 4.1.1, 4.4.4, and 4.5.

#### 3.3.2 Quality.

3.3.2.1 Statistical process control. The contractor shall implement and use statistical process control techniques in the manufacturing process for parts covered by this specification. The SPC program shall be developed and maintained in accordance with all the requirements of EIA-557. The SPC program shall be documented and maintained as part of the overall reliability assurance program as specified in MIL-STD-790. The implementation of statistical process control shall be 12 months from the date of this specification. Processes for application of SPC techniques should include but are not limited to:

- Section assembly
- Section clamping
- Visual inspection clamped sections
- Encapsulation
- Group A SG3 - Visual/Mechanical
- High voltage stabilization
- Group A SG2 - Capacitance/DF
- Marking
- Quality assurance audit

3.3.2.2 Quality levels. The quality of lots that have been subject to and passed the subgroup 1 100 percent screening inspection of the group A inspection shall be established and maintained in accordance with 4.4.4.2 and EIA-554. Individual PPM defect level (i.e., PPM-2 and PPM-3) and an overall PPM defect level (i.e., PPM-5) shall be established based on the tests prescribed in the subgroup 2 tests of the group A inspections. The defect level of PPM-2 shall be less than 100 PPM. The implementation of part per million verification shall be 12 months from the date of this specification.

3.3.2.2.1 Noncompliance. The contractor shall notify the qualifying activity when the 100 PPM level is reached or exceeded for PPM-2. The contractor shall provide sufficient information to the qualifying activity documenting the causes of the problem and what corrective action is being taken. Failure to correct this problem shall be the basis for removal of the affected product from the QPL.

3.4 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 capacitors 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.

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3.4.1 Insulating, impregnating, and sealing compounds. Insulating, impregnating, and sealing compounds, including varnishes, waxes, and the like, shall be suitable for each particular application. Compounds shall preserve the electrical characteristics of the insulation to which applied. The compound, either in the state of its original application or as a result of cracking or aging, shall have no adverse effect on the performance of the capacitor.

3.4.2 Terminal leads. Leads shall be made of a solid conductor of the length and diameter specified (see 3.1), and shall be coated with solder having a tin content of 40 to 75 percent and shall meet the solderability requirements of 3.12.

3.4.2.1 Solder dip (retinning) leads. Only the manufacturer (or his authorized category B or C distributor) may solder dip/retin the leads of product supplied to this specification provided the solder dip process has been approved by the qualifying activity (see 3.4.2.3).

3.4.2.2 Qualifying activity approval. Approval of the solder dip process shall 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 a., approval for the process to be used for solder dip shall be based on the following test procedure:
  - (1) Thirty samples of any capacitance value for each style and lead finish are subjected to the manufacturing's solder dip process. Following the solder dip process, the capacitors are subject to the high voltage stabilization, DWV, IR, CAP, and DF measurements. 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 subject to the resistance to solder heat test. No defects are allowed. (Note: Solder dip of gold plated leads is not allowed.)

3.4.2.3 Solder dip/retinning options. The manufacturer (or authorized category B or C distributor) may solder dip/retin as follows (see 3.4.2.1):

- a. As a corrective action if the lot fails the group A solderability test.
- b. After the group A inspection has been completed, following the solder dip/retinning process, the high voltage stabilization, DWV, IR, CAP, and DF measurements shall be performed on 100 percent of the lot. The percent defective allowable (PDA) for the electrical measurements shall be as for the subgroup 1 tests. Following these tests, the manufacturer shall submit the lot to the group A solderability test as specified in 4.7.8.

3.5 Design and construction. Capacitors shall be of the design, construction, and physical dimensions specified (see 3.1).

3.5.1 Body enclosure. Capacitors shall be effectively sealed against the entry of moisture, and the elements shall be mounted so as to prevent injurious movement in the capacitor body enclosures. The capacitor elements shall be completely enclosed by the body enclosure.

3.5.2 Connections. Internal electrical connections shall be secured by pressure and not depend upon the case material for maintenance of contact over the operating temperature range. Connections between the terminal clip and the active element shall be secured by soldering or welding. The connection between the lead wire and the terminal clip shall be soldered or welded.

3.6 Dielectric withstanding voltage. Capacitors shall withstand the direct-current (dc) potential specified in 4.7.2 without damage, arcing, or breakdown.

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3.7 High voltage stabilization. When capacitors are tested as specified in 4.7.3, there shall be no evidence of damage, arcing, or breakdown; and the insulation resistance shall be not less than the applicable value specified on figure 1 or in table VI.

3.8 Barometric pressure. Capacitors shall withstand the dc potential specified in 4.7.4 without damage, arcing, or breakdown.

3.9 Insulation resistance (see 4.7.5).

3.9.1 At room ambient temperature. When measured as specified in 4.7.5.1, the insulation resistance shall be not less than the applicable value specified on figure 1 or in table VI.

3.9.2 At high ambient temperature. When measured as specified in 4.7.5.2, the insulation resistance shall be not less than the applicable value specified on figure 1 or in table VI.

TABLE VI. Insulation resistance.

Capacitance rating	Minimum insulation resistance
<u>At 25°C</u>	
0 to 10,000 picofarads	100,000 megohms
10,000 picofarads and greater	1,000 megohm-microfarads <sup>1/</sup>
<u>At 125°C</u>	
0 to 3,300 picofarads	10,000 megohms
3,300 picofarads and greater	33 megohm-microfarads
<u>At 150°C</u>	
0 to 1,500 picofarads	5,000 megohms
1,500 picofarads and greater	7.5 megohm-microfarads

<sup>1/</sup> Product obtained by multiplying the capacitance in microfarads by the insulation resistance in megohms.

3.10 Capacitance. When measured as specified in 4.7.6, the capacitance shall be within the tolerance shown in the type designation (see 3.1).

3.11 Dissipation factor. When measured as specified in 4.7.7, the dissipation factor shall not exceed the applicable value shown on figure 2.

3.12 Solderability. When capacitors are tested as specified in 4.7.8, the dipped surface of the lead shall be at least 95 percent covered with continuous new solder coating. The remaining 5 percent of the lead surface shall show only small pinholes or voids. These shall not be concentrated in one area. No individual view of the dipped surface shall show less than 95 percent coverage. Bare base metal and areas where the solder dip failed to cover the original coating are indications of poor solderability, and shall be cause for failure. In case of dispute, the percent of coverage with pinholes or voids shall be determined by actual measurement of these areas, as compared to the total area.

3.13 Vibration. When capacitors are tested as specified in 4.7.9, there shall be no intermittent contacts of 0.5 milliseconds (ms) or greater duration, or momentary arcing, or other indication of breakdown, nor shall there be any open- or short-circuiting or evidence of mechanical damage.

3.14 Temperature coefficient and capacitance drift. When measured as specified in 4.7.10, the temperature coefficient and capacitance drift shall be within the limits specified in table I for the characteristic listed (see 3.1).

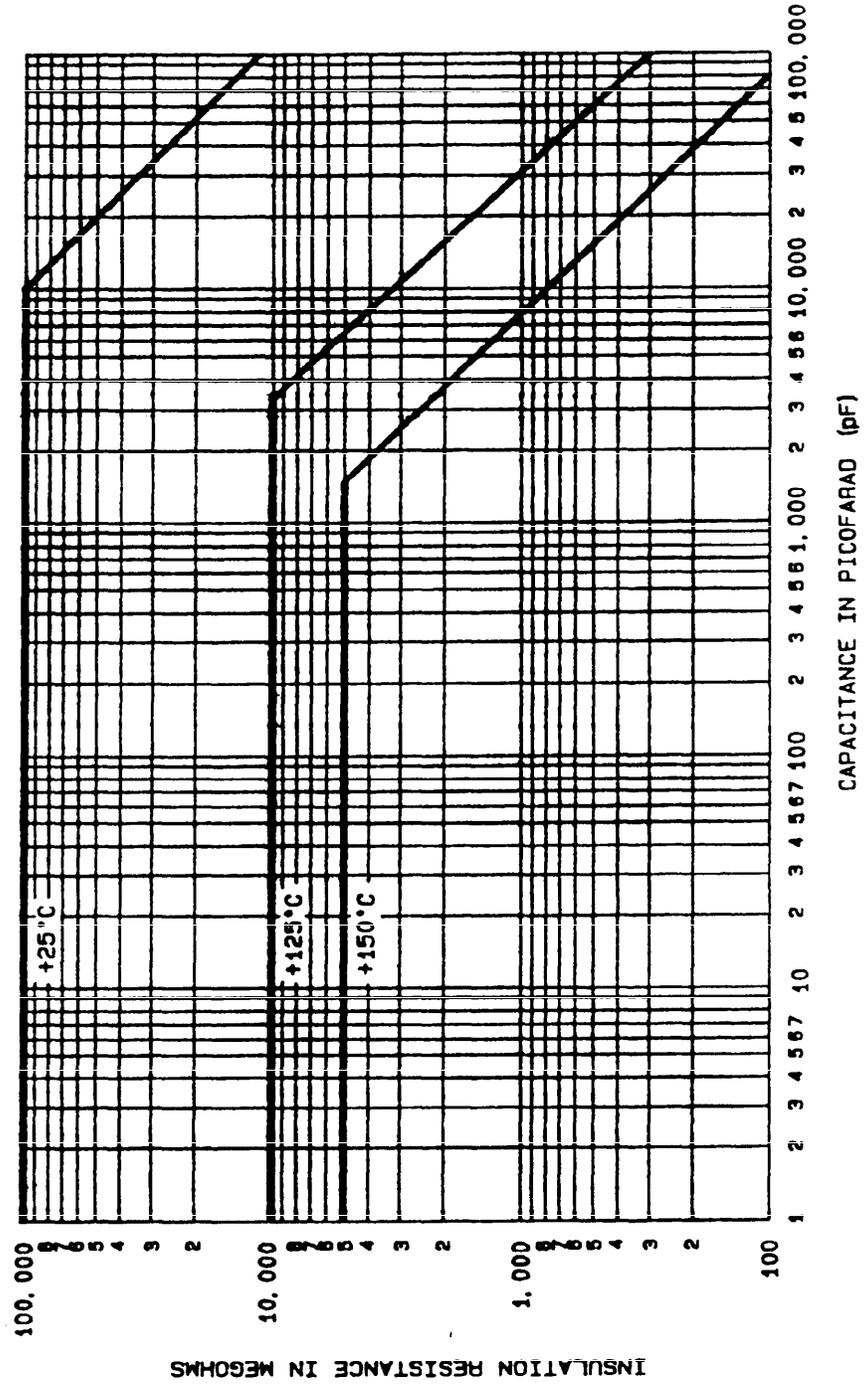


FIGURE 1. Insulation resistance versus capacitance at test temperatures.

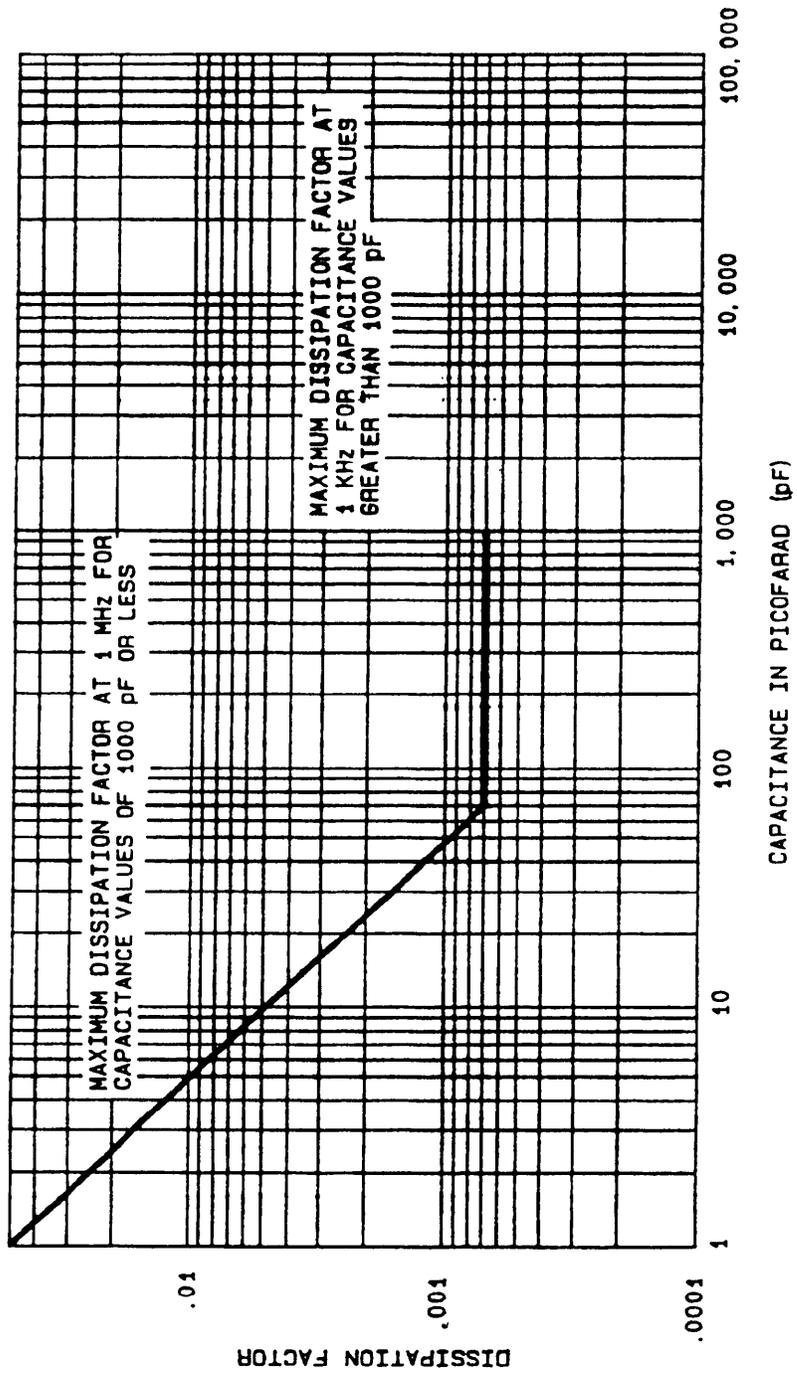


FIGURE 2. Capacitance versus dissipation factor.

3.15 Thermal shock and immersion. When tested as specified in 4.7.11, capacitors shall meet the following requirements:

- a. Dielectric withstanding voltage: As specified in 3.6.
- b. Insulation resistance: Shall be not less than 30 percent of initial requirement (see 3.9).
- c. Capacitance: The capacitance change shall not exceed 1 percent or 1 pF, whichever is greater, from the reference measurement (see 4.3.2.1).
- d. Dissipation factor: Shall not exceed 150 percent of the initial requirement specified in 3.11.
- e. Visual examination: No visible evidence of deterioration, permanent damage to leads or case, or corrosion on leads.

3.16 Shock, specified pulse. When capacitors are tested as specified in 4.7.12, there shall be no intermittent contacts of 0.5 milliseconds (ms) or greater duration, or momentary arcing, or other indication of breakdown, nor shall there be any open- or short-circuiting or evidence of mechanical damage.

3.17 Terminal strength. When capacitors are tested as specified in 4.7.13, the terminals shall not loosen or rupture and no other damage shall result. Chipping of the resinous coating on the leads, in the R dimension area only (see 3.1), shall not be considered as a failure.

3.18 Resistance to soldering heat. When tested as specified in 4.7.14, capacitors shall meet the following requirements:

- a. Insulation resistance: Shall not be less than the initial requirement (see 3.9).
- b. Capacitance: The capacitance change shall not exceed  $\pm 5$  percent or  $\pm 5$  pF, whichever is greater, from the initial measurement.
- c. Dissipation factor: Shall not exceed initial requirement.

3.19 Moisture resistance. When tested as specified in 4.7.15, capacitors shall meet the following requirements:

- a. Dielectric withstanding voltage: As specified in 3.6.
- b. Insulation resistance: Shall be not less than 25 percent of initial requirement (see 3.9).
- c. Capacitance: The capacitance change shall not exceed 1 percent or 1 pF, whichever is greater, from the reference measurement (see 4.3.2.1).
- d. Dissipation factor: Shall not exceed 150 percent of the initial requirement specified in 3.11.
- e. Visual examination: No visible evidence of deterioration, permanent damage to the leads or case, nor corrosion on the leads.

3.20 Life. When tested as specified in 4.7.16, capacitors shall meet the following requirements:

- a. Dielectric voltage: As specified in 3.6.
- b. Insulation resistance: Shall not be less than the applicable value specified on figure 1 or in table VI.
- c. Capacitance. The capacitance change shall not exceed  $\pm 1$  percent or  $\pm 1$  pF, whichever is greater, of the initial measurement.
- d. Dissipation factor: Shall not be greater than 150 percent of initial requirement (see 3.11).
- e. Visual examination: No visible evidence of deterioration, permanent damage to leads or case, arcing, or breakdown.

3.21 Fungus. The manufacturer shall certify that all external materials are fungus resistant or shall perform the test specified in 4.7.17. When capacitors are tested as specified in 4.7.17, examination shall disclose no evidence of fungus growth on the external surface of the capacitor.

3.22 Resistance to solvents. When capacitors are tested as specified in 4.7.18, marking shall remain legible and shall not smear or rub off. In addition, there shall be no visible indication of damage or deterioration to the capacitor body.

3.23 Marking. Marking of capacitors shall conform to method 1 of MIL-STD-1285, and unless otherwise specified (see 3.1), shall include the type designation, JAN brand, trademark, source code, date code (inspection lot of 4.6.1.1.1), rated voltage, capacitance, capacitance tolerance, and highest rated temperature. Capacitors shall be marked as specified (see 3.1).

3.23.1 "JAN" and "J" marking. The United States Government has adopted, and is exercising legitimate control over the certification marks "JAN" and "J", respectively, to indicate that items so marked or identified are manufactured to, and meet all the requirements of military specifications. Accordingly, items acquired to, and meeting all of the criteria specified herein and in applicable specifications shall bear the certification mark "JAN" except that items too small to bear the certification mark "JAN" shall bear the letter "J". The "JAN" or "J" shall be placed immediately before the part number except that if such location would place a hardship on the manufacturer in connection with such marking, the "JAN" or "J" may be located on the first line above or below the part number. Items furnished under contracts or orders which either permit or require deviation from the conditions or requirements specified herein or in applicable specifications shall not bear "JAN" or "J". In the event an item fails to meet the requirements of this specification and the applicable specification sheets or associated detail specifications, the manufacturer shall remove the "JAN" or the "J" from the sample tested and also from all items represented by the sample. The "JAN" or "J" certification mark shall not be used on products acquired to contractor drawings or specifications. The United States Government has obtained Certificate of Registration No. 504,860 for the certification mark "JAN".

3.23.2 Non-established reliability (non-ER) marking. An established reliability (ER) part manufactured in accordance with this specification may be marked and furnished as a non-ER part from MIL-C-5, if produced on the same assembly line, and provided it is subjected to and meets all the inspection requirements of the ER part.

3.23.3 Substitutability of failure rate levels. A manufacturer may supply to all higher failure rate levels than to which he is qualified, see table VII. Parts qualified and marked to lower failure rate levels, with acquiring agency approval, are substitutable for higher failure rate levels, and shall not be remarked unless specified in the contract or acquisition document (see 6.2).

TABLE VII. Failure rate level substitutability.

Parts qualified to failure rate level	Are substitutable for failure rate level
S	M, P, and R
R	M and P
P	M

3.23.4 Substitutability of capacitance tolerance and rated voltage. Parts qualified and marked to tighter capacitance tolerance or higher rated voltage, with acquiring agency approval, are substitutable for parts marked to looser capacitance tolerance or lower rated voltage, provided all other values, such as case size, characteristic, and leads are the same. The substitutable parts shall not be remarked unless specified in the contract or acquisition document (see 6.2).

3.24 Workmanship. Capacitors shall be processed in such a manner as to be uniform in quality and shall be free from pits, corrosion, cracks, rough edges, and other defects that will affect life, serviceability, or appearance.

3.24.1 Soldering. Where soldering is employed, in the construction of capacitors, only fluxes with low corrosive properties shall be used, unless it can be shown that corrosive elements have been satisfactorily removed after soldering. All excess flux and solder shall be removed. Solder shall not be used primarily for obtaining mechanical strength. Electrical connections shall be electrically continuous after soldering and, where possible, mechanically secure before soldering.

## 4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the manufacturer is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the supplier may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. 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 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 Reliability assurance program. A reliability assurance program shall be established and maintained in accordance with MIL-STD-790. Evidence of such compliance shall be verified by the qualifying activity of this specification as a prerequisite for qualification and continued qualification.

4.1.3 Statistical process control (SPC). An SPC program shall be established and maintained in accordance with EIA-557. Evidence of such compliance shall be verified by the qualifying activity as a prerequisite for qualification and retention of qualification.

4.2 Classification of inspections. The inspections specified herein are classified as follows:

- a. Qualification inspection (see 4.4).
- b. Verification of qualification (see 4.5).
- c. Quality conformance inspection (see 4.6).

4.3 Inspection conditions and methods.

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

4.3.2 Methods.

4.3.2.1 Reference measurements. When requirements are based on comparative measurements made before and after conditioning, the reference measurement shall be considered the last measurement made at 25°C ±5°C prior to conditioning. Unless reference measurements have been made within 30 days prior to the beginning of conditioning, they shall be repeated.

4.3.3 Power supply. The power supply used for life testing shall have a regulation of ±2 percent or less of the applicable applied test voltage. The power supply used for dc leakage current measurements shall be stabilized to at least ±100 parts per million. No voltage fluctuations shall occur during measurements that would produce a variation in the current measurement.

4.4 Qualification inspection. 1/ Qualification inspection shall be performed at a laboratory acceptable to the Government (see 6.4), on sample units produced with equipment and procedures normally used in production.

1/ The decision as to whether or not the product will be included on the QPL will be made after successful completion of the 2,000-hour life test.

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4.4.1 Sample size. The number of sample units comprising a sample of capacitors to be submitted for qualification inspection shall be as specified in table VIII, or in the appendix of this specification. The sample shall be taken from a production run and shall be produced with equipment and procedures normally used in production. Each capacitor style shall be qualified separately.

TABLE VIII. Qualification inspection.

Inspection	Requirement paragraph	Method paragraph	Number of sample units to be inspected	Number of defectives allowed <u>1/</u>
<b>Group I <u>2/</u></b>				
Dielectric withstanding voltage	3.6	4.7.2	] 102	] 0
High voltage stabilization	3.7	4.7.3		
<b>Group II <u>2/</u></b>				
Visual and mechanical examination <u>3/</u>	3.1, 3.4 to 3.5.2 incl. 3.23 to 3.24.1 incl.	4.7.1	] 102 <u>4/</u>	] 0
Barometric pressure	3.8	4.7.4		
Insulation resistance	3.9	4.7.5		
Capacitance	3.10	4.7.6		
Dissipation factor	3.11	4.7.7		
<b>Group III</b>				
Solderability	3.12	4.7.8	] 18	] 1
Vibration	3.13	4.7.9		
Temperature coefficient and capacitance drift	3.14	4.7.10	] 18	] 1
Thermal shock and immersion	3.15	4.7.11		
<b>Group IV</b>				
Shock, specified pulse	3.16	4.7.12	] 18	] 1
Terminal strength	3.17	4.7.13		
Resistance to soldering heat	3.18	4.7.14		
Moisture resistance	3.19	4.7.15		
<b>Group V</b>				
Life (rated conditions)	3.20	4.7.16.1.1	50	] 1
Life (accelerated conditions)	3.20	4.7.16.1.2	6	
<b>Group VI</b>				
Fungus <u>5/</u>	3.21	4.7.17	5	] 0
Resistance to solvents	3.22	4.7.18	5	

1/ A sample unit having one or more defects shall be considered as a single defective.

2/ Nondestructive tests.

3/ Marking defects are based on visual examination only and shall be charged only for illegible, incomplete, or incorrect marking.

4/ Sample units shall be selected from those which have passed group I inspection.

5/ Certification of fungus resistance may be substituted for testing.

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4.4.2 Inspection routine. Sample units shall be subjected to the qualification inspection specified in table VIII, in the order shown. All sample units shall be subjected to the group I and II tests. These sample units shall then be divided as shown in table VIII for groups III to VI, inclusive, and subjected to the tests for their particular group. The units subjected to life test at rated conditions shall be continued on test for 48,000 additional hours.

4.4.3 Failures. Failures in excess of those allowed in table VIII shall be cause for refusal to grant qualification approval.

4.4.4 Failure rate level and quality level verification.

4.4.4.1 Failure rate (FR) qualification and lot conformance FR inspection. FR qualification and lot conformance FR inspection, shall be in accordance with the general and detailed requirements of MIL-STD-690 and the following details:

- a. Procedure I: Qualification at the initial FR level. Level M (1.0 percent), of FRSP-90 shall apply. Upon successful completion of the 2,000-hour qualification test (group V, table VIII), those sample units which have been subjected to rated conditions shall be continued on test for an additional period as specified in 4.7.16.3.
- b. Procedure II: Extension of qualification to lower FR levels. To extend qualification to the P (0.1 percent), R (0.01 percent), and S (0.001 percent) FR levels, data from two or more voltages within a style and of similar construction may be combined. For FR levels R and S, two or more styles of similar construction (see 4.6.1.1.1) may be combined.
- c. Procedure III: Maintenance of FR level qualification. Maintenance period B of FRSP-10 shall apply. Regardless of the number of production lots produced during this period, the specified number of unit hours shall be accumulated to maintain qualification (see 4.5f).

4.4.4.2 Quality level verification. The contractor is responsible for establishing a quality system to verify the PPM defect level of lots that are subjected to subgroup 2 tests of the group A inspections. The PPM defect level shall be maintained for each specification sheet. The PPM defect level shall be based on a 6-month moving average. The contractor shall verify and report individual PPM categories (i.e., PPM-2 and PPM-3) and an overall PPM defect level (i.e., PPM-5). In the event that the contractor meets or exceeds 100 PPM for PPM-2, the qualifying activity shall take the actions specified in 3.3.2.2.1.

4.5 Verification of qualification. Every 6 months, within 30 days of completion of group C inspection, the manufacturer shall compile a summary of the results of quality conformance inspections and extended FR test data, in the form of a Verification of Qualification Report, and forward it to the qualifying activity as the basis of continued qualification approval. In addition to the periodic submission of test data, the manufacturer shall immediately notify the qualifying activity whenever the data indicates that the manufacturer has failed to maintain his qualified FR level. Continued qualification approval will be based on evidence that, over the 6-month period, the following has been met:

- a. Verification by the qualifying activity that the manufacturer meets the requirements of MIL-STD-790.
- b. The manufacturer has not modified the design of the item.
- c. The specification requirements for the item have not been amended so as to affect the character of the item.
- d. Lot rejection for group A inspection does not exceed 10 percent or one lot, whichever is greater.
- e. The requirements of group C inspection are met.
- f. The records of all tests combined substantiate the M (1.0 percent), P (0.1 percent) FR level has been maintained or that the manufacturer continued to meet the R (0.01 percent) or S (0.001 percent), FR level for which qualified, although the total component hours of testing does not, as yet, meet the requirements of 4.4.4.1c.

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- g. The contractor shall provide documentation to the qualifying activity pertaining to PPM calculations including numbers of part types tested, individual PPM defect categories (i.e., PPM-2 and PPM-3) and the overall PPM defect rate (PPM-5). This information shall be submitted on a specification sheet basis.

If group C test requirements were not met and the manufacturer has taken corrective action satisfactory to the Government, the manufacturer shall submit a verification of qualification report within 30 days after completion of the group C testing. In this case, the qualifying activity shall be notified within the time the original verification of qualification report was due. All reports shall be certified by the responsible company official. The qualifying activity shall be contacted for report format.

4.5.1 Records. Maintenance of life test and FR level records shall be as specified in MIL-STD-690.

4.6 Quality conformance inspection.

4.6.1 Inspection of product for delivery. Inspection of product for delivery shall consist of group A inspection for FR levels M, P, R, and S.

4.6.1.1 Inspection and production lot.

4.6.1.1.1 Inspection lot. An inspection lot shall consist of all capacitors from the same production line or lines, of the same style, rated voltage, dielectric material and offered for inspection during a single work month. Each lot shall be kept separate from every other lot. The sample selected from the lot shall be representative of the capacitance values and case sizes in the lot. Styles CMR03, CMR04, CMR06, CMR07, and CMR08 may be combined for FR level maintenance.

4.6.1.1.2 Production lot. A production lot shall consist of all capacitors of the same style, voltage rating, characteristic, nominal capacitance value, capacitance tolerance, and case size. The manufacture of all parts in the lot shall have been started, processed, assembled, and tested as a group. Lot identity shall be maintained throughout the manufacturing cycle.

4.6.1.2 Subgroup 1 tests. Subgroup 1 tests shall be performed on a production lot basis on 100 percent of the product supplied under this specification. Capacitors failing the tests of subgroup 1 shall be removed from the lot. If during the 100 percent inspection, screening requires that more than 8 percent of the capacitors be discarded, the entire production shall be rejected.

4.6.1.2.1 Manufacturer's production inspection. If the manufacturer performs tests equal to or more stringent than those specified in subgroup 1, table IX, as the final step of his production process, group A, subgroup 1 inspection may be waived and the data resulting from the manufacturer's production tests may be used instead. Authority to waive the subgroup 1 inspection shall be granted by the qualifying activity only. The following criteria shall be complied with:

- a. Tests conducted by the manufacturer during production shall be clearly identical to or more stringent than that specified for subgroup 1. Test conditions shall be equal to or more stringent than those specified for subgroup 1 tests.
- b. Manufacturer subjects 100 percent of the product supplied under this specification to his production tests.
- c. The parameters measured and the failure criteria shall be the same or more stringent than those specified herein.
- d. The lot rejection criteria is the same or more stringent than that specified herein.
- e. The manufacturer shall make available all information concerning the test procedures and instrumentation used in the production tests which are a substitute for subgroup 1 tests. This data shall be provided as part of the evaluation required for MIL-STD-790. The manufacturer shall also make available to the Government all records of all detail test data resulting from production tests which are a substitute for subgroup 1 tests.
- f. Once approved, the manufacturer shall not change the test procedures or criteria without prior notification and concurrence by the qualifying activity.

TABLE IX. Group A inspection.

Inspection	Requirement paragraph	Test method paragraph	Sample	Lot criteria
<u>Subgroup 1</u>				
High voltage stabilization	3.7	4.7.3	100% inspection	
Dielectric withstanding voltage	3.6	4.7.2		
Insulation resistance (@ 25°C)	3.9	4.7.5		
Capacitance	3.10	4.7.6		
Dissipation factor	3.11	4.7.7		
<u>Subgroup 2 (PPM)</u>				
Dielectric withstanding voltage (PPM-2)	3.6	4.7.2	See table IX	Reject one defect
Insulation resistance (@ 25°C) (PPM-2)	3.9.1	4.7.5.1		
Insulation resistance (@ 125°C) (PPM-2)	3.9.2	4.7.5.2		
Capacitance (PPM-2)	3.10	4.7.6		
Dissipation factor (PPM-2)	3.11	4.7.7		
Mechanical examination (PPM-3) <u>1/</u>	3.5	4.7.1	13	0
<u>Subgroup 3</u>				
Visual dimensions:			13	0
Physical dimensions	3.1	4.7.1		
Marking <u>2/</u>	3.23	4.7.1		
<u>Subgroup 4</u>				
Solderability	3.12	4.7.8	13	0

1/ Dimensions only.

2/ Marking defects are based on visual inspection and shall be charged only for illegible, incomplete, or incorrect marking. Any subsequent electrical defects shall not be used as a basis for determining marking defects.

#### 4.6.1.3 Subgroup 2 tests (PPM categories).

4.6.1.3.1 Sampling plans. Subgroup 2 tests shall be performed on an inspection lot basis. Samples subjected to subgroup 2 shall be selected in accordance with table X, based on the size of the inspection lot. In the event of one or more failures the lot shall be rejected. Equipment and operators used to perform the subgroup 2 tests shall not be the same as those used in the subgroup 1, 100 percent tests.

TABLE X. Sampling plans for PPM categories.

Lot size	Sample size
1 - 125	100 percent
126 - 3,200	125
3,201 - 10,000	200
10,001 - 35,000	315
35,001 - 150,000	500
150,001 - 500,000	800
500,001 - up	1,250

4.6.1.3.2 Rejected lots. The rejected lot shall be segregated from new lots and those lots that have passed inspection. The rejected lot shall be 100 percent inspected for those quality characteristics found defective in the sample and any defectives found removed from the lot. A new sample of parts shall then be randomly selected in accordance with table X. If one or more defects are found in this second sample, the production lot shall be rejected and shall not be supplied to this specification.

4.6.1.3.3 PPM calculations. PPM calculation shall be based on the results of the first sample check as prescribed in 4.6.1.3.1. Calculations and data exclusion shall be in accordance with EIA-554. (Note: PPM calculations shall not use data on the second sample submission.)

4.6.1.4 Subgroup 3 tests. Subgroup 3 shall be performed on an inspection lot basis. The sampling procedures shall be as specified in table IX.

4.6.1.5 Subgroup 4 (solderability).

4.6.1.5.1 Sampling plan. Thirteen samples shall be selected randomly from each inspection lot and subjected to the solderability test. The manufacturer may use electrical rejects from the subgroup 1 screening test for all or part of the samples to be used for solderability testing. If there are one or more defects, the lot shall be rejected.

4.6.1.5.2 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 4.6.1.5.1. 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 b.
- b. The manufacturer submits the failed lot to a 100 percent solder dip using an approved solder dip process in accordance with 3.4.2.1. Following the solder dip, the electrical measurements required in group A subgroup 1 tests shall be repeated on 100 percent of the lot. The percent defective allowance (PDA) for the electrical measurements shall be as for the subgroup 1 tests.

Thirteen additional samples shall be then selected and subjected to the solderability test with zero defects allowed. If the lot fails this solderability test, the lot shall be considered rejected and shall not be furnished against the requirements of this specification.

4.6.1.5.3 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.

4.6.2 Periodic inspection.

4.6.2.1 Group C inspection. Group C inspection shall be performed on sample units which have been subjected to and have passed group A inspection for FR levels M, P, R, and S shall consist of the tests specified in table XI, in the order shown. The maximum and minimum case size manufactured during a month's production shall be represented in the sample in at least the approximate ratio of production. Test data obtained shall be reviewed as part of the complete verification of qualification.

4.6.2.1.1 Sampling plan.

4.6.2.1.1.1 For all FR levels. Seventy-two sample units, representative of a month's production, shall be taken from production every 2 months, divided into subgroups as listed in table XI for subgroups 1 and 2, and subjected to the test specified herein. Allowable failures shall be as specified in table XI.

4.6.2.1.1.2 For M, P, R, and S FR levels. In addition to the tests specified in 4.6.2.1.1.1, a minimum of 10 sample units from each inspection lot shall be subjected to subgroup 3 of table XI. Allowable failures shall be as specified in MIL-STD-690, table IV, maintenance period B.

4.6.2.1.2 Failures. If the number of failures exceeds the number allowed in table XI or MIL-STD-690, as applicable, the sample shall be considered to have failed.

TABLE XI. Group C inspection.

Inspection	Requirement paragraph	Method paragraph	Number of sample units	Allowable failures
<u>All FR levels</u>				
<u>Subgroup 1</u>				
Vibration	3.13	4.7.9	36	1
Temperature coefficient and capacitance drift	3.14	4.7.10		
Thermal shock and immersion	3.15	4.7.11		
<u>Subgroup 2</u>				
Barometric pressure	3.8	4.7.4	36	1
Shock, specified pulse	3.16	4.7.12		
Terminal strength	3.17	4.7.13		
Resistance to soldering heat	3.18	4.7.14		
Moisture resistance	3.19	4.7.15		
<u>M, P, R, and S FR levels</u>				
<u>Subgroup 3</u>				
Life (2,000 hours accelerated)	3.20	4.7.16.2	10 <u>1/</u>	<u>1/</u>

1/ See 4.6.2.1.1.2.

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

4.6.2.1.4 Noncompliance. If a sample fails to pass group C inspection, the manufacturer 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 inspections, or the inspection which the original sample failed, at the option of the Government). Group A inspections may be reinstated; 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 corrective action taken shall be furnished to the cognizant inspection activity and the qualifying activity.

4.6.3 Inspection of packaging. Sample packages and packs and the inspection of the preservation and packaging, packing, and marking for shipment and storage shall be in accordance with the requirements of MIL-C-39028.

#### 4.7 Methods of inspection.

4.7.1 Visual and mechanical examination. Capacitors 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, 3.4 to 3.5.2 inclusive, and 3.23 to 3.24.1, inclusive).

4.7.2 Dielectric withstanding voltage (see 3.6). Capacitors shall be tested in accordance with method 301 of MIL-STD-202. The following details shall apply:

- a. Magnitude and nature of test voltage: 200 percent of rated dc voltage.
- b. Duration of application of test voltage: Not less than 1 second nor more than 5 seconds. The duration of the test shall begin when 95 percent of the test potential is reached.

- c. Points of application of test voltage: Between terminals.
- d. Limiting value of surge current: Shall not exceed 50 milliamperes (mA) during charging and discharging.
- e. Examination after test: Capacitors shall be examined for evidence of damage, arcing, and breakdown.

4.7.3 High voltage stabilization (see 3.7). Capacitors shall be subjected to 200 percent of rated dc voltage at a minimum temperature of 125°C or 150°C, as applicable, for a minimum of 48 hours. During the test, the capacitors shall be adequately protected against voltage surges of 25 percent or more of test voltage and surge current shall not exceed 50 mA. Capacitors shall be examined for evidence of damage, arcing, and breakdown. Insulation resistance shall then be measured as specified in 4.7.5.1.

4.7.4 Barometric pressure (see 3.8). Capacitors shall be tested in accordance with method 105 of MIL-STD-202. The following details shall apply:

- a. Method of mounting: Not applicable.
- b. Test condition: D (100,000 feet).
- c. Tests during subjection to reduced pressure: A test potential of 100 percent of rated dc voltage for style CNR04, 500 volts, and 150 percent for all other styles and voltages shall be applied between the terminals for 60 +15, -0 seconds. Surge current shall not exceed 50 mA.
- d. Examination after test: Capacitors shall be examined for evidence of damage, arcing, and breakdown.

4.7.5 Insulation resistance (see 3.9).

4.7.5.1 At room ambient temperature (see 3.9.1). Capacitors shall be tested in accordance with method 302 of MIL-STD-202. The following details shall apply:

- a. Test condition: A. (At the option of the manufacturer, a higher voltage may be used).
- b. Points of measurement: From terminal to terminal. (Condensed moisture may be removed by a blast of air).
- c. Electrification time: Not less than 10 seconds and not more than 2 minutes.

4.7.5.2 At high ambient temperature (see 3.9.2). Capacitors shall be subjected to the high ambient temperature, 125°C +5°C, -0°C or 150°C +5°C, -0°C, as applicable, for a period of time sufficient to reach thermal stability and shall be measured as specified in 4.7.5.1.

4.7.6 Capacitance (see 3.10). Capacitance shall be measured in accordance with method 305 of MIL-STD-202. The following details shall apply:

- a. Test frequency: 1 megahertz (MHz) ±1,000 hertz (Hz) when the nominal capacitance is 1,000 pF or less, and 1 kilohertz (kHz) ±100 Hz when the nominal capacitance is greater than 1,000 pF. At the option of the manufacturer, capacitance measurements may be made at any frequency from 1 kHz to 1 MHz and referred to measurements at 1 MHz and 1 kHz, as applicable.
- b. Limit of accuracy: Shall be ±0.2 percent of nominal capacitance value or ±0.2 pF, whichever is greater.

4.7.7 Dissipation factor (see 3.11). Dissipation factor shall be measured at a frequency of 1 MHz ±1,000 Hz when the nominal capacitance is 1,000 pF or less, and 1 kHz ±100 Hz when the nominal capacitance is greater than 1,000 pF. Measurement accuracy shall be within ±2 percent for dissipation factor and within ±5 Hz for frequency.

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4.7.8 Solderability (see 3.12). Capacitors shall be tested in accordance with method 208 of MIL-STD-202. The following details may apply:

- a. Number of terminations of each part to be tested: Two.
- b. Depth of immersion in flux and solder: To a point at which exposed metal is solderable.
- c. No physical damage after test.

4.7.9 Vibration (see 3.13).

4.7.9.1 Vibration, high frequency. Capacitors shall be tested in accordance with method 204 of MIL-STD-202. The following details and exceptions shall apply:

- a. Mounting: Capacitors shall be rigidly mounted by the body to a vibration-test apparatus.
- b. Test condition: B.
- c. Measurements during vibration: During the last cycle in each direction, an electrical measurement shall be made to determine intermittent contacts of 0.5 ms or greater duration or open- or short-circuiting.
- d. Examination and measurements after test: Capacitors shall be examined for evidence of mechanical damage.

4.7.9.2 Vibration, random. Capacitors shall be tested in accordance with method 214 of MIL-STD-202. The following details shall apply:

- a. Mounting: Body of the capacitor shall be rigidly supported.
- b. Test condition: E of table 214-II.
- c. Duration and direction of motion: 1 hour 30 minutes in each of three mutually perpendicular directions (total of 4 hours 30 minutes).
- d. Measurements: During the last 30 minutes in each direction, an electrical measurement shall be made to determine intermittent contacts, or open- or short-circuiting. Detecting equipment shall be sufficiently sensitive to detect any interruption of 0.5 ms or greater duration.
- e. Examination after test: Capacitors shall be examined for evidence of mechanical damage.

4.7.10 Temperature coefficient and capacitance drift (see 3.14).

4.7.10.1 For qualification inspection. Capacitance measurements shall be made in accordance with 4.7.6 (a frequency of 100 kHz  $\pm 10$  percent may be used as an alternate) at the following temperatures in the order listed:

Step	Temperature °C	Step	Temperature °C
1	25 $\pm 2$	6	45 $\pm 2$
2	-55 +0, -2	7	65 $\pm 2$
3	-40 $\pm 2$	8	85 +2, -0
4	-10 $\pm 2$	9	125 +2, -0 (For temperature ranges O and P)
5	25 $\pm 2$	10	150 +2, -0 (For temperature range P)
		11	25 $\pm 2$

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The measurement at each temperature shall be recorded when two successive readings taken at 5-minute intervals at that temperature indicate no change in capacitance. An accuracy of  $\pm 0.025$  percent of nominal capacitance  $\pm 0.05$  pF shall be maintained for measurement of capacitance change.

4.7.10.1.1 Temperature coefficient. The temperature coefficient shall be computed as follows:

$$TC = \frac{(C_x - C_5) 10^6}{(T_2 - T_1) C_5}$$

Where: TC = Temperature coefficient in parts per million per degree centigrade.

$C_x$  = Capacitance at test temperature in pF.

$C_5$  = Capacitance at step 5 temperature in pF.

$T_1$  = 25°C.

$T_2$  = Test temperature in degrees centigrade.

4.7.10.1.2 Capacitance drift. Capacitance drift shall be computed by dividing the greatest single difference between any two of the three values recorded at 25°C by the step 5 value recorded at 25°C.

4.7.10.2 For quality conformance inspection. Capacitance measurements shall be made as specified in 4.7.10.1, except that measurements shall be made only for steps 1, 2, 5, 9 or 10, as applicable, and 11.

4.7.10.3 Continuous-curve temperature coefficient. As an alternate to the measurements specified in 4.7.10.1, a continuous curve of capacitance versus temperature may be produced by subjecting the capacitors to a slowly varying temperature. The temperature shall be varied from 25°C to -55°C, to 125°C or 150°C, as applicable, and to 25°C. A temperature-sensing device shall be embedded in a dummy capacitor in a manner to assure accurate internal readings in the capacitor under test. The temperature shall be varied slowly enough to produce a smooth, uniform curve with no loops at -55°C or 125°C or 150°C, as applicable. Measurements shall be made at a frequency of 100 kHz  $\pm 10$  kHz. Accuracy shall be as specified in 4.7.10.1.

4.7.11 Thermal shock and immersion (see 3.15).

4.7.11.1 Thermal shock. Capacitors shall be tested in accordance with method 107 of MIL-STD-202. The following details and exceptions shall apply:

- a. Test condition: A, except that elevated temperature shall be 125°C  $\pm 3$ °C, -0°C, or 150°C  $\pm 3$ °C, -0°C, as applicable.
- b. Measurement before cycling: Capacitance.
- c. Measurement after cycling: Not applicable.

4.7.11.2 Immersion. The temperature cycling shall be followed by immersion cycling in accordance with method 104, test condition B, of MIL-STD-202. Capacitors shall be visually examined for evidence of deterioration, permanent damage to leads and case, and corrosion on the leads. Dielectric withstanding voltage, insulation resistance, capacitance, and dissipation factor shall then be measured as specified in 4.7.2, 4.7.5.1, 4.7.6, and 4.7.7 respectively.

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4.7.12 Shock, specified pulse (see 3.16). Capacitors shall be tested in accordance with method 213 of MIL-STD-202. The following details shall apply:

- a. Mounting: Capacitors shall be rigidly mounted by the body.
- b. Test condition: I (100 G(pk), sawtooth).
- c. Measurements during shock: During the last shock in each direction, an electrical measurement shall be made to determine intermittent contacts of 0.5 ms or greater duration or open- or short-circuiting.
- d. Measurements after shock: Capacitors shall be examined for evidence of mechanical damage.

4.7.13 Terminal strength (see 3.17).

4.7.13.1 Pull test. All terminals shall be subjected for  $5 \pm 1$  seconds, to a pull of 5-pounds +2, -0 ounces in a direction perpendicular to the leads.

4.7.13.2 Twist test. Capacitors shall be tested in accordance with method 211, test condition D, of MIL-STD-202.

4.7.14 Resistance to soldering heat (see 3.18). Capacitors shall be tested in accordance with method 210 of MIL-STD-202. The following details and exceptions shall apply:

- a. Depth of immersion: Within .250 inch of the case.
- b. Test condition: G.
- c. Cooling time prior to final measurement: 1 minute  $\pm 10$  seconds.
- d. Measurements after test: Insulation resistance, capacitance, and dissipation factor shall be measured as specified in 4.7.5, 4.7.6, and 4.7.7, respectively.

4.7.15 Moisture resistance (see 3.19). Capacitors shall be tested in accordance with method 106 of MIL-STD-202. The following details and exceptions shall apply:

- a. Number of cycles: Capacitors shall be subjected to twenty continuous temperature cycles.
- b. Mounting: Capacitors shall be mounted by the leads in a manner that will keep the capacitor body from touching the test fixture during test or measurement.
- c. Conditioning prior to test: Capacitors shall be tested as specified in 4.7.11.1.
- d. Polarization: A dc potential of 100 volts or rated volts, whichever is less, shall be applied across the capacitor terminals of 50 percent of the units under test and no voltage applied to the other 50 percent.
- e. Vibration: The vibration requirement of steps 7a and 7b shall not apply.
- f. Final measurements: After completion of step 6 of the final cycle, capacitors shall be maintained at  $25^\circ\text{C} \pm 5^\circ\text{C}$ , and 50  $\pm 5$  percent relative humidity for a period of 4 to 24 hours. Insulation resistance, dielectric withstanding voltage, capacitance, and dissipation factor shall then be measured as specified in 4.7.5.1, 4.7.2, 4.7.6, and 4.7.7, respectively. Capacitors shall then be examined for evidence of deterioration, permanent damage to the leads or case, and corrosion on the leads.

4.7.16 Life (see 3.20). Capacitors shall be preconditioned for life test by subjecting them to a temperature of  $-55^\circ\text{C}$   $+0^\circ\text{C}$ ,  $-2^\circ\text{C}$  for a minimum period of 48 hours. Capacitors shall then be subjected to the tests specified in 4.7.16.1 or 4.7.16.2 as applicable.

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4.7.16.1 For qualification inspection (2,000 hour) (see 3.20).

4.7.16.1.1 Rated conditions. Capacitors shall be subjected to 100 percent of rated dc voltage at 125°C ±3°C or 150°C ±3°C, as applicable, for 2,000 +72, -0 hours. During the test, the surge current shall be limited to 50 milliamperes. At the conclusion of the test, capacitors shall be returned to the inspection conditions specified in 4.3.1, and shall be visually examined for evidence of mechanical damage; the dielectric withstanding voltage, insulation, resistance, capacitance, and dissipation factor shall then be measured as specified in 4.7.2, 4.7.5, 4.7.6, and 4.7.7, respectively (see 3.20).

4.7.16.1.2 Accelerated conditions. Capacitors shall be tested as specified in 4.7.16 and 4.7.16.1.1, except that the capacitors shall be subjected to 150 percent of rated dc voltage.

4.7.16.2 For quality conformance inspection (see 3.20).

4.7.16.2.1 For FR levels M, P, R, and S. Capacitors shall be tested as specified in 4.7.16.1.2.

4.7.16.3 Extended Life (see 3.20).

4.7.16.3.1 Following 2000 hour qualification test. Capacitors shall be continued on test for an additional 8,000 +96, -0 hours; measurements during and after exposure shall be accomplished after 2,000 +96, -0 hours and every 2,000 +96, -0 hours thereafter until a combined total of 10,000 +96, -0 hours have elapsed. The measurements are the same specified in 4.7.16.1.1.

4.7.17 Fungus (see 3.21). Capacitors shall be tested in accordance with method 508 of MIL-STD-810. Pretest and post-test measurements are not required.

4.7.18 Resistance to solvents (see 3.22). Capacitors shall be tested in accordance with method 215 of MIL-STD-202. The following details shall apply:

- a. Portion of specimen to be brushed: That portion on which marking is present.
- b. Number of specimens to be tested: As specified in table VIII.
- c. Permissible extent of damage: As specified in 3.22.

5. PACKAGING

5.1 Packaging requirements. The requirements for packaging shall be in accordance with MIL-C-39028.

6. NOTES

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

6.1 Intended use. The capacitors covered by this specification are intended for use in equipment where a known order of reliability is required.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of this specification.
- b. Title, number, and date of the applicable specification sheet, and the complete type designation (see 1.2.1 and 3.1).
- c. Levels of preservation and packaging and packing, and applicable marking (see section 5).
- d. Marking requirements for failure rate level (see 3.23).

6.3 Retinning leads. If retinning (hot solder dip) of the leads is required, see 3.4.2.1.

6.4 Qualification. With respect to products requiring qualification, awards will be made only for products which are at the time set for opening of bids, qualified for inclusion in the applicable QPL, 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 for the products covered by this specification. The activity responsible for the QPL is U.S. Army Laboratory Command (LABCOM), ATTN: SLCET-R-S, Fort Monmouth, NJ 07703-5302; however, information pertaining to qualification of products may be obtained from the Defense Electronics Supply Center (DESC-E), Dayton, OH 45444. Applications for qualification tests shall be made in accordance with SD-6, "Provisions Governing Qualification" (see 6.4.1).

6.4.1 Copies of forms. Copies of "Provisions Governing Qualification" may be obtained upon application to Commanding Officer, Naval Publication and Form Center, Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

6.4.2 Failure rate level qualification. Where the invitation for bids specifies a failure rate level below the P level, awards will be made only for those products that have been qualified prior to the bid-opening date by the qualifying activity as meeting the failure rate level specified in the invitation for bids.

6.5 Selection and use information. Equipment designers should refer to MIL-STD-198, "Capacitors, Selection and Use of" for a selection of standard capacitor types and values for new equipment design. Application and use information concerning these capacitors are also provided in MIL-STD-198.

6.6 Failure-rate level determination. The curves presented on figures 3 and 4 are the best engineering approximation of the reliability characteristics (random failures) for these capacitors when employed repeatedly, within their specification ratings, in complex electronic equipment. These reliability characteristics are based on ground-level severity experience. Failures are considered to be opens, shorts, or radical departures from initial characteristics. The failures are considered to be occurring in an unpredictable manner and in too short a period of time to permit detection through normal preventive maintenance. The curves shown on this figure are based on catastrophic failures and will differ from the failure rates established in the specification, since the established failure rates are based on "parameter failures over long term life tests at rated conditions. Figures 3 and 4 have been extracted from MIL-HDBK-217, "Reliability Stress and Failure Rate Data for Electronic Equipment." The curves have been modified from their original versions in that the ordinate has been normalized in order to provide multiplier factors in place of discrete failure rate levels and in order that the multiplying factor for a failure rate at rated conditions is unity. As indicated, these curves are the best estimates based on catastrophic failures; however, they can provide an estimate of the relative effect of operating under conditions other than rated.

6.7 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.

6.8 Subject term (key word) listing.

Capacitance

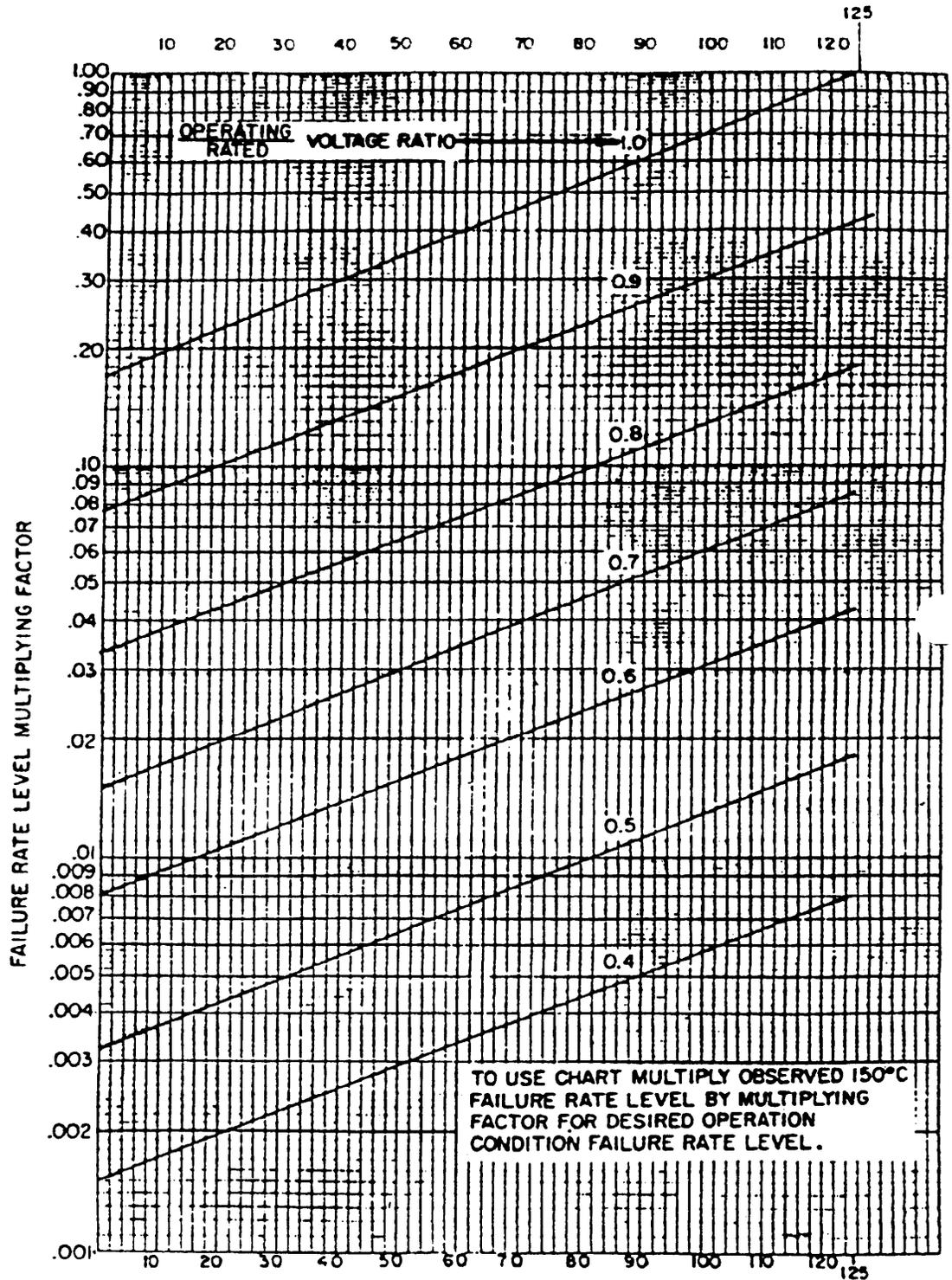


FIGURE 3. Failure rate curves; 0°C to 125°C.

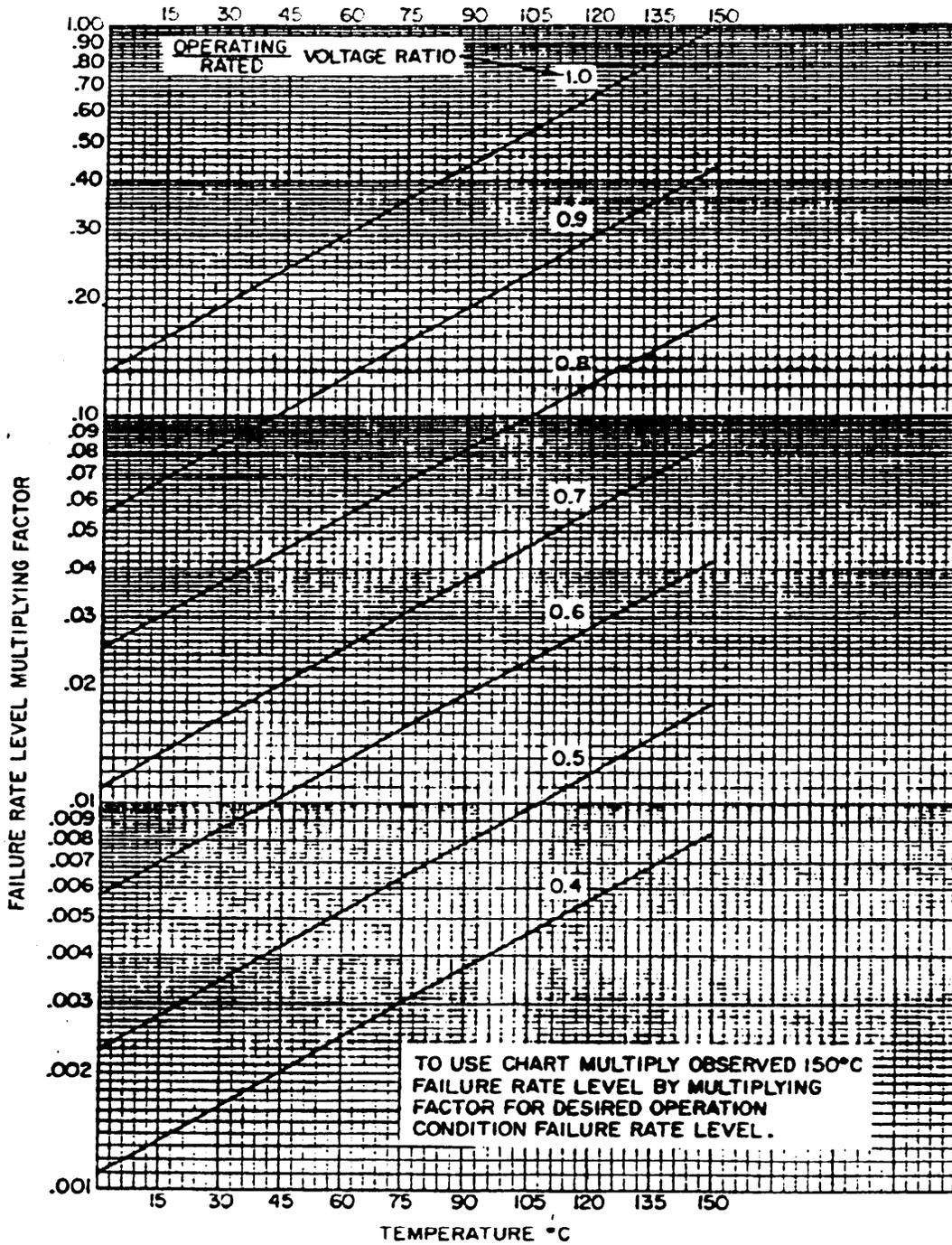


FIGURE 4. Failure rate curves; 0°C to 150°C.

APPENDIX

PROCEDURE FOR QUALIFICATION INSPECTION

10. SCOPE

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

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

30. SUBMISSION

30.1 Sample.

30.1.1 Single-type submission. A sample consisting of 102 sample units of each type for which qualification is sought shall be submitted (see 40.1).

30.1.2 Single-style submission. A maximum of two types, 51 of each type, may be represented in a single style submission. Both types shall be of the same capacitance tolerance and characteristic. The highest and lowest capacitance value within a style or characteristic shall be equally represented. However, where the lowest capacitance value listed for a particular style or characteristic is below 47 pF, specimens of the 47 pF value, or preferably lower, may be submitted.

30.2 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 VIII. Each submission shall be accompanied by the test record obtained from these examinations and 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 Certification of material. When submitting samples for qualification, the manufacturer shall submit certification, in duplicate, that the materials used in his components are in accordance with the applicable specification requirements.

30.4 Description of items. The manufacturer shall submit a detailed description of the materials and general constructional features of the complete range of capacitors for which qualification is sought; for example, case material, type of electrodes and lead material, dielectric thickness, margin, etc.

40. EXTENT OF QUALIFICATION

40.1 Single-type submission. Qualification will be restricted to the style, capacitance value, characteristic, and capacitance tolerance equal to or broader than the characteristic and capacitance tolerance submitted.

40.2 Single-style submission. Qualification of all types in the submission automatically carries with it qualification of all types within the style and capacitance range submitted, except that approval of the lowest capacitance value in the F characteristic will be the basis for approval of all lesser capacitance values and broader characteristics within a style. Qualification of characteristics and capacitance tolerances shall be restricted to those equal to or broader than that submitted. This extension of qualification is contingent on the use of the same materials, design, and construction for all types qualified. Wherever material, design, or constructional differences exist, submission shall be made in accordance with 30.1.1.

MIL-C-39001B

CONCLUDING MATERIAL

Custodians:

Army - ER  
Navy - EC  
Air Force - 85

Review activities:

Air Force - 17, 99  
DLA - ES

User activity:

Air Force - 19

Preparing activity:

Army - ER

Agent:

DLA - ES

(Project 5910-1726)



# 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.

<b>RECOMMEND A CHANGE:</b>	1. DOCUMENT NUMBER MIL-C-39001B	2. DOCUMENT DATE (YYMMDD) 920402
3. DOCUMENT TITLE CAPACITORS, FIXED, MICA DIELECTRIC, ESTABLISHED RELIABILITY, 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) COMMANDER LABCOM		b. ORGANIZATION AUTOVON (If Applicable)
7. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON		8. DATE SUBMITTED (YYMMDD)
9. PREPARING ACTIVITY a. NAME COMMANDER LABCOM		b. TELEPHONE (Include Area Code) (1) Commercial (908) 544-3148 (2) AUTOVON 995-3148
c. ADDRESS (Include Zip Code) ATTN: SLCET-RS FORT MONMOUTH, NJ 07703		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

