

MILITARY SPECIFICATION

CAPACITORS, FIXED, METALLIZED, PAPER-PLASTIC FILM,  
OR PLASTIC FILM DIELECTRIC, DIRECT AND ALTERNATING CURRENT,  
(HERMETICALLY SEALED IN METAL 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 and alternating current (dc and ac), metallized paper-plastic film, or plastic film dielectric, fixed capacitors, hermetically sealed <sup>1/</sup> in metal cases. Capacitors covered by this specification have failure rate (FR) levels established in accordance with MIL-STD-690. The reliability for each level is identified by a symbol in accordance with table I. These FR levels are established at a 90-percent confidence level and maintained at a 10-percent producer's risk and are based on life tests performed at maximum rated voltage at maximum rated temperature. 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 rated temperature.

TABLE I. FR level (established at a 90-percent confidence level).

Symbol	FR level
	Percent/1,000 hr
L - - - - -	5.0
M - - - - -	1.0
P - - - - -	0.1
R - - - - -	0.01
S - - - - -	0.001

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

- 1/ For the purpose of this specification, a hermetically-sealed capacitor is one in which the capacitance element is contained within a sealed enclosure of ceramic, glass or metal, or combinations thereof, where sealing is accomplished by material fusion, welding, brazing, or soldering.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Naval Electronic Systems Command, ATTN: ELEX 5043, Department of the Navy, Washington DC 20360, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

2. APPLICABLE DOCUMENTS

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

SPECIFICATIONS

FEDERAL

QQ-S-571 - Solder; Tin Alloy; Lead-Tin Alloy; and Lead Alloy.

MILITARY

MIL-C-18312 - Capacitors, Fixed, Metallized (Paper, Paper-Plastic, or Plastic Film) Dielectric, Direct Current (Hermetically Sealed in Metal Cases), General Specification For.

MIL-C-39028 - Capacitors, Packaging of.

(See supplement 1 for list of associated specification sheets.)

STANDARDS

MILITARY

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.  
MIL-STD-202 - Test Methods for Electronic and Electrical Component 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-1285 - Marking of Electrical and Electronic Parts.

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

2.2 Other publications. The following document forms a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

D92-57 - Standard Method of Test for Flash and Fire Points by Cleveland Open Cup.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103. Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

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 3.1).

3.2 Qualification. Capacitors furnished under this specification shall be products which are qualified for listing on the applicable qualified products list at the time set for opening of bids (see 4.4 and 6.2). 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. Unless procured from the manufacturer or his authorized distributor listed or approved for listing on the qualified products list, parts furnished under this specification shall not be considered as having met the requirements of this specification.

3.3 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, 4.5, and 4.6.1.3.

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 and insulating and filling compounds. The impregnant and insulating and filling compounds, including varnish and similar materials, shall be chemically inactive with respect to the capacitor element and the case. The impregnant and compounds, 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-filled capacitors, the same material shall be used for impregnating as is used for filling (see 6.3.2).

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 allowed). The use of dissimilar metals separated by insulating material will also be permitted.

3.4.2.2 Solder. Solder for electrical connections shall be in accordance with QQ-S-571.

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

3.5.1 Terminals.

3.5.1.1 Axial-wire lead. Axial-wire lead terminals shall be of copper, copper alloy, or copper-clad steel, of the size specified (see 3.1). Copper alloy and copper-clad steel terminals shall have a minimum of 30 percent of the conductivity of electrolytic copper. Terminals shall be coated with solder having a tin content of 40 to 70 percent.

3.5.2 Case. Each capacitor shall be enclosed in a hermetically-sealed metal (magnetic or non-magnetic as specified, see 3.1) case which will prevent leakage of the impregnant or filling compound, and, in addition, will protect the capacitor element from moisture and mechanical damage under all the test conditions specified herein. The use of exterior cardboard sleeves for insulating purposes will not be permitted.

3.5.3 Capacitor element. The capacitor element shall consist of metallized plastic film, or a combination of metallized paper and plastic film. The capacitor dielectric may include uncoated dielectric tissues (plastic film or paper).

3.5.3.1 Construction. All capacitors shall have extended electrode construction to minimize inductance.

3.6 Burn-in (applicable to style CHR49 only). When tested as specified in 4.7.2, capacitors shall withstand the extremes of high temperature without visible damage.

3.7 Radiographic inspection (X-ray). When capacitors are tested as specified in 4.7.3, X-ray examination shall disclose no evidence of improperly made connections, misalignment of seals or eyelets, substandard soldering or structural weakness, or attached solder particles or slivers.

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- 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, or open- or short-circuiting. Momentary breakdowns (see 6.3.1) will be permitted.

3.11 Insulation resistance.

3.11.1 Terminal to terminal. When measured as specified in 4.7.7b.1, the product of the nominal capacitance (expressed in microfarads (uF)) 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 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). When tested as specified in 4.7.10, capacitors shall withstand the specified potential (see 3.1) without visible damage, external flashover, or open- or short-circuiting.

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

<u>Dielectric withstanding voltage:</u>	
Insulating sleeves (when applicable) - - - - -	Greater than 4,000 volts, dc.
Terminal to terminal - - - - -	As specified in 3.10.
Terminals to case (when case is not a terminal) - -	As specified in 3.10.
<u>Insulation resistance:</u>	
Insulating sleeves (when applicable) - - - - -	100 megohms, minimum.
Terminal to terminal - - - - -	Not less than the specified percent of the initial requirement (see 3.1).
Terminals to case (when case is not a terminal) - -	Not less than the value specified (see 3.1).
Capacitance change - - - - -	Within ±10 percent of initial measured value (see 3.12).
Dissipation factor - - - - -	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.

3.18 Solderability (axial-wire lead terminals). When capacitors are tested as specified in 4.7.14, the dipped surface of the terminals shall be at least 95 percent covered with a new, smooth, solder coating. The remaining 5 percent of the terminal surface shall show only small pinholes or rough spots; these shall not be concentrated in one area. 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 by pinholes or rough spots shall be determined by actual measurement of these areas, as compared to the total area.

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, or open- or short-circuiting.

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

<u>Dielectric withstanding voltage:</u>	
Insulating sleeves (when applicable) - - - - -	Greater than 4,000 volts, dc.
Terminal to terminal - - - - -	As specified in 3.10.
Terminals to case (when case is not a terminal) - - -	As specified in 3.10.
<u>Insulation resistance:</u>	
Insulating sleeves (when applicable) - - - - -	100 megohms, minimum.
Terminal to terminal - - - - -	Not less than the specified percent of the initial requirement (see 3.1).
Terminals to case (when case is not a terminal) - - -	Not less than the value specified (see 3.1).
Capacitance change - - - - -	Within ±10 percent of initial measured value (see 3.12).
Dissipation factor - - - - -	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.

3.21 Terminal strength. When capacitors are tested as specified in 4.7.17, there shall be no permanent damage to the terminals or seal.

3.22 Low temperature and capacitance change with temperature. When capacitors are tested as specified in 4.7.18, there shall be no indication of breakdown or arcing, nor shall there be any open- or permanent short-circuiting or any visible evidence of mechanical damage. The capacitance changes at the specified temperatures shall not exceed the applicable limits specified in table II.

TABLE II. 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

3.23 Fungus. The manufacturer shall certify that all external materials are non-nutrient or shall perform the test specified in 4.7.19. When capacitors are tested as specified in 4.7.19, examination shall disclose no evidence of fungus growth on the external surface.

3.24 Resistance to soldering heat. When tested as specified in 4.7.20, capacitors shall meet the following requirements:

Insulation resistance	-----	As specified in 3.11.
Capacitance change	-----	Within $\pm 5$ percent of initial value (see 3.12).
Dissipation factor	-----	Not greater than initial limit.

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.

3.26 Life. When tested as specified in 4.7.22, capacitors shall meet the following requirements:

Dissipation factor:		
At the applicable maximum rated temperature (see 3.1), after 24 hours but not more than 48 hours from start of test	-----	Not greater than the limit specified (see 3.1).
At the applicable maximum rated temperature (see 3.1), any time during the last 48 hours of test	-----	Not greater than the limit specified (see 3.1).
Insulation resistance:		
Insulating sleeves (when applicable)	-----	100 megohms, minimum.
Terminal to terminal	-----	Not less than the value specified (see 3.1).
Terminals to case (when case is not a terminal)	-----	Not less than the value specified (see 3.1).
Capacitance change	-----	Within $\pm 10$ percent of initial measured value (see 3.12).
Dissipation factor	-----	Not greater than the limit specified (see 3.1).
Visual examination	-----	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. Capacitors shall be permanently marked with the part number, "JAN" marking, date code, lot symbol, and manufacturer's source code, followed by the capacitance (in  $\mu\text{F}$ ), capacitance tolerance, and rated voltage. Paper labels shall not be used. Other markings which in any way interfere with, obscure, or confuse those specified herein are prohibited. Each capacitor shall be legibly marked using smear-resistant ink which will withstand the environmental conditions specified herein. Marking shall remain legible after all tests. The date and source codes shall be in accordance with MIL-STD-1285 except that the last two digits of the date code shall designate the week that the items are offered for inspection during the period specified in 4.6.1.1; the lot symbol shall be a single letter except that letters "O" and "I" shall not be used (the letter "A" shall be used to identify a single lot and the date code will indicate the lot). Manufacturing records shall include these same date codes and lot symbols. The manufacturer shall provide for lot traceability by date code and lot symbol. Example of marking:

M39022/01-        - Part number  
 1001  
 JAN7833A 12345 - "JAN" marking, date code, lot symbol, and source code.  
 .018  $\mu\text{F}$  5% 50 V - Capacitance, capacitance tolerance, and rated voltage.

The date and source codes shall also be marked on the unit package.

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 electrical equipment, namely, resistors, capacitors, electron tubes and the like, procured by, or manufactured for use by, or for the Government in accordance with standard Government specifications. Accordingly, capacitors procured to, and meeting all of the criteria specified herein, and in applicable specification sheets shall bear the certification mark "JAN", except that capacitors too small to bear the certification mark "JAN" shall bear the letter "J". Capacitors furnished under contracts or orders which either permit or require deviation from the conditions or requirements specified herein and in applicable specification sheets shall not bear "JAN" or "J". In the event a capacitor sample fails to meet the requirements of this specification and the applicable specification sheets, the manufacturer shall remove the "JAN" or the "J" from the sample tested and also from all capacitors represented by the sample. The United States Government has obtained Certificate of Registration No. 504,860 for the certification mark "JAN".

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.

3.29 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.

3.29.1 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 or shearing stress, such a 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.

#### 4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor 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 Reliability assurance program. A reliability assurance program shall be established and maintained in accordance with MIL-STD-790, with the following exceptions:

- a. Only the following of paragraph 5.2.7(j) shall apply: "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. Paragraph 5.2.11.3 shall not apply.

Evidence of such compliance shall be verified by the qualifying activity of this specification as a prerequisite for qualification and continued qualification.

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

- a. Qualification inspection (see 4.4).
- b. Retention 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 inspection shall be made in accordance with the general requirements of MIL-STD-202 except relative humidity shall not exceed 75 percent. Accuracy of all test voltage measurements shall be within  $\pm 2.0$  percent of the specified voltage.

#### 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  $25^\circ \pm 3^\circ\text{C}$  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  $\pm 2$  percent or less of the specified test voltage.

4.4 Qualification inspection. <sup>2/</sup> Qualification inspection shall be performed at a laboratory acceptable to the Government (see 6.2) 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 Test routine. Sample units shall be subjected to the qualification inspection specified in table III, in the order shown. All sample units shall be subjected to the inspection of group II. The sample units shall then be divided into five remaining groups as specified in table III, and subjected to the tests for their particular group. Samples which have been selected to be submitted to the life test 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.

<sup>2/</sup> Application for qualification tests shall be made in accordance with "Provisions Governing Qualification" (see 6.2.1).

TABLE III. Qualification inspection.

Examination or test	Requirement paragraph	Method paragraph	Number of sample units to be inspected	Number of defectives allowed <sup>1/</sup>
Flash point of impregnant - - - - -	3.27	4.7.23	1	0
<b>Group I</b>				
Burn-in (style CHR49 only) - - - - -	3.6	4.7.2	76	0
<b>Group II <sup>2/</sup></b>				
Visual and mechanical examination - -	3.1, 3.4, 3.5	4.7.1	} 76	} 0
Marking <sup>3/</sup> - - - - -	3.28	4.7.1		
Workmanship (external) - - - - -	3.29	4.7.1		
Radiographic inspection (x-ray) <sup>4/</sup> -	3.7	4.7.3		
Thermal shock <sup>5/</sup> - - - - -	3.8	4.7.4		
Seal - - - - -	3.9	4.7.5		
Dielectric withstanding voltage - - -	3.10	4.7.6		
Insulation resistance - - - - -	3.11	4.7.7		
Capacitance - - - - -	3.12	4.7.8		
Dissipation factor - - - - -	3.13	4.7.9		
Barometric pressure (reduced) - - -	3.14	4.7.10		
<b>Group III</b>				
Vibration - - - - -	3.15	4.7.11	} 6	}
Salt spray (corrosion) - - - - -	3.16	4.7.12		
Immersion <sup>5/</sup> - - - - -	3.17	4.7.13		
<b>Group IV</b>				
Solderability (axial-wire lead terminals) - - - - -	3.18	4.7.14	} <sup>6/</sup>	} 1
Shock (specified pulse) - - - - -	3.19	4.7.15		
Moisture resistance - - - - -	3.20	4.7.16		
<b>Group V</b>				
Terminal strength - - - - -	3.21	4.7.17	} 6	}
Low temperature and capacitance change with temperature <sup>2/</sup> - - - -	3.22	4.7.18		
<b>Group VI</b>				
Fungus <sup>7/</sup> - - - - -	3.23	4.7.19	} <sup>4/</sup> 8	} 1
Resistance to soldering heat - - - -	3.24	4.7.20		
Resistance to solvents - - - - -	3.25	4.7.21		
<b>Group VII</b>				
Life (accelerated) - - - - -	3.26	4.7.22	20	} <sup>8/</sup>
Life (rated) <sup>9/</sup> - - - - -	3.26	4.7.22	30	

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

<sup>2/</sup> Nondestructive tests.

<sup>3/</sup> Marking defects are based on visual examination 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.

<sup>4/</sup> Radiographic inspection not required for FR levels L and M of style CHR49.

<sup>5/</sup> Thermal shock for FR level L capacitors will be accomplished as a group II test just prior to immersion.

<sup>6/</sup> 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.

<sup>7/</sup> Certification of fungus resistance may be substituted for testing.

<sup>8/</sup> For FR level L maximum number of failures allowed shall be based on the cumulative unit hours required for verification at 5%/1,000 hours FR level.

<sup>9/</sup> Not applicable for style CHR49.

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

4.4.4 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 FR level. Level L (5.0 percent/1,000 hours) or M (1.0 percent/1,000 hours) as applicable (see 3.1) of FRSP-90 shall apply. Sample units shall be subjected to the qualification inspection specified in group VI, table III (see 4.4.2). The entire life test sample shall be continued on test to 10,000 hours as specified in 4.7.22.1, upon completion of the 2,000 hour qualification.
- b. Procedure II - Extension of qualification to lower FR levels. To extend qualification to the R (0.01 percent) and S (0.001 percent) FR levels, data from two or more styles of similar construction 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 4.6.1).

4.5 Retention of qualification. To retain qualification, the contractor shall forward a summary of the results of quality conformance inspections and, where applicable, extended FR test data, in the form of a qualification report, and forward it to the qualifying activity at 6-month intervals as the basis of qualification retention of the product. In addition to the periodic submission of FR test data, the manufacturer shall immediately notify the qualifying activity whenever the FR data indicates that the manufacturer has failed to maintain his qualified FR level. Retention of qualification shall be based on evidence that, over the 6-month period, the following has been met:

- a. The contractor continues to meet the requirements of MIL-STD-790.
- b. The manufacturer has not modified the design of the item unless prior approval is granted by the qualifying activity.
- c. Lot rejection for group A inspection does not exceed 10 percent or one lot, whichever is greater.
- d. The data from group B quality conformance life tests substantiate that the FR level for which the manufacturer is qualified is being maintained.
- e. The requirements for group C inspection are met. <sup>3/</sup>
- f. The records of all FR tests combined substantiate that the L (5.0 percent), M (1.0 percent), or P (0.1 percent) FR level has been maintained or that the manufacturer continues 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 4.4.4c.

In the event that no production occurred during the reporting period, a report shall be submitted certifying that the company still has the capabilities and facilities necessary to produce the items, provided the requirements of 4.4.4c have been met.

#### 4.6 Quality conformance inspection.

4.6.1 Inspection of product for delivery. Inspection of product for delivery shall consist of groups A and B inspection.

- <sup>3/</sup> If group C test requirements were not met and the manufacturer has taken corrective action satisfactory to the Government, the forwarding of the retention of qualification report may be delayed until within 30 days after completion of retesting of the group C inspections. In this case, the qualifying activity shall be notified of this condition within the time the original retention of qualification report was due. All reports shall be certified by a responsible company official.

4.6.1.1 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 numbers of dielectric layers <sup>4/</sup>, and offered for inspection during a single work week. Each lot shall be kept separate from every other lot. The sample units selected from a lot shall be representative of the styles, capacitance values, and case sizes in the lot. All sample units belonging to a lot shall be identified by means of a code symbol (either letters or numbers, at the option of the manufacturer). The following styles may be combined for quality conformance and FR level maintenance (all voltage ratings may be combined):

<u>Group</u>	<u>Styles</u>
1 - - -	CHR09, CHR12, and CHR19.
2 - - -	CHR49.
3 - - -	CHR59.

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

4.6.1.2.1 Sampling plan. Subgroup 2 tests applicable to FR levels M, P, R, and S shall be performed on each capacitor offered for inspection. Statistical sampling and inspection for subgroup 2 (FR level L) and subgroup 3 shall be in accordance with MIL-STD-105. The acceptable quality levels (AQL) and limiting quality (LQ) where  $P_a = 10$  percent shall be as specified in table IV. At the option of the manufacturer, numerically lower AQL's may be used as long as the specified LQ is not exceeded numerically. Major and minor defects shall be as defined in MIL-STD-105 and as specified in table IV.

4.6.1.2.2 Manufacturer's production inspection. If the manufacturer performs tests similar to those specified in subgroup 2, table IV, as the final step of his production process, group A, subgroup 2 inspection may be waived and the data resulting from the manufacturer's production tests may be used instead. Authority to waive the subgroup 2 inspection shall be granted by the qualifying activity only. The following criteria shall be complied with:

- Tests conducted by the manufacturer during production shall be clearly identical to or more stringent than that specified for subgroup 2 tests.
- Manufacturer subjects 100 percent of the product supplied under this specification to his production tests.
- The parameters measured and the failure criteria shall be the same or more stringent than those specified herein.
- The lot rejection criterion is the same or more stringent than that specified herein.
- The manufacturer shall make available all information concerning the test procedures and instrumentation used in his production 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.
- Once approved, the manufacturer shall not change the test procedures or criteria without prior notification and concurrence by the qualifying activity.

4.6.1.2.3 Rejected lots. Lots rejected by group A inspection shall be segregated from new lots and those lots that have passed inspection. Lots rejected because of failures in subgroups 2 and 3 may be offered for acceptance only if the manufacturer inspects all sample units in the lot for those quality characteristics found defective in the sample and, after removing all defective units found, reinspects the lot using the tightened inspection procedure of MIL-STD-105. Resubmitted lots shall be kept separate from new lots, and shall be clearly identified as resubmitted lots. If, during the 100-percent inspection of subgroup 1, screening requires that over 8-percent of the capacitors be discarded, the lot shall be rejected.

<sup>4/</sup> The minimum number of dielectric layers is that number of layers used in the sample units submitted for qualification.



4.6.2 Periodic inspection. Periodic inspection shall consist of group C inspection. Except where the results of this inspection show noncompliance with the applicable requirements (see 4.6.2.1.2), delivery of products which have passed groups A and B shall not be delayed pending the results of periodic inspection.

4.6.2.1 Group C inspection. Group C inspection shall consist of the tests specified in table VI, in the order shown. Test data obtained therefrom on the periodicity specified in 4.6.2.1.1 shall be reviewed as part of the complete reevaluation of qualification. Subgroup 1 of group C inspection shall be made on sample units selected from inspection lots which have passed group A (and group B for FR level L) inspection. Subgroup 2 inspection shall be made on sample units from lots which have been subjected to and passed group A inspection.

4.6.2.1.1 Sampling plan. For subgroup 1 of table VI, 36 sample units shall be taken from production every 2 months and subjected to the tests specified for subgroups 1A, 1B, and 1C, in the order shown. The maximum and minimum case sizes manufactured during that month shall be represented in the sample in at least the approximate ratio of production. Allowable failures shall be as specified in table VI. For subgroup 2, a minimum of 10 sample units per inspection lot every 2 months shall be subjected to the tests specified in table VI, in the order shown.

4.6.2.1.2 Noncompliance. If a sample unit fails to pass group C inspection, the contractor 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, and so forth, and which are considered subject to the same failure. Acceptance of the product shall be discontinued until corrective action, acceptable to the Government, has been taken. After the corrective action has been taken, group C inspection shall be repeated on additional sample units (all inspection, or the inspection which the original sample failed, at the option of the Government). Groups A and B inspections, as applicable, may be reinstated; however, final acceptance shall be withheld until the group C reinspection has shown that 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.

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

4.6.3 Inspection of preparation for delivery. Sample packages and packs shall be selected and inspected in accordance with MIL-C-39028 to verify conformance with the requirements in section 5 of this specification.

#### 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 3.29).

4.7.2 Burn-in (applicable to style CHR49)(see 3.6). Capacitors shall be tested under accelerated voltage conditions as specified in 4.7.22, with the following exceptions:

- a. 140 percent of rated rms voltage at 400 hertz (Hz) shall be applied.
- b. Test condition letter - Not applicable (use 16 hours).

4.7.3 Radiographic inspection (X-ray)(see 3.7) (not applicable to style CHR49). 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. Positions of specimen - 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.

TABLE VI. Group C inspection.

Test	Requirement paragraph	Method paragraph	Number of sample units for inspection	Allowable failures	
<u>Subgroup 1 (every 2 months)</u> <u>(FR levels L, M, P, R, and S)</u>					
<u>Subgroup 1A</u>					
Vibration - - - - -	3.15	4.7.11	} 12	}	
Salt spray (corrosion) - - - - -	3.16	4.7.12			
Immersion - - - - -	3.17	4.7.13			
<u>Subgroup 1B</u>					
Solderability (axial-wire lead terminals) - - - - -	3.18	4.7.14	} 12 <sup>1/</sup>		}
Shock (specified pulse) - - - - -	3.19	4.7.15			
Moisture resistance - - - - -	3.20	4.7.16			
<u>Subgroup 1C</u>					
Terminal strength - - - - -	3.21	4.7.17	} 12		}
Low temperature and capacitance change with temperature - - - - -	3.22	4.7.18			
Resistance to solvents - - - - -	3.25	4.7.21			
<u>Subgroup 2 (every 2 months)</u> <u>(FR levels M, P, R, and S)</u>					
Insulation resistance (at applicable maximum rated temperature) - - - - -	3.11	4.7.7	} 10 per lot minimum	}	
Barometric pressure (reduced) - - - - -	3.14	4.7.10			
Life (extended) - - - - -	3.26	4.7.22.3.1			

1/ Two sample units shall be tested for solderability with no defectives permitted when maximum rated temperature is less than 100°C. The remaining 10 sample units shall be tested for shock and moisture resistance.

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

4.7.4 Thermal shock (see 3.8). Capacitors shall be tested in accordance with method 107 of MIL-STD-202. The following details shall apply:

- a. Test-condition letter - A (except that step 3 shall be the applicable maximum rated temperature (see 3.1)).
- b. Measurements before and after cycling - Not applicable.

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 Alternate test for liquid-filled capacitors. 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 +3°, -0°C of the applicable maximum rated temperature (see 3.1) for a minimum of 1 hour.

After the test, paper and capacitors shall be visually examined for evidence of leakage of impregnant or filling compound, 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 exceptions shall apply:

- a. Magnitude of test voltage - As specified (see 3.1).
- b. Nature of potential - DC (except style CHR49 which shall be ac).
- c. Duration of application of test voltage - At least 98 percent of applied potential for 1 minute. For 100-percent inspection specified in table IV, capacitors shall be subjected, at the option of the manufacturer, to the application of the percent of rated voltage and for a given time as specified (see 3.1).
- d. Points of application of test voltage - As specified (see 3.1).
- e. Power supply voltage regulation - 2 percent or better.
- f. Current resistor - Sufficient to limit charging current to 1.0 ampere, maximum.

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 - A potential equal to rated voltage or 500 Vdc, whichever is less (see 3.1).
- b. Points of measurement:
  1. Terminal to terminal - Insulation resistance shall be measured between terminals at the applicable maximum rated temperature (see 3.1), and at  $25^{\circ} \pm 3^{\circ}\text{C}$  (see 3.11.1). For group B inspection, measurement at maximum rated temperature (see 3.1) is required only for those items to be subjected to life test.
  2. Terminals to case (when case is not a terminal) - Insulation resistance shall be measured between each terminal and the case at  $25^{\circ} \pm 3^{\circ}\text{C}$ .

4.7.8 Capacitance (see 3.12). Capacitors shall be tested in accordance with method 305 of MIL-STD-202. The following details shall apply:

- a. Test frequency - 1,000  $\pm$ 100 Hz for capacitors having a nominal capacitance of 1  $\mu\text{F}$  or less and 60  $\pm$ 6 Hz (or referenced thereto) for capacitors having a nominal capacitance greater than 1  $\mu\text{F}$ .
- b. Limit of accuracy - Within  $\pm$ 2 percent.

4.7.9 Dissipation factor (see 3.13). Unless otherwise specified (see 3.1), the dissipation factor shall be measured at a temperature of  $25^{\circ} \pm 3^{\circ}\text{C}$  at a voltage not greater than 5 percent of the rated voltage (see 3.1). Capacitors having a nominal capacitance of 1  $\mu\text{F}$  or less shall be measured at 1,000  $\pm$ 100 Hz and capacitors having a nominal capacitance greater than 1  $\mu\text{F}$  shall be measured at 60  $\pm$ 6 Hz.

4.7.10 Barometric pressure (reduced) (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. Test-condition letter - D (100,000 feet), unless otherwise specified (see 3.1).
- 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 examined for evidence of damage.

4.7.11 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 of specimens - Capacitors shall be rigidly mounted by the body to a vibration-test apparatus. Capacitors with axial-wire lead terminals shall be secured 0.500  $\pm$ 0.125 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.

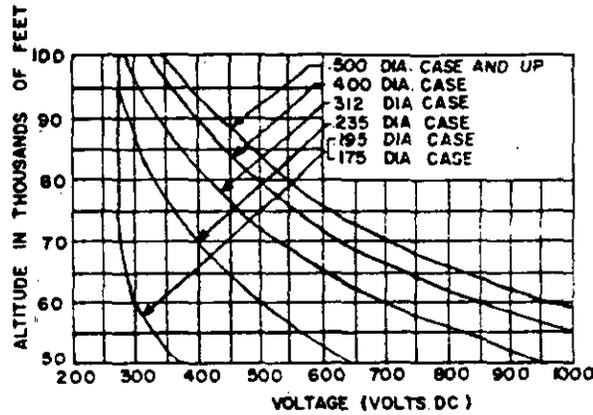


FIGURE 1. Breakdown voltage vs. altitude.

- c. Test-condition letter - D (20g), unless otherwise specified (see 3.1).
- 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. Measurement 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 permanent short-circuiting.
- f. Measurements after vibration - Not applicable.

After the test, capacitors shall be visually examined for evidence of mechanical damage or open- 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. Applicable salt solution - 5 percent.
- b. Test-condition letter - B (48 hours).
- c. Measurements after exposure - Not applicable.

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

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 quality conformance inspection only, two immersion cycles and 30-minute exposure shall be required.
- b. Examinations after final cycle - Capacitors shall be examined for evidence of extensive corrosion, obliteration of markings, and unwrapping of or mechanical damage to 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 0.500 inch apart; each winding shall consist of three close turns of 0.040 inch (18 AWG) bare copper wire. In addition, all capacitors shall be subjected to the dielectric withstanding voltage, insulation resistance, capacitance, and dissipation factor tests as specified in 4.7.6 through 4.7.9. These latter measurements shall be made at  $25^{\circ} \pm 3^{\circ}\text{C}$  and the insulating sleeves shall be removed from insulated units for these measurements.

4.7.14 Solderability (axial-wire 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 0.125 inch of the capacitor body or eyelet closure.

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 the 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 or open- or permanent short-circuiting.

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

4.7.16 Moisture resistance (see 3.20). 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 - Mounted 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 0.625 inch. Tubular capacitors greater than 0.562-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  $25^{\circ} +10, -5^{\circ}\text{C}$  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 examined for evidence of extensive corrosion, obliteration of marking, and unwrapping of or mechanical damage to insulating sleeves (when applicable). Insulation resistance (see 4.7.7) and dielectric withstanding voltage (see 4.7.6) shall be measured between two wire windings, 0.500-inch apart, each winding consisting of three close turns of 0.040 inch (18 AWG) bare copper wire, placed around the sleeve of capacitors having insulating sleeves. In addition, all capacitors shall be subjected to the dielectric withstanding voltage, insulation resistance, capacitance, and dissipation factor tests as specified in 4.7.7 through 4.7.9. The insulating sleeves shall be removed for the latter measurements.

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

4.7.17 Terminal strength (see 3.21). 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.

4.7.18 Low temperature and capacitance change with temperature (see 3.22).

4.7.18.1 Low temperature. Capacitors shall be placed in a chamber maintained at  $-55^{\circ} \pm 0$ ,  $-3^{\circ}\text{C}$  and a potential equal to the dc rated voltage shall be applied at this temperature for  $48 \pm 4$  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.

4.7.18.2 Capacitance change with temperature. At the conclusion of the test specified in 4.7.18.1, capacitance measurements shall be made as specified in 4.7.8, except that measurements shall be made at  $-55^{\circ} \pm 0$ ,  $-3^{\circ}\text{C}$ ,  $25^{\circ} \pm 3^{\circ}\text{C}$ , the applicable maximum rated temperature (see 3.1), and  $25^{\circ} \pm 3^{\circ}\text{C}$ . The  $-55^{\circ}\text{C}$  measurement 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 examined for evidence of breakdown, arcing, open- and short-circuiting, and other visible mechanical damage.

4.7.19 Fungus (see 3.23). Capacitors shall be tested in accordance with method 508, procedure 1, of MIL-STD-810.

4.7.20 Resistance to soldering heat (see 3.24). 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 0.250 inch from the capacitor body.
- b. Test-condition letter - B ( $260 \pm 5^{\circ}\text{C}$  for  $10 \pm 1$  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 as specified in 4.7.7, 4.7.8, and 4.7.9, respectively.

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 tables III and VI.
- 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 one pound.

4.7.22 Life (see 3.26).

4.7.22.1 For 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 - Temperature to be measured on the body of the capacitor.
- b. Test temperature and tolerance - Applicable maximum rated temperature,  $+4^{\circ} - 0^{\circ}\text{C}$ , (see 3.1). (Radiation shall not be used as a means of heating the chamber.)
- c. Operating conditions - Sample capacitors shall be divided into two groups for testing, as follows:
  1. 20 each shall be subjected to an accelerated condition of the specified percent of rated voltage (see 3.1).

2. 30 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:

$$R = \frac{0.025}{C}$$

Where:

C = 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 hours of life test - Capacitors shall be returned to the inspection conditions specified in 4.3, and 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 examined 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 4.7.22.3.2).

4.7.22.2 For group B quality conformance inspection (FR level L only). Capacitors shall be tested under the accelerated voltage conditions as specified in 4.7.22.1, except that time duration of test shall be 240 +48, -0 hours.

4.7.22.3 For extended life (FR levels M, P, R, and S).

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

4.7.22.3.2 At rated conditions (not applicable to style CHR49). 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, -0 hours and the specified measurements shall be accomplished after 240 +48, -0; 1,000 +48, -0; 2,000 +72, -0; and every 2,000 +72, -0 hours thereafter.

4.7.23 Flash point of impregnant (see 3.27). The flash point of impregnant shall be measured as specified in ASTM Publication D92-57, except that fire point and precision do not apply. The word "impregnant" shall be substituted for the word "oil" throughout the test method.

##### 5. PREPARATION FOR DELIVERY

(The preparation for delivery requirements specified herein apply only for direct Government procurements. Preparation for delivery requirements of referenced documents listed in Section 2 do not apply unless specifically stated in the contract or order. Preparation for delivery requirements for products procured by contractors shall be specified in the individual order. In addition to any special marking required by the contract or purchase order (see 6.1), each unit package shall be marked as specified in MIL-STD-1285.)

5.1 Capacitors shall be prepared for delivery in accordance with MIL-C-39028.

## 6. NOTES

6.1 Ordering data. Procurement documents should specify the following:

- a. Title, number, and date of this specification.
- b. Title, number, and date of the applicable specification sheet, and the complete part number (see 3.1).
- c. Required levels of preservation and packaging and packing, and special marking (see section 5).

6.2 Qualification. With respect to products requiring qualification, awards will be made only for products which are at the time set for opening of bids, qualified for inclusion in the applicable qualified products list, whether or not such products have actually been so listed by that date. The attention of the contractors is called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the qualified products list is the Naval Electronic Systems Command, ELEX 0517, Department of the Navy, Washington, D.C. 20360. Information pertaining to qualification of products may be obtained from either the NAVAL ELECTRONIC SYSTEMS COMMAND or the Defense Electronics Supply Center (DESC), Dayton, Ohio 45444, agent for administration of the Qualified Products List. Application for qualification tests shall be made in accordance with "Provisions Governing Qualification"(see 6.2.1).

6.2.1 Copies of "Provisions Governing Qualification" may be obtained upon application to Commanding Officer, Naval Publication and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.

6.3 Definitions.

6.3.1 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.

6.3.2 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.

6.4 Selection and application 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. The 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 (see 6.3.1) can be tolerated.

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

## Custodians:

Army - EL  
Navy - EC  
Air Force - 11

## Review activities:

Army - AR  
Navy -  
Air Force - 85  
DLA - ES

## User activities:

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

## Preparing activity:

Navy - EC

## Agent:

DLA - ES

(Project 5910-1260)

APPENDIX

PROCEDURE FOR QUALIFICATION INSPECTION

10. SCOPE

10.1 This appendix details the procedure for submission of samples, with related data, 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.

20. SUBMISSION

20.1 Sample. For qualification to L or M level (see 3.1) as per table III.

20.1.1 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.

20.1.2 Voltage-group submission. For styles CHR09, CHR12, CHR19, CHR49, and CHR59, 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 single-voltage rating for which qualification is sought, shall be submitted. The style, circuit, dielectric material, capacitance tolerance, and FR level 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 VII). Styles CHR09 and CHR12 with voltage ratings of 200, 400 and 600 volts may be combined for submission as indicated in table VII.

20.1.3 Complete qualification group submission. The types and number of samples which shall be submitted for qualification approval are those shown in table VII and shall be grouped in accordance with that table.

20.1.4 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.

20.2 Test data. When specifically requested, each submission shall be accompanied by test data covering the nondestructive tests listed in table III which have been performed on the specimens. The performance of the destructive tests by the manufacturer on a duplicate set of specimens is encouraged, although not required. All test data shall be submitted in duplicate.

20.3 Description of items. The manufacturer shall submit a detailed statement of the materials and constructional features of the capacitors being submitted for test, including information on whether they are liquid-filled or liquid-impregnated; the type and quantity of the impregnant; the type, thickness, and number of layers of the capacitor tissue; material, thickness, and applied finish of the case; and details of the terminal assemblies.

30. EXTENT OF QUALIFICATION

30.1 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 FR level qualification shall be as specified in 30.4.

30.2 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 FR level qualification shall be as specified in 30.4.

TABLE VII. Samples for complete qualification submissions.

Style	Qualification group	Types to be submitted	Quantity for complete qualification groups
CHR09 CHR12	50 V	M39022/01-1013	38
		M39022/08-2093	38
CHR09 CHR12	200 V	M39022/01-1141	38
		M39022/08-1041	38
	400 V	M39022/01-1185	38
		M39022/08-1069	38
	600 V	M39022/01-1213	38
		M39022/08-1105	38
CHR19	200 V	M39022/02-1001	38
		M39022/02-1053	38
	400 V	M39022/02-1057	38
		M39022/02-1101	38
CHR59	200 V	M39022/05-1001	38
		M39022/05-1109	38
	400 V	M39022/05-1113	38
		M39022/05-1195	38
	600 V	M39022/05-1199	38
		M39022/05-1271	38
CHR49	AC rated voltage 80 V to 300 V	M39022/07-1001	38
		M39022/07-1012	38
		M39022/07-1013	38
		M39022/07-1022	38

30.3 Complete qualification group submission. Qualification of the complete qualification group submission will be a basis for qualification for all types, styles, circuits, dielectric materials, rated voltages, capacitance values, and capacitance tolerances. Extent of FR level qualification shall be as specified in 30.4.

30.4 FR level qualification. The extent of qualification between FR levels shall be as specified in table VIII.

TABLE VIII. Extent of FR level qualification.

Qualification for FR level	Will qualify FR level(s)
S	S, R, P, M, L
R	R, P, M, L
P	P, M, L
M	M, L
L	L

40. QUALIFICATION APPROVAL FOR LOWER FR LEVELS

40.1 Extension of qualification to lower FR levels shall be in accordance with 4.4.4 of this specification.