

INCH-POUND

MIL-PRF-39022H  
18 December 2007  
SUPERSEDING  
MIL-PRF-39022G  
25 February 2002

## PERFORMANCE SPECIFICATION

### CAPACITORS, FIXED, METALLIZED, PAPER-PLASTIC FILM, OR PLASTIC FILM DIELECTRIC, DIRECT AND ALTERNATING CURRENT, (HERMETICALLY SEALED IN METAL OR CERAMIC CASES), ESTABLISHED RELIABILITY, 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 established reliability (ER), direct current (dc) and alternating current (ac), metallized paper-plastic film, or plastic film dielectric, fixed capacitors, hermetically sealed in metal or ceramic cases. Capacitors covered by this specification have failure rate levels (FRL) established in accordance with [MIL-STD-690](#). The reliability for each level is identified by a symbol in accordance with [table IV](#). These FRLs are established at a 90 percent confidence level and maintained at a 10 percent producer's risk unless otherwise specified (see [3.1](#)), and are based on life tests performed at maximum rated voltage at maximum rated temperature. Unless otherwise specified (see [3.1](#)), an acceleration factor of 5:1 has been used to relate life-test data obtained at 140 percent of rated voltage at maximum rated temperature, to rated voltage at maximum rated temperature (see [6.1](#)). A parts per million (PPM) quality system is used for documenting and reporting the average outgoing quality of capacitors supplied to this specification. Statistical process control (SPC) techniques are required in the manufacturing process to minimize variation in production of capacitors supplied to the requirements of this specification.

1.2 Classification. Capacitors covered by this specification are classified by the style, as specified (see [3.1](#)).

1.2.1 Part or identifying number (PIN).

- a. Capacitors specified in [MIL-PRF-39022/1](#), [/2](#), [/8](#), and [/12](#) are identified by a PIN which consists of the basic number of the performance specification sheet followed by an assigned dash number (see [3.1](#)), as shown in the following example:

<u>M39022</u>	<u>/01-</u>	<u>1261</u>
Performance specification number	Specification sheet number	Nonsignificant dash number

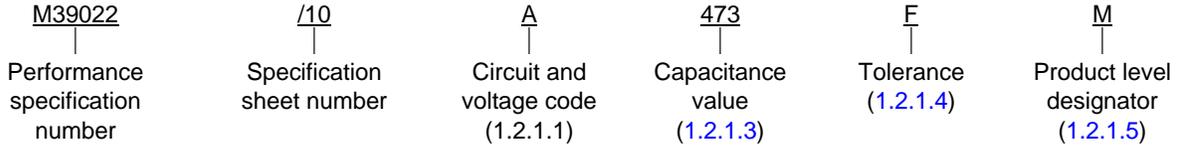
Comments, suggestions or questions on this document should be addressed to Defense Supply Center Columbus, ATTN: VAT, Post Office Box 3990, Columbus, OH 43218-3990), or emailed to [capacitorfilter@dla.mil](mailto:capacitorfilter@dla.mil). Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <http://assist.daps.dla.mil>.

AMSC N/A

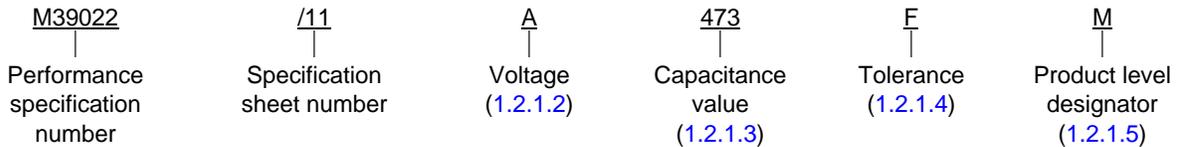
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- b. Capacitors specified in [MIL-PRF-39022/10](#) and [MIL-PRF-39022/13](#) are identified by a PIN which consists of the basic number of the performance specification sheet followed by a series of coded characters. Each performance sheet covers a different capacitor style. The coded number provides information concerning the capacitor's circuit, working voltage, capacitance value, tolerance, and product level. The PIN is in the following form:



- c. Capacitors specified in [MIL-PRF-39022/11](#) are identified by a PIN which consists of the basic number of the performance specification sheet followed by a series of coded characters. The coded number provides information concerning the capacitor's working voltage, capacitance value, tolerance, and product level. The PIN is in the following form:



1.2.1.1 Circuit and voltage code. The circuit and rated voltage for [MIL-PRF-39022/10](#) and [/13](#) are identified by a single letter as shown in table I.

TABLE I. Circuit and voltage codes.

Code	Circuit	Voltage
A	1	50
B	3	50
C	1	100
D	3	100
E	1	200
F	3	200
G	1	400
H	3	400
J	1	600
K	3	600
L	1	300
M	3	300

1.2.1.2 Voltage. The rated voltage for MIL-PRF-39022/11 is identified by a single letter as shown in table II.

TABLE II. Rated voltage.

Symbol	DC rated voltage
A	30
B	50
C	100
D	150
E	200
F	300

1.2.1.3 Capacitance value. 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" is used to indicate the decimal point and the succeeding digit(s) of the group represent significant figure(s). 1R0 indicates 1.0 pF; R75 indicates .75 pF; and 0R5 indicates 0.5 pF.

1.2.1.4 Tolerance. The capacitance tolerance is identified by a single letter as shown in table III.

TABLE III. Capacitance tolerance.

Symbol	Capacitance tolerance ( $\pm$ )
F	1 percent
G	2 percent
J	5 percent
K	10 percent

1.2.1.5 Product level designator. The product level designator is identified by a single letter as shown in table IV.

TABLE IV. Product level designator.

Symbol	FRL (% per 1,000 hours)
M	1.0
P	0.1
R	0.01
S	0.001

## 2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.

### 2.2 Government documents.

2.2.1 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 cited in the solicitation or contract.

#### DEPARTMENT OF DEFENSE SPECIFICATIONS

- |                 |   |  |
|-----------------|---|--|
| MIL-C-18312     | - | Capacitors, Fixed, Metallized (Paper, Paper-Plastic, or Plastic Film) Dielectric, Direct Current (Hermetically Sealed in Metal Cases), General Specification For.  |
| MIL-PRF-83421/1 | - | Capacitors, Fixed, Metallized, Plastic Film Dielectric, DC and AC, Hermetically Sealed In Metal Cases, Established Reliability, Styles CRH01, CRH02, CRH03, CRH04, CRH05, CRH06, CRH07, CRH08, CRH09, and CRH00. |
| MIL-PRF-83421/6 | - | Capacitors, Fixed, Metallized, Plastic Film Dielectric, DC and AC, Hermetically Sealed in Metal Cases, Established Reliability, Styles CRH31, CRH32, CRH33, CRH34, and CRH35.                                    |

(See [Supplement 1](#) for list of associated specification sheets.)

#### DEPARTMENT OF DEFENSE STANDARDS

- |              |   |  |
|--------------|---|--|
| MIL-STD-202  | - | Test Methods Standard Electronics and Electrical Component Parts.  |
| MIL-STD-690  | - | Failure Rate Sampling Plans and Procedures.  |
| MIL-STD-790  | - | Standard Practice for Established Reliability and High Reliability Qualified Products List (QPL) Systems for Electrical, Electronic, and Fiber Optic Parts Specifications. |
| MIL-STD-810  | - | Environmental Engineering Consideration and Laboratory Tests.  |
| MIL-STD-1285 | - | Marking of Electrical and Electronic Parts.  |

(Copies of these documents are available online at <http://assist.daps.dla.mil/quicksearch/> or <http://assist.daps.dla.mil> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

#### AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- |     |   |  |
|-----|---|--|
| D92 | - | Standard Test Method for Flash and Fire Points by Cleveland Open Cup. (DoD adopted). |
|-----|---|--|

(Copies of this document are available from <http://www.astm.org> or American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

- [EIA-554-1](#) - Assessment of Average Outgoing Quality Levels in Parts Per Million (PPM). (DoD adopted).
- [EIA-557](#) - Statistical Process Control Systems. (DoD adopted).

(Copies of these documents are available from <http://global.ihs.com> or Global Engineering Documents, Attn: Customer Service Department, 15 Inverness Way East, Englewood, CO 80112-5776.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related specification sheets), 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 sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheets. In the event of any conflict between requirements of this specification and the specification sheets, 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 (QPL) before contract award. In addition, the manufacturer shall obtain certification from the qualifying activity that the QPL system requirements of 3.3 and [4.2](#) have been met and are being maintained. Authorized distributors that are approved to [MIL-STD-790](#) distributor requirements by the QPL manufacturers are listed in the QPL.

3.3 QPL system. The manufacturer shall establish and maintain a QPL system for parts covered by this specification. Requirements for this system are specified in [MIL-STD-690](#) and [MIL-STD-790](#). In addition, the manufacturer shall establish a Statistical Process Control (SPC) and Part Per Million (PPM) system which meets the requirements of 3.3.1 and 3.3.2, respectively. The following [MIL-STD-790](#) exceptions are allowed:

- a. Under "Description of production processes and controls", the procedure for identification of each production lot shall include only "the manufacturer shall as a minimum be able to identify the time period during which the final production operation was performed on each item of product prior to final test. The date or lot code marked on each part shall be identified to a production lot."
- b. "Traceability" of materials shall not apply.

3.3.1 SPC system. As part of the overall [MIL-STD-790](#) QPL system, the manufacturer shall establish a SPC system which meets the requirements of [EIA-557](#). Typical manufacturing processes for application of a SPC include pre-assembly, assembly, encapsulation, and packaging.

3.3.2 PPM system. As part of the overall [MIL-STD-790](#) QPL system, the manufacturer shall establish a PPM system for assessing the average outgoing quality of lots in accordance with [EIA-554-1](#). Data exclusion, in accordance with [EIA-554-1](#), may be used with approval of the qualifying activity. The PPM system shall identify the PPM rate at the end of each month and shall be based on a six month moving average.

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.

3.4.1 Impregnant. The impregnant shall be chemically inactive with respect to the capacitor element and the case. The impregnant, either in the state of original application or as a result of having aged, shall have no adverse effect on the performance of the capacitor. For liquid-impregnated capacitors, the same material shall be used for impregnating as is used for filling.

3.4.2 Metals. Metals shall be of a corrosion-resistant type or shall be plated or treated to resist corrosion. Silver plating shall not be used in any external portions of these capacitors.

3.4.2.1 Dissimilar metals. Where dissimilar metals are used in intimate contact with each other, provision shall be made to provide protection against electrolysis and corrosion. The use of dissimilar metals in contact, which may tend toward active electrolytic corrosion (particularly brass, copper, or steel used in contact with aluminum or aluminum alloy), shall not be acceptable. However, metal plating or metal spraying of dissimilar metals to base metals to provide similar or suitable abutting surfaces will be permitted (for example, the spraying of copper on aluminum for soldering operations will be permitted). The use of dissimilar metals separated by insulating material will also be permitted.

3.5 Interface and physical dimension requirements. Capacitors and retainers shall meet the interface and physical dimensions specified (see 3.1).

3.5.1 Case. Each capacitor shall be enclosed in a hermetically-sealed case (see 3.1) which will protect the capacitor element from moisture, impregnant or filling compound leakage, and mechanical damage under all test conditions specified herein.

3.5.2 Sleeving. The sleeving material shall not soften, creep, or shrink to a point where any part of the cylindrical portion of the case is left uncovered at any test temperature specified herein. The sleeving shall not obscure the part marking.

3.5.3 Leads. Leads shall be solderable and meet the requirements of 3.18.

3.5.3.1 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 (see appendix) has been approved by the qualifying activity.

3.5.3.2 Pure tin. The use of pure tin, as an underplate or final finish, is prohibited both internally and externally. Tin content of capacitor components and solder shall not exceed 97 percent, by mass. Tin shall be alloyed with a minimum of 3 percent lead, by mass (see 6.8).

3.6 Burn-in (when specified, see 3.1). When tested as specified in 4.7.2, capacitors shall withstand the exposure to high temperature and voltage without visible damage.

3.7 Radiographic inspection (X-ray) (when specified, see 3.1). When the capacitors are radiographed in accordance with 4.7.3, there shall be no evidence of improperly made connections, misalignments of seals or eyelets, substandard soldering, structural weakness, or loose metallic particles larger than .032 inch (0.81 mm).

3.8 Thermal shock. When tested as specified in 4.7.4, capacitors shall withstand the extremes of high and low temperatures without visible damage.

3.9 Seal.

3.9.1 Liquid-impregnated or solid-impregnated capacitors. When capacitors are tested as specified in 4.7.5, there shall be no evidence of leakage of impregnant or repetitive bubbling.

3.9.2 Liquid-filled capacitors. When capacitors are tested as specified in 4.7.5, there shall be no evidence of liquid leakage.

3.10 Dielectric withstanding voltage. When tested as specified in 4.7.6, capacitors shall be capable of withstanding the potentials specified (see 3.1) without permanent damage, open-circuiting or short-circuiting. Unless otherwise specified (see 3.1), momentary breakdowns (see 6.5.1) will be permitted.

3.11 Insulation resistance. When capacitors are tested as specified in 4.7.7, the following shall apply.

3.11.1 Terminal to terminal. When measured as specified in 4.7.7b(1), the product of the nominal capacitance (expressed in microfarads ( $\mu\text{F}$ )) and the insulation resistance (expressed in megohms) shall be not less than the values specified (see 3.1).

3.11.2 Terminals to case (when case is not a terminal). When measured as specified in 4.7.7b(2), the insulation resistance between terminals and case shall be not less than the value specified (see 3.1).

3.12 Capacitance. When measured as specified in 4.7.8, the capacitance shall be within the applicable tolerance specified (see 3.1).

3.13 Dissipation factor. When measured as specified in 4.7.9, the dissipation factor shall not exceed the value specified (see 3.1).

3.14 Barometric pressure (reduced) for qualification only. When tested as specified in 4.7.10, capacitors shall withstand the specified potential (see 3.1) without visible damage, external flashover, open-circuiting or short-circuiting.

3.15 Vibration. When capacitors are tested as specified in 4.7.11, there shall be no evidence of mechanical damage, intermittent contacts of 0.5 millisecond (ms) or greater duration, open-circuiting or short-circuiting.

3.16 Salt spray (corrosion). When capacitors are tested as specified in 4.7.12, there shall be no harmful or extensive corrosion, and at least 90 percent of any exposed metal surface of the capacitor shall be protected by the finish. Harmful corrosion shall be construed as being any type of corrosion which in any way interferes with mechanical or electrical performance. There shall be no unwrapping of, or mechanical damage to the insulating sleeves, when applicable. In addition, there shall be not more than 10 percent corrosion of the terminal hardware or mounting surface. Marking shall remain legible.

3.17 Immersion. When tested as specified in 4.7.13, capacitors shall meet the following requirements:

Dielectric withstanding voltage:

Insulating sleeves (when applicable) - Shall be greater than 4,000 volts, dc.

Terminal to terminal----- Shall be as specified in 3.10.

Terminals to case (when case is  
not a terminal)----- Shall be as specified in 3.10.

Insulation resistance:

Insulating sleeves (when applicable) - Shall be 100 megohms, minimum.

Terminal to terminal----- Shall be not less than the specified percent of the initial  
requirement (see 3.1).

Terminals to case (when case is  
not a terminal)----- Shall be not less than the value specified (see 3.1).

Capacitance change ----- Shall change within  $\pm 10$  percent of initial measured value (see  
3.12).

Dissipation factor----- Shall not be more than the specified percent (see 3.1).

As a result of the test, corrosion of exposed metal surfaces shall not exceed 10 percent. Discoloration and tarnishing alone shall not be cause for rejection. There shall be no unwrapping of, or mechanical damage to the insulating sleeves, when applicable, or obliteration of markings.

3.18 Solderability. When capacitors are tested as specified in 4.7.14, the terminals shall conform to the criteria of method 208 of MIL-STD-202.

3.19 Shock (specified pulse). When capacitors are tested as specified in 4.7.15, there shall be no mechanical damage, no evidence of intermittent contacts of 0.5 ms or greater duration, open-circuiting or short-circuiting.

3.20 Resistance to soldering heat. When tested as specified in 4.7.16, capacitors shall meet the following requirements:

- Insulation resistance ----- Shall be as specified in 3.11.
- Capacitance ----- Shall change within  $\pm 5$  percent of initial measured value (see 3.12).
- Dissipation factor ----- Shall be not greater than initial limit.

3.21 Moisture resistance. When tested as specified in 4.7.17, capacitors shall meet the following requirements:

Dielectric withstanding voltage:

- Insulating sleeves (when applicable) - Shall be greater than 4,000 volts, dc.
- Terminal to terminal ----- Shall be as specified in 3.10.
- Terminals to case (when case is not a terminal) ----- Shall be as specified in 3.10.

Insulation resistance:

- Insulating sleeves (when applicable) - Shall be 100 megohms, minimum.
- Terminal to terminal ----- Shall be not less than the specified percent of the initial requirement (see 3.1).
- Terminals to case (when case is not a terminal) ----- Shall be not less than the value specified (see 3.1).

- Capacitance change ----- Shall change within  $\pm 10$  percent of initial measured value (see 3.12).
- Dissipation factor ----- Shall be not more than the specified percent (see 3.1).

As a result of the test, corrosion of exposed metal surfaces shall not exceed 10 percent. Discoloration and tarnishing alone shall not be cause for rejection. There shall be no unwrapping of, or mechanical damage to the insulating sleeves, when applicable, or obliteration of markings.

3.22 Terminal strength. When capacitors are tested as specified in 4.7.18, there shall be no permanent damage to the terminals or seal.

3.23 Low temperature and capacitance change with temperature. When capacitors are tested as specified in 4.7.19, there shall be no indication of breakdown or arcing, nor shall there be any open-circuiting or permanent short-circuiting or any visible evidence of mechanical damage. Unless otherwise specified (see 3.1), the capacitance changes at the specified temperatures shall not exceed the applicable limits specified in table V.

3.24 Fungus. The manufacturer shall certify that all external materials are fungus resistant or shall perform the test specified in 4.7.20. When capacitors are tested as specified in 4.7.20, examination shall disclose no evidence of fungus growth on the external surface.

3.25 Resistance to solvents. When capacitors are tested as specified in 4.7.21, marking shall remain legible and shall not smear or rub off. In addition, there shall be no visible indication of damage or deterioration of the capacitor body.

TABLE V. Capacitance change at extreme temperatures.

Dielectric material	Maximum capacitance change (in percent)	
	-55°C	High test temperature
Paper-polyethylene-terephthalate	-10	+20
Polycarbonate (dcV)	-2.0	±2.0
Polycarbonate (acV)	-3.0	±3.0
Polyethylene-terephthalate	-8.0	+8.0
Cellulose acetate	-12	+4.0

3.26 Life. Unless otherwise specified (see 3.1), when tested as specified in 4.7.22, capacitors shall meet the following requirements:

Dissipation factor

At the applicable maximum rated temperature after 24 hours but not more 48 hours from start of test----- Shall be not greater than the limit specified.

At the applicable maximum rated temperature any time during the last 48 hours of test ----- Shall be not greater than the limit specified.

Insulation resistance:

Insulating sleeves (when applicable) - Shall be 100 megohms, minimum.

Terminal to terminal----- Shall be not less than the value specified.

Terminals to case (when case is not a terminal) ----- Shall be not less than the value specified.

Capacitance change ----- Shall be within ±10 percent of initial measured value (see 3.12).

Dissipation factor----- Shall be not greater than the limit specified.

Visual inspection ----- There shall be no corrosion, leakage of impregnant or filling compound, or mechanical damage either during or after the test. Marking shall remain legible.

3.27 Flash point of impregnant. When tested as specified in 4.7.23, the flash point of impregnant shall be not lower than 145°C.

3.28 Marking. Marking of capacitors shall conform to [method I of MIL-STD-1285](#), and shall include the Part or Identifying Number (PIN) (see 1.2.1), "JAN" marking, date code, lot symbol, and manufacturer's source code. The capacitance (in µF), capacitance tolerance, and rated voltage shall also be included. The date code and lot code shall be in accordance with [MIL-STD-1285](#). The date code and source code shall also be marked on the unit package. Example of marking (unless otherwise specified), see 4.7.1):

M39022/01- - PIN (may be on one line if space permits).

1001

JAN0148A 12345 - "JAN" marking, date code, lot symbol, and source code.

.018 µF 5% 50 V - Capacitance, capacitance tolerance, and rated voltage.

3.28.1 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 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" and "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, the manufacturer shall remove completely the military part number and 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 Number 504,860 for the certification mark "JAN" and Registration Number 1,586,261 for the certification mark "J".

3.28.2 Marking of non-ER parts. An ER part may be marked and furnished as a non-ER part for items in [MIL-C-18312](#), if produced on the same assembly line and provided it is subjected to and meets all the inspection requirements of the ER part.

3.28.3 Supplying to higher failure rate levels. A manufacturer may supply to all higher failure rate levels than to which he is qualified. 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](#)).

3.28.4 Supplying to looser capacitance tolerance and lower 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](#)).

3.29 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials should be used to the maximum extent possible provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

3.29.1 Connections. The electrical connections of capacitors shall not depend on wires, lugs, terminals, or other connectors clamped between a metallic member and an insulating material. Where the maintenance of a tight connection depends on the resistance of an insulating material to compressive stress or shearing stress, such connection shall be securely soldered or welded.

3.29.2 Soldering. Where soldering is employed, 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.

3.30 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 (see [4.7.1](#)).

#### 4. VERIFICATION

4.1 Classification of inspection. The inspection requirements specified herein are classified as follows:

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

4.2 QPL system. The manufacturer shall establish and maintain a QPL system in accordance with 3.3. Evidence of such compliance is a prerequisite for qualification and retention of qualification.

4.3 Inspection conditions. Unless otherwise specified, all inspections shall be performed in accordance with the test conditions specified in the "GENERAL REQUIREMENTS" of MIL-STD-202, except relative humidity shall not exceed 75 percent. Unless otherwise specified (see 3.1), accuracy of all test voltage measurements shall be within  $\pm 2.0$  percent of the specified voltage.

4.3.1 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  $25^{\circ}\text{C} \pm 3^{\circ}\text{C}$  prior to beginning of conditioning. Unless reference measurements have been made within 30 days prior to the beginning of conditioning, they shall be repeated.

4.3.2 Power supply. The power supply used for life testing shall have a regulation of  $\pm 2$  percent or less of the specified test voltage.

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

4.4.1 Sample size. The number of capacitors to be subjected to qualification inspection shall be as specified in the appendix to this specification.

4.4.2 Inspection routine. Sample units shall be subjected to the qualification inspection specified in table VI, in the order shown. All sample units shall be subjected to the inspections of group II. The sample units shall then be divided into six remaining groups as specified in table VI, and subjected to the tests for their particular group.

Sample units which have been selected to be submitted to the life tests shall be divided into two groups. One group shall be subjected to the accelerated condition and the other group to the rated condition. The decision as to whether or not the product is to be included on the qualified products list shall be made at the conclusion of the 2,000-hour life test.

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

TABLE VI. Qualification inspection.

Inspection	Requirement paragraph	Test method paragraph	Number of sample units to be inspected		Number of defects permitted <u>1/</u>
<u>Group I</u> Burn-in (when specified, see 3.1)	3.6	4.7.2	76		0
<u>Group II</u> <u>2/</u> Visual and mechanical examination Marking <u>3/</u> Workmanship (external) Radiographic inspection (X-ray) <u>4/</u> Thermal shock Seal Dielectric withstanding voltage Insulation resistance Capacitance Dissipation factor Barometric pressure (reduced)	3.1, 3.4, 3.5 3.28 3.30 3.7 3.8 3.9 3.10 3.11 3.12 3.13 3.14	4.7.1 4.7.1 4.7.1 4.7.3 4.7.4 4.7.5 4.7.6 4.7.7 4.7.8 4.7.9 4.7.10	76		0
<u>Group III</u> Vibration Salt spray (corrosion) Immersion	3.15 3.16 3.17	4.7.11 4.7.12 4.7.13	6		
<u>Group IV</u> Solderability Shock (specified pulse) Resistance to soldering heat Moisture resistance	3.18 3.19 3.20 3.21	4.7.14 4.7.15 4.7.16 4.7.17	<u>5/</u> 6		1
<u>Group V</u> Terminal strength Low temperature and capacitance change with temperature <u>2/</u>	3.22 3.23	4.7.18 4.7.19	6		
<u>Group VI</u> Fungus <u>6/</u> Resistance to solvents	3.24 3.25	4.7.20 4.7.21	4 4	8	1
<u>Group VII</u> Life (accelerated conditions) Life (rated conditions) <u>7/</u>	3.26 3.26	4.7.22 4.7.22	20 30		1
<u>Group VIII</u> Flash point of impregnant	3.27	4.7.23	1		0

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

2/ Nondestructive tests.

3/ Marking defects are based on visual inspection only 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/ Where applicable, see 3.1.

5/ Two sample units shall be tested for solderability with no defectives permitted when maximum rated temperature is less than 100°C. The remaining 4 sample units shall be tested for shock and moisture resistance.

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

7/ Not applicable for style CHR26.

4.4.4 Failure rate (FR) qualification. FR qualification 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 FRL. Level "M" (1.0 percent) of FRSP-90 shall apply. Sample units shall be subjected to the qualification inspection specified in group VII, [table VI](#) (see [4.4.2](#)). Upon completion of the 2,000 hour qualification life test (rated conditions), the entire sample shall be continued on test for an additional 8,000 hours for a total of 10,000 hours as specified in [4.7.22.1](#). Voltages may be combined.
- b. Procedure II: Extension of qualification to lower FRLs. To extend qualification to the "P" (0.1 percent) FRL, data from two or more voltages within a style may be combined. To extend qualification to the "R" (0.01 percent) and "S" (0.001 percent) FRLs, data from two or more styles of similar construction (see [4.6.1.1.1](#)) may be combined.
- c. Procedure III: Maintenance of FRL 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.

4.4.5 Quality level verification. The manufacturer is responsible for establishing a quality system to assess the ppm defect level of lots that are subjected to 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.

4.5 Verification of qualification. Every 6 months, the manufacturer shall provide verification of qualification to the qualifying activity. Continuation shall be based on meeting the following requirements:

- a. [MIL-STD-790](#) program.
- b. The capacitor design has not been modified.
- c. Lot rejection for [group A](#) inspection does not exceed 10 percent or one lot, whichever is greater.
- d. The requirements for [group B](#) inspections are met.
- e. Verification of FRLs.
- f. PPM assessment.

In the event that there is no production of any devices within a specification sheet during a maintenance period and the manufacturer is listed for more than one specification sheet on the QPL, the manufacturer shall certify that they retain the capabilities and facilities necessary to produce that product. However, the manufacturer shall still maintain the required number of unit hours in the maintenance period using those styles produced in order to remain qualified to the applicable failure rate levels. In the case where the lowest failure rate for an un-produced style is M, styles need not be manufactured for testing only but the manufacturer must certify that the capability and facilities needed to produce those styles are still in place. In the event that units must be built for the purpose of maintaining the required hours, they shall also undergo all required testing prior to being placed on life test. If during three consecutive reporting periods there has been no production of any devices within a specification sheet, the manufacturer may be required, at the discretion of the qualifying activity, to submit a newly-produced (not from stock) representative product of those styles to testing.

4.6 Conformance inspection.

4.6.1 Inspection of product for delivery. Inspection of product for delivery shall consist of [group A](#) inspection.

4.6.1.1 Inspection lot 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 one or more styles, one or more voltage ratings and the same dielectric, not less than the minimum number of dielectric layers, and offered for inspection during a single work month. The minimum number of dielectric layers is that number of layers used in the sample units submitted for qualification. Each lot shall be kept separate from every other lot. The sample selected from the lot shall be representative of the voltage ratings, styles, capacitance values, and case sizes in the lot. The following styles are considered to be of similar style and may be combined for conformance and FRL maintenance (all voltage ratings may be combined):

Group	Styles
1	- CHR09 (/1), CHR12 (/8), and CHR19 (/2).
2	- CHR20, CHR21, CHR22, CHR23, CHR24, and CHR25 (/11).
3	- CHR10 (/10) and CHR26 (/12). (May be maintained by MIL-PRF-83421/1.)
4	- CHR26 (/12), CHR27 (/13), and CRH31 through CRH 35 (MIL-PRF-83421/6).

4.6.1.1.2 Production lot. A production lot shall consist of capacitors of the same style, voltage rating, and nominal capacitance value. 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 Group A inspection. Group A inspection shall consist of the examinations and tests specified in table VII, and shall be made on the same set of sample units, in the order shown.

TABLE VII. Group A inspection.

Inspection	Requirement paragraph	Test method paragraph	Sampling procedure
<u>Subgroup 1</u>			
Thermal shock <u>2/</u>	3.8	4.7.4	100% inspection
Radiograph inspection (X-ray) <u>1/</u>	3.7	4.7.3	
Burn-in	3.6	4.7.2	
Seal	3.9	4.7.5	
Dielectric withstanding voltage	3.10	4.7.6	
Insulation resistance (at 25°C)	3.11	4.7.7	
Capacitance	3.12	4.7.8	
Dissipation factor	3.13	4.7.9	
<u>Subgroup 2 <u>3/</u></u>			
Visual inspection, external	3.1	4.7.1	See table VIII
Physical dimensions	3.4, 3.5	4.7.1	
Marking <u>4/</u>	3.28	4.7.1	
Workmanship	3.30	4.7.1	
<u>Subgroup 3</u>			
Solderability <u>5/ 6/</u>	3.18	4.7.14	5 samples 0 failures

1/ Where applicable, see 3.1.

2/ The minimum number of cycles is 5.

3/ The manufacturer may request deletion of subgroup 2 (visual inspection) provided an in-line or process control system to assure the visual inspection requirements are met and can be validated and approved by the qualifying activity. Deletion of these inspections does not relieve the manufacturer from meeting these requirements in case of dispute. If the design, material, construction, or processing of the part is changed or if there are any quality problems, the qualifying activity may require resumption of these inspections.

TABLE VII. Group A inspection – Continued.

- 4/ 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.
- 5/ Electrical rejects from subgroup 1 may be used for solderability.
- 6/ The manufacturer may request the deletion of the subgroup 3 solderability test, provided an inline or process control system for assessing and assuring the solderability of leads can be validated and approved by the qualifying activity. Deletion of the test does not relieve the manufacturer from meeting this test requirement.

TABLE VIII. Sampling plans for subgroup 2.

Lot size	Sample size
1 - 13	100%
14 - 150	13
151 - 280	20
281 - 500	29
501 - 1,200	34
1,201 - 3,200	42
3,201 - 10,000	50
10,001 - 35,000	60
35,001 - 150,000	74
150,001 - 500,000	90
500,001 - Up	102

4.6.1.2.1 Subgroup 1 tests. Subgroup 1 tests shall be performed on a production lot basis on 100 percent of the product supplied under this specification. Lots having more than 8 percent total rejects shall not be furnished on contracts. A failure is defined as capacitance value  $\pm 20$  percent of its nominal value, insulation resistance (IR) less than 100 megohms, or dissipation factor (DF) exceeding the limits specified after 10,000-hour life.

4.6.1.2.1.1 Manufacturer's production inspection. If the manufacturer performs tests similar to those specified in subgroup 1, [table VII](#), as the final step of the 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 the 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 are the same or more stringent than those specified herein.
- e. The manufacturer shall make available all information concerning the test procedures and instrumentation used in the production tests. The manufacturer shall also make available to the Government all records of all detail test data resulting from production tests.
- f. Once approved, the manufacturer shall not change the test procedures or criteria without prior notification and concurrence by the qualifying activity.

4.6.1.2.2 Subgroup 2 tests. Subgroup 2 tests shall be performed on an inspection lot basis. The sampling procedure shall be as specified in [table VII](#). If one or more defects are found, the lot shall be rescreened and defects removed. A new sample shall then randomly be selected. If one or more defects are found in this second sample, the lot shall be rejected and shall not be supplied to this specification.

4.6.1.2.3 Subgroup 3 tests (solderability).

4.6.1.2.3.1 Inspection lot. An inspection lot for the purpose of subgroup 3 (solderability) testing shall consist of all lots manufactured with the same diameter lead wire and offered for inspection within the same work week. Each production lot shall be kept separate from every other lot. All samples belonging to a production lot shall be identified to that lot. Means of identification is at the option of the manufacturer.

4.6.1.2.3.2 Sampling plan. A minimum of 5 pieces shall be selected randomly from each inspection lot; however, each production lot shall be represented in the sample. If the inspection lot consists of more than 5 production lots, then a minimum of one sample shall be selected from each production lot. If there are one or more failures, the inspection lot shall be considered to have failed. Test samples may be selected from subgroup 1 electrical failures.

4.6.1.2.3.3 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 4.6.1.2.3.2. 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 4.6.1.2.3.3b.
- b. The manufacturer submits the failed lot to a 100 percent solder dip using an approved solder dip process in accordance with the [appendix](#). Following the solder dip, the electrical measurements required in [group A](#), subgroup 1 tests (dielectric withstanding voltage, insulation resistance at 25°C, capacitance, and dissipation factor) shall be repeated on 100 percent of the lot. The PDA for the electrical measurements shall be as for the subgroup 1 tests. (Note: If x-ray and hermetic seal are required in the [group A](#), subgroup 1 tests, these tests shall be repeated.) 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.

4.6.1.2.3.4 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. The samples may be used at the discretion of the manufacturer for [group B](#) testing.

4.6.1.2.4 PPM calculations. The manufacturer shall establish a PPM system in accordance with [3.3.2](#) for assessing and calculating average outgoing quality of capacitors. A PPM rate combining capacitance, DF, and IR (25°C) shall be assessed for lots that have passed the [group A](#) inspection. The manufacturer's PPM system shall also address rectification procedures for lots failing PPM assessment. Data from the rectification process shall not be used to calculate PPM.

4.6.2 Periodic group B inspection. Periodic [group B](#) inspection shall consist of the tests specified in [table IX](#), in the order shown, and shall be performed on sample units selected from inspection lots that have passed [group A](#) inspection. Except where the results of these inspections show noncompliance with the applicable requirements (see [4.6.2.3](#)), delivery of products that have passed [group A](#) shall not be delayed pending the results of this periodic inspection.

4.6.2.1 Sampling plan.

4.6.2.1.1 Subgroup 1. Sample units shall be taken from production every 2 months. The time period for vibration and shock shall be every 24 months. Voltage ratings and dielectric materials may be grouped. Styles may be grouped, but styles CHR20 through CHR25 (1/1) shall be tested separately from all other styles. The maximum and minimum case sizes manufactured during the period shall be represented in the sample in at least the approximate ratio of production. Allowable failures shall be as specified in table IX.

TABLE IX. Group B inspection.

Inspection	Requirement paragraph	Test method paragraph	Number of sample units to be inspected	Number of defects permitted	
<u>Subgroup 1 (every 2 months)</u>					
<u>Subgroup 1A (every 2 months)</u>					
Vibration <u>1/</u>	3.15	4.7.11	12	1	
Salt spray (corrosion) <u>2/</u>	3.16	4.7.12			
Immersion <u>2/</u>	3.17	4.7.13			
<u>Subgroup 1B (every 2 months)</u>					
Shock (specified pulse) <u>1/</u>	3.19	4.7.15	10		
Resistance to soldering heat <u>2/</u>	3.20	4.7.16			
Moisture resistance <u>2/</u>	3.21	4.7.17			
<u>Subgroup 1C (every 2 months)</u>					
Terminal strength <u>2/</u>	3.22	4.7.18	12		
Low temperature and capacitance change with temperature <u>2/</u>	3.23	4.7.19			
Resistance to solvents <u>2/</u>	3.25	4.7.21			
<u>Subgroup 2 (every 2 months)</u>					
Insulation resistance (at applicable maximum rated temperature)	3.11	4.7.7	10 per inspection lot minimum	<u>3/</u>	
Life (accelerated)	3.26	4.7.22.2.1			

1/ The time period for shock and vibration tests is a minimum of once every 24 months.

2/ If the manufacturer can demonstrate that this test has been performed five consecutive times with zero failure, this test, with the approval of the qualifying activity, can be deleted. The manufacturer, however, shall perform this test every 3 years after the deletion as part of long term design verification. If the design, material, construction processing of the part is changed, or if there are any quality problems, the qualifying activity may require resumption of the specified testing. Deletion of testing does not relieve the manufacturer from meeting the test requirements in case of dispute.

3/ See MIL-STD-690 for number of failures permitted.

4.6.2.1.2 Subgroup 2. A minimum of 10 sample units shall be selected from each group A inspection lot as defined in 4.6.1.1.1. The voltage ratings, styles, capacitance values, and case sizes shall be representative of the capacitors in the inspection lot. Allowable failures shall be as specified in table IX.

4.6.2.2 Disposition of sample units. Sample units that have been subjected to group B inspection shall not be delivered on the contract.

4.6.2.3 Noncompliance. If a sample fails to pass [group B](#) inspection, the manufacturer shall notify the qualifying activity and cognizant inspection activity of such failure and 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, and which are considered subject to the same failure. Acceptance of the product shall be discontinued until corrective action, acceptable to the qualifying activity, has been taken. After the corrective action has been taken, [group B](#) 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). [Group A](#) inspections may be reinstated; however, final acceptance shall be withheld until the [group B](#) 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 qualifying activity and the contracting officer or purchaser.

#### 4.7 Methods of examination and test.

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](#), [3.5](#), [3.28](#), and [3.30](#)).

4.7.2 Burn-in (see [3.1](#) and [3.6](#)). Capacitors shall be tested under accelerated voltage conditions as specified in [4.7.22](#), with the following exceptions:

AC burn-in: CHR26 style shall be exposed to a temperature of +85°C +4°C, -0°C with 140 percent of rated rms voltage 400 Hz applied on voltages of ≤ 300 volts; 120 percent of rated rms voltage at 400 Hz shall be applied on voltages ≥ 350 volts for 16 hours, minimum.

4.7.3 Radiographic inspection (X-ray) (see [3.1](#) and [3.7](#)). Capacitors shall be tested in accordance with [method 209 of MIL-STD-202](#). The following details shall apply:

- a. Radiographic quality: Sufficient definition to determine that specimens are free from defects specified in [3.7](#).
- b. Image-quality indicator: A sample part of the same type as the part being radiographed that contains either an actual or simulated defect which is at least 10 percent smaller than the smallest defect to be detected.
- c. Position of specimens: Two views perpendicular to the terminal axis. After first view, specimen shall be rotated 90 degrees for the second view.
- d. Evaluation of images:
  - (1) Special kind of viewing equipment: Magnifying glass.
  - (2) Magnification: 10X.
  - (3) Defects to be sought in specimen: As specified in [3.7](#).

4.7.4 Thermal shock (see [3.8](#)). Capacitors shall be tested in accordance with [method 107 of MIL-STD-202](#). Test condition letter B shall apply, except that in step 3, sample units shall be tested at the applicable maximum rated temperature (see [3.1](#)).

4.7.5 Seal (see 3.9). Capacitors shall be tested in accordance with [method 112 of MIL-STD-202](#). The following details shall apply:

- a. Test condition letters: As specified (see 3.1).
- b. Measurements after test: Not applicable.

4.7.5.1 Seal - alternative test. For capacitors with a liquid impregnant, the following seal test may be substituted: Capacitors shall be placed with the terminals facing sideways (not upward) on a clean sheet of absorbent paper and exposed to a case temperature within +4°C, -0°C of the applicable maximum rated temperature (see 3.1) for a period of 4 hours, minimum. The capacitor and absorbent paper shall then be visually examined for evidence of leakage of impregnant or filling compounds or bubbles from the seal.

4.7.6 Dielectric withstanding voltage (see 3.10). Capacitors shall be tested in accordance with [method 301 of MIL-STD-202](#). The following details and exception shall apply:

- a. Magnitude and nature of test voltage: As specified (see 3.1).
- b. Nature of potential: dc (except style CHR26 which shall be ac).
- c. Duration of application of test voltage: Unless otherwise specified (see 3.1), 1 minute.
- d. Points of application of test voltage: As specified (see 3.1).
- e. Power supply voltage regulation:  $\pm 2$  percent or better.
- f. Current resistor: Sufficient to limit charging current 1.0 ampere, maximum, for DC voltage only.

4.7.7 Insulation resistance (see 3.11). Capacitors shall be tested in accordance with [method 302 of MIL-STD-202](#). The following details shall apply:

- a. Test potential: Rated voltage or 500 V dc, whichever is less (see 3.1).
- b. Points of measurement:
  - (1) Terminal to terminal: Between terminals at the applicable maximum rated temperature (see 3.1), and at 25°C  $\pm 3$ °C.
  - (2) Terminals to case (when case is not a terminal): Between each terminal and the case at 25°C  $\pm 3$ °C.

4.7.8 Capacitance (see 3.12). Capacitors shall be tested in accordance with [method 305 of MIL-STD-202](#). Unless otherwise specified (see 3.1), the following details shall apply:

- a. Test frequency: 1,000  $\pm 100$  Hz.
- b. Limit of accuracy: Within  $\pm 0.05$  percent.

4.7.9 Dissipation factor (see 3.13). Unless otherwise specified (see 3.1), the dissipation factor shall be measured at 1,000  $\pm 100$  Hz (for capacitors having a nominal capacitance of 1  $\mu$ F or less) or 100  $\pm 10$  Hz (for capacitors having a nominal capacitance greater than 1  $\mu$ F).

4.7.10 Barometric pressure (reduced) for qualification only (see 3.14). Capacitors shall be tested in accordance with method 105 of MIL-STD-202. The following details shall apply:

- a. Method of mounting: By normal mounting means.
- b. Unless otherwise specified (see 3.1), test condition letter D (100,000 feet).
- c. Tests during subjection to reduced pressure: The specified potential (see 3.1) shall be applied for at least 1 minute between each terminal and the case when the terminal is not connected to the case, or between the insulated terminal and the case when the case is a terminal. However, at no time shall the potential exceed those limits specified (by altitude and case diameter) on figure 1. A suitable means shall be used to detect momentary or permanent breakdown.

After the test, capacitors shall be visually inspected for evidence of damage.

4.7.11 Vibration (see 3.15). Capacitors shall be tested in accordance with method 204 of MIL-STD-202. The following details and exceptions shall apply:

- a. Mounting of specimens: Rigidly mounted by the body to the vibration-test apparatus; terminals shall be secured  $.500 \pm .125$  inch from the case.
- b. Electrical-load conditions: During the test, a dc potential equal to 50 percent of the rated voltage (see 3.1) shall be applied between the terminals of the capacitor.
- c. Unless otherwise specified (see 3.1), test condition letter D (20 g's).
- d. Duration and direction of motion: 4 hours in each of two mutually perpendicular directions (total of 8 hours), one parallel and the other perpendicular to the cylindrical axis.
- e. Measurements: During the last cycle in each direction, an electrical measurement shall be made to determine intermittent contacts of 0.5 ms or greater duration, open-circuiting or permanent short-circuiting.
- f. Measurements after vibration: Not applicable.

After the test, capacitors shall be visually inspected for evidence of mechanical damage open-circuiting or short-circuiting.

4.7.12 Salt spray (corrosion) (see 3.16). Capacitors shall be tested in accordance with method 101 of MIL-STD-202. The following details shall apply:

- a. Test condition letter B (48 hours).
- b. Measurements after exposure: Not applicable.

After the test, capacitors shall be visually inspected for evidence of harmful corrosion and unwrapping of, or mechanical damage to the insulating sleeves (when applicable), and obliteration of marking.

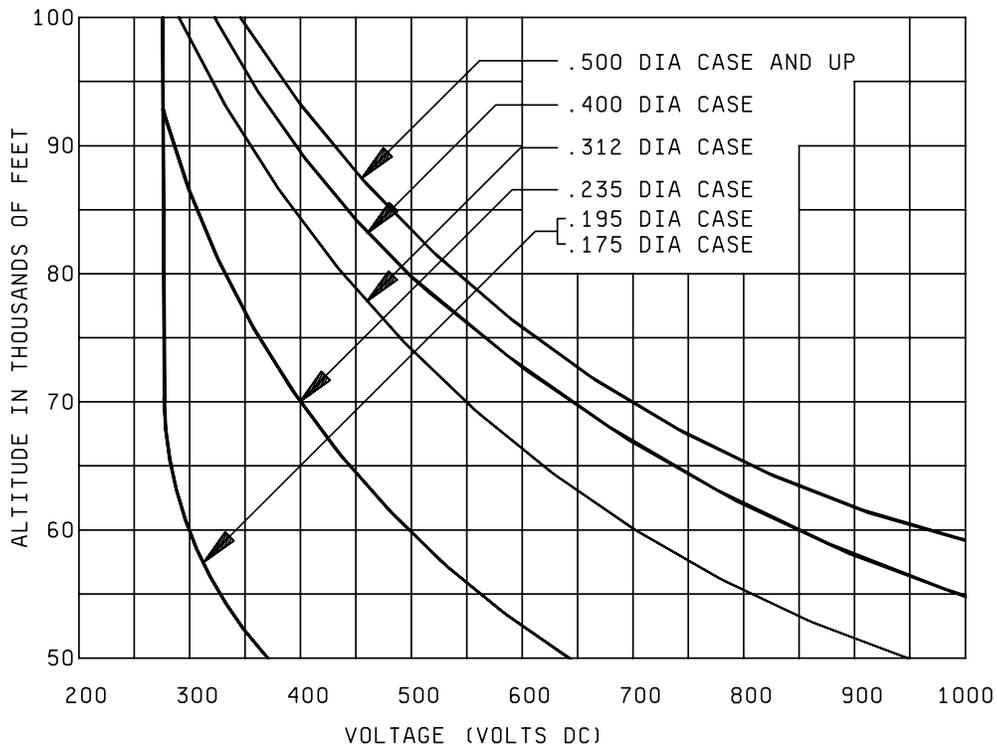


FIGURE 1. Breakdown voltage versus altitude.

4.7.13 Immersion (see 3.17). Capacitors shall be tested in accordance with [method 104 of MIL-STD-202](#). The following details and exception shall apply:

- a. Test condition letter C, with the following exceptions:
  - (1) Both hot and cold baths shall be a saturated solution of sodium chloride and water.
  - (2) For [group B](#) inspection only, two immersion cycles and 30 minute exposure shall be required.
- b. Inspections after final cycle: Capacitors shall be inspected for evidence of extensive corrosion, obliteration of markings, and unwrapping of or mechanical damage to the insulating sleeves, when applicable.
- c. Measurements after final cycle: For capacitors with insulating sleeves, dielectric withstanding voltage and insulation resistance shall be measured as specified in 4.7.6 and 4.7.7, respectively. The measurements shall be made between two wire windings placed around the sleeve of the capacitor .500 inch apart; each winding shall consist of three close turns of .040 inch (18 AWG) bare copper wire. The insulating sleeves shall be removed, and the dielectric withstanding voltage, insulation resistance, capacitance, and dissipation factor shall then be measured at 25°C ±3°C as specified in 4.7.6 to 4.7.9, inclusive.

4.7.14 Solderability (lead terminals) (see 3.18). Capacitors shall be tested in accordance with [method 208 of MIL-STD-202](#). The following details shall apply:

- a. Number of terminations of each capacitor to be tested: 2.
- b. Depth of immersion in flux and solder: Both terminals shall be immersed to within .125 inch of the capacitor body or eyelet closure.
- c. No physical damage after test.

4.7.15 Shock (specified pulse) (see 3.19). Capacitors shall be tested in accordance with [method 213 of MIL-STD-202](#). The following details shall apply:

- a. Special mounting means: Rigidly mounted by the body.
- b. Test condition letter I.
- c. Electrical loading during shock: During the test, a potential of 50 percent of rated voltage shall be applied between the terminals of the capacitor.
- d. Measurements during and after shock: During the test, a cathode-ray oscilloscope (or other comparable means) shall be used as an indicating device in determining any electrical failures and intermittent contacts of 0.5 ms or greater duration, open-circuiting or permanent short-circuiting.

After the test, capacitors shall be visually inspected for evidence of breakdown, arcing, fractures, and other visible mechanical damage.

4.7.16 Resistance to soldering heat (see 3.20). Capacitors shall be tested in accordance with [method 210 of MIL-STD-202](#). The following details shall apply:

- a. Depth of immersion in molten solder: To a minimum of .250 inch from the capacitor body.
- b. Test condition letter C, except test time shall be  $10 \pm 1$  seconds.
- c. Cooling time prior to final measurement:  $10 \pm 1$  minutes.
- d. Measurements after test: Insulation resistance, capacitance, and dissipation factor shall be measured at  $25^{\circ}\text{C} \pm 3^{\circ}\text{C}$  as specified in [4.7.7](#), [4.7.8](#), and [4.7.9](#), respectively.

4.7.17 Moisture resistance (see 3.21). Capacitors shall be exposed to five cycles of the thermal shock specified in [4.7.4](#) to condition the capacitors, and shall then be tested in accordance with [method 106 of MIL-STD-202](#). The following details and exceptions shall apply:

- a. Mounting: By normal mounting means. Capacitors which are normally supported by their wire leads shall be mounted to rigidly supported terminals so spaced that the length of each lead from the capacitor body shall be approximately .625 inch. Tubular capacitors greater than .562 inch nominal diameter and 1.562 inches in length shall have a supplementary mounting means, and the leads shall be supported at the ends during vibration.
- b. Subcycle: A total of five subcycles shall be performed. The vibration required in step 7 shall be in any direction.
- c. Loading (polarization): During steps 1 to 6 inclusive, a dc potential of 100 volts or rated voltage (see [3.1](#)), whichever is less, shall be applied across the terminals of 50 percent of the capacitors. No potential shall be applied to the remaining 50 percent of the capacitors.

- d. Final measurements: After the final cycle, capacitors shall be conditioned at 25°C +10°C, -5°C at a relative humidity of less than 80 percent, and a barometric pressure between 28 and 32 inches of mercury. After a maximum of 24 hours, capacitors shall be inspected for evidence of extensive corrosion, obliteration of marking, and unwrapping of or mechanical damage to the insulating sleeves (when applicable).

Dielectric withstanding voltage and insulation resistance shall be measured only on the insulating sleeves of case sizes .400 diameter x 1.063 long and larger at 25°C ±3°C as specified in 4.7.6 and 4.7.7, respectively, with the following exceptions: Measurements shall be made between two wire windings placed around the sleeve of the capacitor .500 inch apart; each winding shall consist of three close turns of .040 inch (18 AWG) bare copper wire.

All capacitors shall have dielectric withstanding voltage, insulation resistance, capacitance, and dissipation factor shall then be measured at 25°C ±3°C as specified in 4.7.6 through 4.7.9. These tests shall be done with insulating sleeves removed.

After the test, capacitors shall be visually inspected for evidence of extensive corrosion, and unwrapping of, or mechanical damage to the insulating sleeves.

4.7.18 Terminal strength (see 3.22). Capacitors shall be tested in accordance with [method 211 of MIL-STD-202](#). The following details and exceptions shall apply:

- a. Test condition letters A (pull test) and D (twist test).
- b. Test condition A:
  - (1) Method of holding: Capacitors shall be clamped by one terminal, and pull test load applied to the other terminal.
  - (2) Applied force: 5 pounds.

4.7.19 Low temperature and capacitance change with temperature (see 3.23).

4.7.19.1 Low temperature. Capacitors shall be placed in a chamber maintained at -55°C +0°C, -3°C and a potential equal to dc rated voltage shall be applied at this temperature for 48 ±4 hours. The voltage shall be applied to each capacitor through its individual current-limiting resistor of such value to limit the charging current to 50 milliamperes. The air within the conditioning chamber shall be circulated.

4.7.19.2 Capacitance change with temperature. At the conclusion of the test specified in 4.7.19.1, capacitance measurements shall be made as specified in 4.7.8, except that measurements shall be made at -55°C +0°C, -3°C, 25°C ±3°C, the applicable maximum rated temperature (see 3.1), and 25°C ±3°C. The -55°C measurements shall be made before the capacitors are removed from the conditioning chamber. The measurement at each temperature shall be recorded when two successive readings taken at 5 minute intervals indicate no change in capacitance.

After the test, capacitors shall be visually inspected for evidence of breakdown, arcing, open-circuiting, short-circuiting, and other visible mechanical damage.

4.7.20 Fungus (see 3.24). Capacitors shall be tested in accordance with [method 508 of MIL-STD-810](#).

4.7.21 Resistance to solvents (see 3.25). 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, see [table VI](#) and [table IX](#).
- c. Permissible extent of damage: As specified in [3.25](#).

Following each immersion, capacitors shall be brushed with a common hard-bristle toothbrush for 10 strokes. Brushing force shall be 1 pound.

4.7.22 Life (see [3.26](#)).

4.7.22.1 Qualification inspection. Capacitors shall be tested in accordance with [method 108 of MIL-STD-202](#). The following details and exceptions shall apply:

- a. Distance of temperature measurements from specimens: Measured on the body of the capacitor.
- b. Test temperature and tolerance: Applicable maximum rated temperature, +4°C, -0°C (see [3.1](#)). Radiation shall not be used as a means of heating the chamber.
- c. Operating conditions: Conditions shall be divided into two groups for testing, as follows:
  - (1) Twenty each shall be subjected to an accelerated condition of the specified percent of rated voltage (see [3.1](#)).
  - (2) Thirty each shall be subjected to 100 percent of rated voltage.

The voltage shall be applied to each capacitor through its individual current-limiting resistor as determined from the formula:

$$R = \frac{0.025}{C} \quad \text{Where: } C = \text{The nominal capacitance in farads.}$$

R = Resistance in ohms. Note: The actual current-limiting resistor employed shall have a resistance value within  $\pm 10$  percent of the calculated value (R); however, R need not exceed 2 megohms.

- d. Test condition letter F (2,000 +72, -0 hours).
- e. Measurements:
  - (1) During life test: The dissipation factor of each sample shall be measured as specified in [4.7.9](#) at the applicable maximum rated temperature (see [3.1](#)) after 24 hours, but not more than 48 hours from the start of the life test, and also at any time during the last 48 hours of the life test. During these measurements, the dc voltage shall be removed from the capacitor terminals.
  - (2) After 2,000 hour life test: Capacitors shall be returned to the inspection conditions specified in [4.3](#), and the insulation resistance, capacitance, and dissipation factor shall be measured as specified in [4.7.7](#), [4.7.8](#), and [4.7.9](#), respectively. Capacitors shall then be visually inspected for evidence of corrosion, leakage of impregnant or filling compound, mechanical damage, and legibility of marking.

Upon completion of the 2,000 hour test and related inspections, the capacitors which were tested under rated voltage conditions shall be tested for an additional 8,000 hours (see [4.7.22.2.2](#)).

4.7.22.2 Conformance inspection.

4.7.22.2.1 Accelerated condition. Capacitors shall be tested under accelerated conditions as specified in 4.7.22.1, except that time duration of test shall be 2,000 hours +72 hours, -0 hours. Measurements shall be accomplished after 240 hours +48 hours, -0 hour; 1,000 hours +48 hours, -0 hour; and 2,000 hours +72 hours, -0 hours.

4.7.22.2.2 Rated condition (see 3.1). Capacitors shall be tested under rated voltage conditions as specified in 4.7.22.1, except that time duration of test shall be 10,000 +96 hours, -0 hours. Measurements shall be accomplished after 240 +48 hours, -0 hour; 1,000 +48 hours, -0 hour; 2,000 +72 hours, -0 hours; and every 2,000 +72 hours, -0 hour thereafter.

4.7.23 Flash point of impregnant (see 3.27). The flash point of impregnant shall be measured as specified in ASTM-D92, except that fire point and precision do not apply. The word "impregnant" shall be substituted for the word "oil" throughout the test method.

5. PACKAGING.

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

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

6.1 Intended use. Capacitors covered by this specification are primarily intended for use in power supply filter circuits, by-pass applications, and other applications where the alternating current (ac) component of voltage is small with respect to the applied dc voltage and where occasional periods of low-insulation resistance and momentary breakdowns can be tolerated.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of this specification, the applicable specification sheet, and the complete PIN (see 1.2.1 and 3.1) and lead material if other than that specified (see 3.1).
- b. Capacitor marking requirements (see 3.28.3 and 3.28.4).
- c. Packaging requirements (see 5.1).

6.3 Solder dip (retinning). If retinning (hot solder dip) of the leads is required, see 3.5.3.1.

6.4 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 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 orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from the Defense Supply Center, Columbus, ATTN: DSCC-VQP, PO Box 3990, Columbus, OH 43218-3990, or by e-mail to [vqp.chief@dla.mil](mailto:vqp.chief@dla.mil).

6.4.1 Copies of SD-6. Copies of SD-6, "Provisions Governing Qualification" are available online at <http://assist.daps.dla.mil/quicksearch/> or <http://assist.daps.dla.mil> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.

6.5 Definitions.

6.5.1 Momentary breakdown. Momentary breakdown is defined as a single or a series of rapidly-succeeding capacitor discharges evidenced by abrupt decreases in insulation resistance of values below the limit specified in 3.10 and followed by restoration of the resistance to a value above this limit.

6.5.2 Liquid-filled capacitors. A liquid-filled capacitor is a capacitor in which a liquid impregnant occupies substantially all of the case volume not required by the capacitor element and its connections. Space may be allowed for expansion of the liquid under temperature variation.

6.6 Dielectric material. Dielectric materials normally used in the construction of the capacitors described herein are of the material specified (3.1), however is not restricted thereto.

6.7 Subject term (key word) listing.

Capacitance  
Dissipation factor  
Insulation resistance

6.8 Tin whisker growth. The use of alloys with tin content greater than 97 percent, by mass, may exhibit tin whisker growth problems after manufacture. Tin whiskers may occur anytime from a day to years after manufacture and can develop under typical operating conditions, on products that use such materials. Conformal coatings applied over top of whisker-prone surface will not prevent the formation of tin whiskers. Alloys of 3 percent lead, by mass, have shown to inhibit the growth of tin whiskers. For additional information on this matter, refer to [ASTM-B545](#) (Standard Specification for Electrodeposited Coatings of Tin).

6.9. Environmentally preferable material. Environmentally preferable materials should be used to the maximum extent possible to meet the requirements of this specification. As of the dating of this document, the U.S. Environmentally Protection Agency (EPA) is focusing efforts on reducing 31 priority chemicals. The list of chemicals is available on their website at <http://www.epa.gov/epaoswer/hazwaste/minimize/chemlist.htm>. Further information is available at the following EPA site: <http://www.epa.gov/epaoswer/hazwaste/minimize/>. Included in the EPA list of 31 priority chemicals are cadmium, lead, and mercury. Use of the materials on the list should be minimized or eliminated unless needed to meet the requirements specified herein (see [Section 3](#)).

6.10 Changes from previous issue. The margins of this specification are marked with vertical lines to indicate where changes from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

APPENDIX

PROCEDURE FOR QUALIFICATION INSPECTION

A.1 SCOPE

A.1.1 Scope. This appendix details the procedure for submission of samples for 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. This appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

A.2 APPLICABLE DOCUMENTS

DEPARTMENT OF DEFENSE STANDARDS

[MIL-STD-1276](#) - Leads for Electronic Component Parts.

A.3 SUBMISSION

A.3.1 Sample. For qualification to "M" level (see [3.1](#)) as in accordance with [table VI](#).

A.3.1.1 Single type submission. A sample consisting of 76 sample units of each style, circuit, dielectric material, rated voltage, capacitance value, and capacitance tolerance for which qualification is sought shall be submitted.

A.3.1.2 Voltage group submission. A sample consisting of 38 sample units of the highest capacitance value in the smallest case size and 38 sample units of the highest capacitance value in the largest case size, within a voltage rating for which qualification is sought, shall be submitted. The style, circuit, dielectric material, capacitance tolerance, and FRL of the sample units shall be the same. Separate submission shall be made for each voltage group in each style (except CHR09 and CHR12) for which qualification is sought (see [table A-I](#)). Styles CHR09 and CHR12 with voltage ratings of 200, 400 and 600 volts may be combined for submission as indicated in [table A-I](#).

A.3.1.3 Complete qualification group submission. The types and number of samples which shall be submitted for qualification approval are those shown in [table A-I](#) and shall be grouped in accordance with that table.

A.3.1.4 Impregnant. Two-hundred cubic centimeters of each impregnant used in the specimens for which approval is sought shall be submitted. On subsequent submissions, an impregnant which has successfully withstood the flash point of impregnant test (see [4.7.23](#)) need not be submitted.

A.4 EXTENT OF QUALIFICATION

A.4.1 Single type submission. Qualification of a capacitance type will be restricted to the dielectric material, dc rated voltage, and capacitance value submitted. Capacitance-tolerance qualification will be restricted to the capacitance tolerances equal to and wider than the tolerance submitted. Circuit 1 qualification will be the basis for qualification for circuit 3. Extent of FRL qualification shall be as specified in [A.4.4](#).

A.4.2 Voltage group submission. Qualification of the capacitance types submitted will be a basis for qualification for all capacitance values and case sizes in the voltage group. Capacitance-tolerance qualification will be restricted to the capacitance tolerances equal to and wider than the tolerance submitted. Circuit 1 qualification will be the basis for qualification for circuit 3. Extent of FRL qualification shall be as specified in [A.4.4](#).

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TABLE A-I. Samples for complete qualification submission.

Style	Qualification group	Types to be submitted	Quantity for complete qualification groups
CHR09 CHR12	50 V	M39022/01-1273	38
		M39022/08-2193	38
	200 V	M39022/01-1401	38
		M39022/08-1161	38
	400 V	M39022/01-1445	38
		M39022/08-1189	38
	600 V	M39022/01-1473	38
		M39022/08-1225	38
CHR19	200 V	M39022/02-1111	38
		M39022/02-1163	38
	400 V	M39022/02-1167	38
		M39022/02-1211	38
CHR10	50 V	M39022/10A473FM	38
		M39022/10A226FM	38
	100 V	M39022/10C103FM	38
		M39022/10C226FM	38
	200 V	M39022/10E103FM	38
		M39022/10E106FM	38
	300 V	M39022/10L103FM	38
		M39022/10L395FM	38
	400 V	M39022/10G103FM	38
		M39022/10G275FM	38
	600 V	M39022/10J103FM	38
		M39022/10J105FM	38
CHR20	30 V	M39022/11A333FM	38
		M39022/11A105FM	38
CHR21	50 V	M39022/11B103FM	38
		M39022/11B684FM	38
CHR22	100 V	M39022/11C562FM	38
		M39022/11C224FM	38
CHR23	150 V	M39022/11D332FM	38
		M39022/11D104FM	38
CHR24	200 V	M39022/11E222FM	38
		M39022/11E683FM	38
CHR25	300 V	M39022/11F102FM	38
		M39022/11F393FM	38

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TABLE A-I. Samples for complete qualification submission - Continued.

CHR26	165 V (AC)	M39022/12-1031	38
	110 V (AC)	M39022/12-1042	38
	80 V (AC)	M39022/12-1043	38
	200 V (AC)	M39022/12-1052	38
	400 V (AC)	M39022/12-1171 M39022/12-1177	38 38
CHR27	50 V	M39022/13A473FM	38
		M39022/13A226FM	38
	100 V	M39022/13C103FM	38
		M39022/13C226FM	38
	200 V	M39022/13E103FM	38
		M39022/13E106FM	38
	300 V	M39022/13L103FM	38
		M39022/13L395FM	38
400 V	M39022/13G103FM	38	
	M39022/13G275FM	38	
600 V	M39022/13J103FM	38	
	M39022/13J105FM	38	

A.4.3 Complete qualification group submission. Qualification of the complete qualification group submission will be the basis for qualification for all types, styles, circuits, dielectric materials, rated voltages, capacitance values, and capacitance tolerances. Extent of FRL qualification shall be as specified in A.4.4.

A.4.4 FRL qualification. The extent of qualification between FRL shall be as specified in table A-II.

TABLE A-II. Extent of FRL qualification.

Qualification for FRL	Will qualify FRL(s)
S	S, R, P, M
R	R, P, M
P	P, M
M	M

APPENDIX

A.5 QUALIFICATION APPROVAL FOR LOWER FRL

A.5.1 FR qualification. Extension of qualification to lower FRLs shall be in accordance with 4.4.4 of this specification.

A.6 SOLDER DIP (RETNING) LEADS

A.6.1 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.

A.6.2 Qualifying activity approval. Approval of the solder dip 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, the manufacturer shall use the same solder dip process for retinning as is used in the original manufacture of the product. (Note: The 200 microinch maximum thickness is not applicable)
- b. When the lead originally qualified was not hot solder dip lead finish 52 of MIL-STD-1276 as prescribed in A.6.2a, 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 capacitance, DF, and IR measurements. No defects are allowed. (Note: If X-ray and hermetic seal testing are required in group A, these tests would also be performed.) 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 seal test. No defects are allowed. (Note: Solder dip of gold plated leads is not allowed.)

A.6.3 Solder dip/retinning options. The manufacturer (or authorized category C distributor) may solder dip/retin as follows:

- 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 capacitance, DF, and IR 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. (Note: If X-ray and hermetic seal are required in the group A, subgroup 1 tests, these tests shall be repeated.) Following these tests, the manufacturer shall submit the lot to the group A solderability test as specified in 4.7.14.

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Custodians:

Army - CR  
Navy - EC  
Air Force - 11  
DLA - CC

Preparing activity:

DLA - CC

(Project 5910-2007-023)

Review activities:

Army - AR  
Navy - AS, MC, OS, SH  
Air Force - 19

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