

MILITARY SPECIFICATION

CAPACITORS, FIXED, PLASTIC (OR METALLIZED PLASTIC)  
 DIELECTRIC, DC OR DC-AC, IN NONMETAL CASES,  
 ESTABLISHED RELIABILITY  
 GENERAL SPECIFICATION FOR

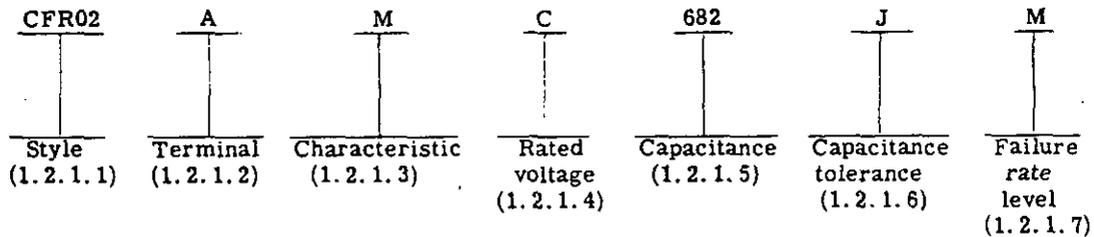
This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the general requirements for plastic (or metallized plastic) dielectric, fixed capacitors, enclosed in nonmetal cases intended primarily, in view of the limited long term moisture resistant characteristics, for use in potted or encapsulated systems, in blocking, filter and by-pass applications (see 6.3). Capacitors covered by this specification have failure rates ranging from 1.0 percent to 0.001 percent per 1,000 hours (see 1.2.1.7). These failure rate 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 85°C. An acceleration factor of 5:1 has been used to relate life test data obtained at 125 percent, or 140 percent of rated voltage at +85°C to rated voltage at +85°C. The failure rate levels are based on catastrophic failures and failures occurring outside the degradation limits.

1.2 Classification. Capacitors covered by this specification shall be classified as indicated by style (see 1.2.1.1 and 3.1).

1.2.1 Type designation. The type designation shall be in the following form, and as specified (see 3.1 and 6.1): (See 3.23.)



1.2.1.1 Style. The style is identified by the three-letter symbol "CFR" followed by a two-digit number; the letters identify established reliability, plastic dielectric fixed capacitors in nonmetal cases.

1.2.1.2 Terminal. The terminal is identified by a single letter as shown in table I.

TABLE I. Terminal.

Symbol	Terminal
A - - - - -	Axial wire-lead
R - - - - -	Radial wire-lead

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, U.S. Army Electronics Command, ATTN: DELET-RP, Fort Monmouth, NJ 07703 by using the self addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document, or by letter.

1.2.1.3 Characteristic. The characteristic is identified by a single letter as shown in table II.

TABLE II. Characteristic.

Symbol	Construction		Operating temperature range
	Dielectric material	Electrode	
M - - - - -	Polyethylene terephthalate	Foil	-55° to +85° C
N - - - - -	Polyethylene terephthalate	Metallized polyethylene terephthalate	-55° to +85° C
Q - - - - -	Polycarbonate	Foil	-55° to +125° C <sup>1/</sup>
R - - - - -	Polycarbonate	Metallized polycarbonate	-55° to +125° C <sup>1/</sup>
S - - - - -	Poly-para-xylylene	Foil	-55° to +125° C <sup>1/</sup>
T - - - - -	Polysulfone	Metallized polysulfone	-55° to +150° C

<sup>1/</sup> For operation at +125° C, characteristics Q, R, and S capacitors shall be voltage derated (see table III).

1.2.1.4 Rated voltage. The rated voltage is for operation at 85° C and is identified by a single symbol as shown in table III.

TABLE III. Voltage rating at 85° C. <sup>1/</sup>

Symbol	DC voltage rating
A	50
B	100
C	200
D	300
E	400
F	600
G	75
H	150

<sup>1/</sup> Voltage derating at high ambient temperatures is dependent on the characteristic as follows: Characteristics M and N are rated for +85° C operating only. The +85° C rating of characteristic Q capacitors shall be derated by 1/3 for operation at +125° C. The +85° C ratings of characteristics R and S capacitors shall be derated by 1/2 for operation at +125° C.

1.2.1.5 Capacitance. The nominal capacitance value, expressed in picofarads (pF), is identified by a three-digit number; the first two digits represent significant figures and the last digit specifies the number of zeros to follow.

NOTE: Tabulated capacitance values expressed in microfarads ( $\mu$ F) are given for information only (see 3.1).

1.2.1.6 Capacitance tolerance. The capacitance tolerance is identified by a single letter as shown in table IV.

TABLE IV. Capacitance tolerance.

Symbol	Capacitance tolerance
	Percent ( $\pm$ )
F - - - - -	1
G - - - - -	2
J - - - - -	5
K - - - - -	10
M - - - - -	20

1.2.1.7 Failure rate level. The failure rate level (based on life test performed at 85° C) is identified by a single letter as shown in table V.

TABLE V. Failure rate level (established at a 90-percent confidence level).

Symbol	Failure rate level
	<u>Percent/1,000 hr</u>
M - - - - -	1.0
P - - - - -	0.1
R - - - - -	0.01
S - - - - -	0.001

## 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

#### MILITARY

MIL-C-39028 - Capacitors, Packaging of, General Specification for.  
(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.)

## 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 the requirements of this specification and the specification sheet, the latter shall govern (see 6.1).

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). 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, and 4.5.

3.4 Materials. Materials 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 Insulating and sealing materials. Compounds and films used in the insulating and sealing of capacitors shall be chemically inactive with respect to the capacitor element. The material, either in state of original application or as a result of having aged, shall have no adverse effect on the performance of the capacitors.

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

3.5.1 Case. Each capacitor shall be enclosed in a nonmetal case which will protect the capacitor element from moisture, impregnant leakage, and mechanical damage under the test conditions specified herein. Cardboard shall not be used for insulating purposes.

3.5.2 Capacitor element. The capacitor element shall consist of foil or metallized conducting electrodes separated by one or more layers of dielectric film. Extended foil construction shall be used for characteristics M, Q, and S, and extended electrode construction for characteristics N and R.

3.5.3 Terminals. Terminals shall be of a solid conductor, of the length and diameter specified (see 3.1), and shall be suitably treated to facilitate soldering. When a coating containing tin is used, the tin content shall range between 40 and 70 percent.

3.6 Resistance to solvents. When capacitors are tested as specified in 4.7.2, markings shall remain legible, and shall not smear.

3.7 Preconditioning. When tested as specified in 4.7.3, capacitors shall withstand the test conditions specified without evidence of unwrapping of the capacitor case or sleeve or other damage to the case.

3.8 Burn-in (when specified, see 3.1). When tested as specified in 4.7.4, capacitors shall withstand the exposure to high temperature and overvoltages without visible damage.

3.9 AC conditioning (when specified, see 3.1). When tested as specified in 4.7.5, capacitors shall withstand the AC voltage and current exposure without visible damage.

3.10 Insulation resistance. When measured as specified in 4.7.6, unless otherwise specified (see 3.1), the insulation resistance shall be not less than the applicable value specified in table VI, and as shown on figure 1. The value of insulation resistance varies with temperature, and a correction factor obtained in accordance with table VII shall be applied, when necessary, by multiplying the value measured by the correction factor.

3.11 Dielectric withstanding voltage. When capacitors are tested as specified in 4.7.7, there shall be no momentary or intermittent arcing or other indication of breakdown, nor shall there be any visible evidence of damage.

3.12 Barometric pressure (reduced). When capacitors are tested as specified in 4.7.8, there shall be no momentary or intermittent arcing or other indication of breakdown, nor shall there be any visible evidence of damage.

TABLE VI. Insulation resistance.

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Capacitance	Minimum insulation resistance (terminal to terminal)
<u>Characteristic M</u> 0 to .1 $\mu\text{F}$ Greater than .1 $\mu\text{F}$  0 to .1 $\mu\text{F}$ Greater than .1 $\mu\text{F}$	At 25° C 500,000 megohms 50,000 megohm-microfarads <u>1/</u> At 85° C 50,000 megohms 5,000 megohm-microfarads <u>1/</u>
<u>Characteristic N</u> 0 to .25 $\mu\text{F}$ Greater than .25 $\mu\text{F}$  0 to .1 $\mu\text{F}$ Greater than .1 $\mu\text{F}$	At 25° C 200,000 megohms 50,000 megohm-microfarads <u>1/</u> At 85° C 35,000 megohms 3,500 megohm-microfarads <u>1/</u>
<u>Characteristic Q</u> 0 to .2 $\mu\text{F}$ Greater than .2 $\mu\text{F}$  0 to .1 $\mu\text{F}$ Greater than .1 $\mu\text{F}$  0 to .1 $\mu\text{F}$ Greater than .1 $\mu\text{F}$	At 25° C 500,000 megohms 100,000 megohm-microfarads <u>1/</u> At 85° C 100,000 megohms 10,000 megohm-microfarads <u>1/</u> At 125° C 10,000 megohms 1,000 megohm-microfarads <u>1/</u>
<u>Characteristic R</u> 0 to .2 $\mu\text{F}$ Greater than .2 $\mu\text{F}$  0 to .1 $\mu\text{F}$ Greater than .1 $\mu\text{F}$  0 to .1 $\mu\text{F}$ Greater than .1 $\mu\text{F}$	At 25° C 500,000 megohms 100,000 megohm-microfarads <u>1/</u> At 85° C 70,000 megohms 7,000 megohm-microfarads <u>1/</u> At 125° C 7,000 megohms 700 megohm-microfarads <u>1/</u>
<u>Characteristic S</u> 0 to .2 $\mu\text{F}$ Greater than .2 $\mu\text{F}$  0 to .1 $\mu\text{F}$ Greater than .1 $\mu\text{F}$  0 to .1 $\mu\text{F}$ Greater than .1 $\mu\text{F}$	At 25° C 500,000 megohms 100,000 megohm-microfarads <u>1/</u> At 85° C 50,000 megohms 5,000 megohm-microfarads <u>1/</u> At 125° C 1,000 megohms 100 megohm-microfarads <u>1/</u>
<u>Characteristic T</u> 0 to .2 $\mu\text{F}$ Greater than .2 $\mu\text{F}$  0 to .1 $\mu\text{F}$ Greater than .1 $\mu\text{F}$  0 to .1 $\mu\text{F}$ Greater than .1 $\mu\text{F}$  0 to .1 $\mu\text{F}$ Greater than .1 $\mu\text{F}$	At 25° C 500,000 megohms 100,000 megohm-microfarads <u>1/</u> At 85° C 70,000 megohms 7,000 megohm-microfarads <u>1/</u> At 125° C 7,000 megohms 700 megohm-microfarads <u>1/</u> At 150° C 700 megohms 70 megohm-microfarads <u>1/</u>

1/ Product obtained by multiplying the capacitance (in  $\mu\text{F}$ ) by the measured insulation resistance (in megohms).

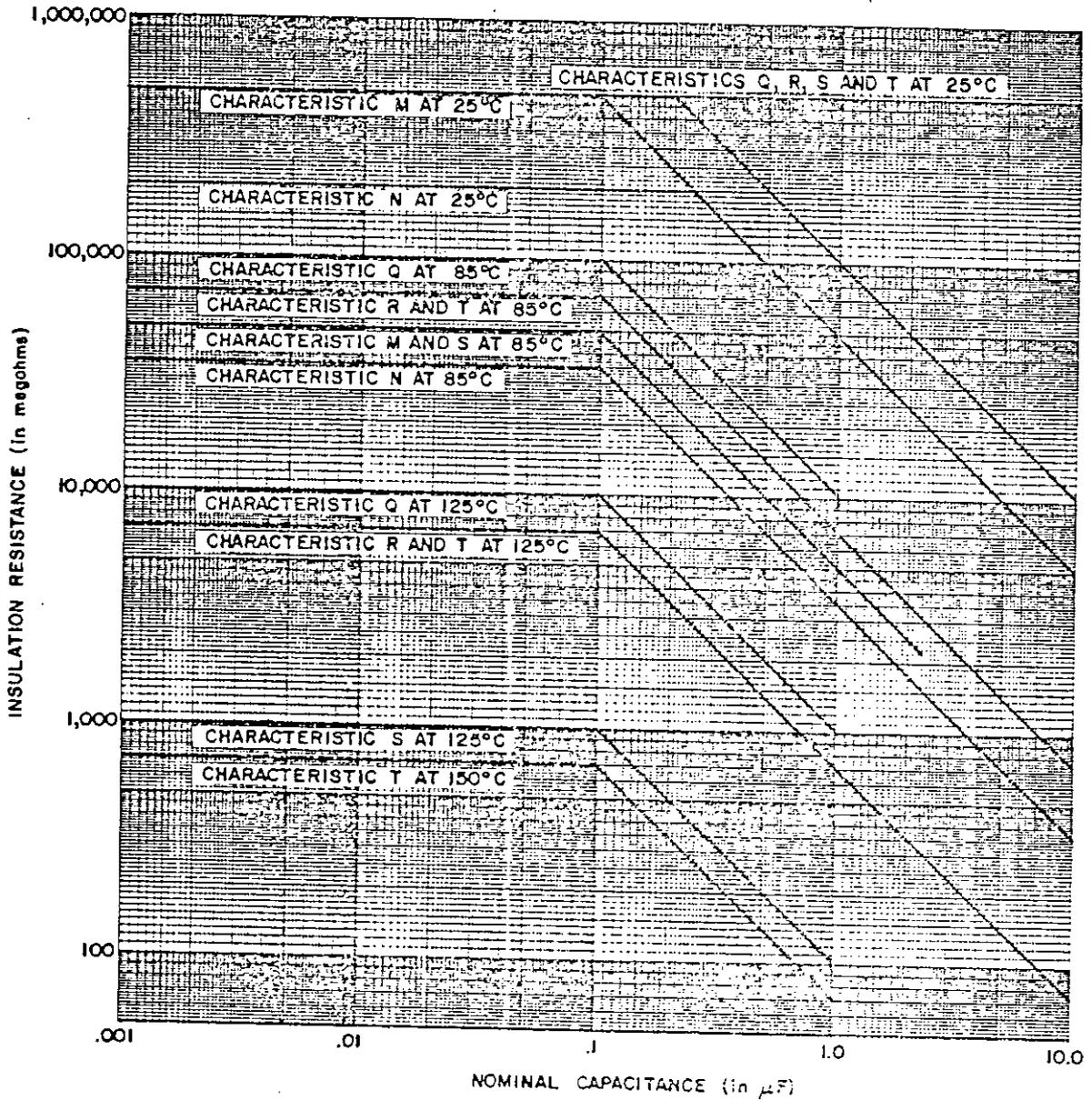


FIGURE 1. Graphical representation of minimum insulation resistance.

TABLE VII. Insulation resistance correction factors.

Correction factor	Temperature (°C)	Correction factor	Temperature (°C)
2.00 - - - - -	15	.94 - - - - -	26
1.87 - - - - -	16	.87 - - - - -	27
1.74 - - - - -	17	.82 - - - - -	28
1.62 - - - - -	18	.76 - - - - -	29
1.52 - - - - -	19	.71 - - - - -	30
1.42 - - - - -	20	.67 - - - - -	31
1.33 - - - - -	21	.63 - - - - -	32
1.24 - - - - -	22	.59 - - - - -	33
1.16 - - - - -	23	.55 - - - - -	34
1.08 - - - - -	24	.51 - - - - -	35
1.00 - - - - -	25		

3.13 Capacitance. When measured as specified in 4.7.9 the capacitance shall be within the applicable tolerance specified (see 3.1).

3.14 Dissipation factor. When measured as specified in 4.7.10 the dissipation factor shall not exceed the applicable value specified in table VIII.

TABLE VIII. Dissipation factor.

Characteristic	Dissipation factor at			
	25°C	85°C	125°C	150°C
	%	%	%	%
M - - - - -	0.75	0.85	---	---
N - - - - -	1.0	1.0	---	---
Q - - - - -	0.3	0.3	0.3	---
R - - - - -	0.3	0.3	0.3	---
S - - - - -	0.25	0.25	0.25	---
T - - - - -	0.25	0.25	0.25	0.25

3.15 Resistance to soldering heat. When tested as specified in 4.7.11 capacitors shall meet the following requirements:

Capacitance - - - - - Shall change not more than  $\pm 5$  percent  
from the initial measured value.  
Dissipation factor (at 25°C) - - - Shall be as specified in 3.14.

3.16 Vibration (high frequency). When capacitors are tested as specified in 4.7.12 there shall be no mechanical damage, momentary or intermittent arcing of 0.5 millisecond (ms) or greater duration, or other indication of breakdown, nor shall there be any open-or short-circuiting or visible mechanical damage.

3.17 Shock (specified pulse). When capacitors are tested as specified in 4.7.13 there shall be no momentary or intermittent arcing of 0.5 millisecond (ms) or greater duration, or other indication of breakdown, nor shall there be any evidence of fractures or other visible mechanical damage.

3.18 Terminal strength. When capacitors are tested as specified in 4.7.14 there shall be no mechanical damage to the capacitor or terminals.

3.19 Solderability. When capacitors are tested as specified in 4.7.15 the criteria for evaluation shall be as specified in method 208 of MIL-STD-202.

3.20 Low-temperature conditioning and capacitance change with temperature. When capacitors are tested as specified in 4.7.16, there shall be no indication of breakdown or arcing, nor shall there be any open-or short-circuiting or any visible evidence of mechanical damage. The capacitance shall change not more than the applicable values specified in table IX (the initial +25°C capacitance value (see 3.13), shall be used for determination of the capacitance change). In addition (for qualification testing only), the insulation resistance shall equal or exceed the minimum value specified in table VI for the high test temperature and the dissipation factor shall not exceed the applicable value for the high test temperature as specified in table VIII.

TABLE IX. Capacitance change with temperature.

Characteristic	Capacitance change (in percent) from +25°C value			
	-55°C	+85°C	+125°C	150°C
M - - - - -	0 to -10.0	0 to +10.0	- - -	- - -
N - - - - -	0 to -10.0	0 to +10.0	- - -	- - -
Q - - - - -	0 to -2.5	±1.0	+2.0 to -1.0	- - -
R - - - - -	0 to -2.5	±1.0	+2.0 to -1.0	- - -
S - - - - -	0 to +4.0	0 to -2.0	0 to -4.0	- - -
T - - - - -	0 to +1.0	0 to ±0.5	0 to +1.0	0 to +1.0

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

- Dielectric withstanding voltage - - - - Shall be as specified in 3.11.
- Insulation resistance (at 25°C)
  - Terminal to terminal - - - - - Shall be not less than 50 percent of the value specified in table VI.
- Visual examination - - - - - Shall show no visible deterioration, permanent damage to terminals or case, or corrosion on terminals.

3.22 Moisture resistance. When tested as specified in 4.7.18, capacitors shall meet the following requirements:

- Dielectric withstanding voltage - - - - Shall be as specified in 3.11.
- Insulation resistance (at 25°C)
  - Terminal to terminal - - - - - Shall be not less than 50 percent of the requirement specified in table VI.
- Dissipation factor - - - - - Shall not exceed the requirements specified in table VIII.
- Capacitance - - - - - (Characteristic S)
  - Shall change not more than 0.5 percent from the initial measured value.
  - (Characteristics M, N, Q, R and T)
    - Shall change not more than 5.0 percent from the initial measured value.
- Visual examination - - - - - Shall show no visible deterioration, permanent damage to terminals or case, or corrosion on terminals.

3.23 Life. When tested as specified in 4.7.19, capacitors shall meet the following requirements:

- Insulation resistance (at 25°C) - - - - Shall meet or exceed the initial requirement.
- Capacitance - - - - - Shall change not more than ± 5 percent from the initial measured value (Group I or Subgroup 2).
- Dissipation factor (at 25°C) - - - - Shall not exceed the value specified (see 3.14).

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 Marking. Capacitors shall be permanently and legibly marked with the type designation, "JAN" or "J" marking, date code, and manufacturer's name, trademark, or code symbol. In the event the manufacturer's name, trademark, or code symbol exceeds two characters, it may appear on the next line. (Paper labels shall not be used.) Other markings which in any way interfere with, obscure, or confuse those specified herein are prohibited. Markings shall remain legible after all tests.

3.25.1 Type designation (see 1.2.1). There shall be no space between the symbols which comprise the type designation. When the size of the capacitor does not permit the type designation to be marked on one line, it may be divided into two or three lines as shown in the following examples:

Examples:	CFR02AM		CFR02
	C682JM	or	AMC
	J7011 <u>TM</u>		682JM
			J7011 <u>TM</u>

3.25.2 Date code. The date code shall be in accordance with MIL-STD-1285.

3.25.3 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 requirements 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 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".

3.25.4 Supplying to higher FR levels. A manufacturer may supply to all higher failure rate levels than that to which he is qualified. Parts qualified and marked to lower failure rate levels are substitutable for higher failure level parts, and shall not be remarked unless specified in the contract (see 6.1).

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

#### 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. 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. Verification of qualification (see 4.5).
- c. Quality conformance inspection (see 4.6).

4.3 Inspection conditions. Unless otherwise specified herein, all inspections shall be performed in accordance with the test conditions specified in the "GENERAL REQUIREMENTS" of MIL-STD-202.

4.3.1 Accuracy of voltage measurements. Accuracy of voltage measurements shall be within  $\pm 2$  percent of the specified voltage.

4.4 Qualification inspection. <sup>1/</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 table X, or in the appendix to this specification.

4.4.2 Test routine. The sample shall be subjected to the inspections specified in table X, in the order shown. Except as specified below, all sample units shall be subjected to the inspections of group I (two sample units are to be subjected to the visual and mechanical examination, five sample units are to be subjected to the resistance to solvents examination, and the remaining sample units are to be subjected to the subsequent examinations of group I). The sample shall then be divided as specified in table X for groups II through VI and subjected to the inspections for their particular group.

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

4.4.4 FR qualification. FR qualification and lot conformance FR inspection shall be in accordance with the general and detailed requirements of MIL-STD-690 and the following details:

- a. Procedure I - Qualification at the initial FR level. Level M (1.0 percent) of FRSP-90 shall apply. Sample units which have been subjected to rated conditions testing of the qualification inspection specified in group V, table X (see 4.4.2), shall be continued on test as specified in 4.7.19.3.
- 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 voltage ratings within a style and characteristic 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.
- d. Procedure IV - Lot conformance FR inspection. Lot conformance FR procedures shall be in accordance with 4.6.2.1.1.3.

<sup>1/</sup> 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.

TABLE X. Qualification inspection.

Inspection	Requirement paragraph	Test method paragraph	Number of sample units to be inspected <u>1/</u>	Number of failures allowed <u>2/</u>
<u>Group I</u>				
Visual and mechanical examination (internal): Material, design, construction, and workmanship - - - - -	3.1, 3.4 to 3.5.3, and 3.25 to 3.26	4.7.1	2	0
Visual and mechanical examination (external) <u>3/</u> : Physical dimensions, marking, <u>4/</u> and workmanship - - - - -	3.1, 3.5, 3.5.1, 3.5.3, 3.25, and 3.26	4.7.1	120	0
Resistance to solvents - - - - -	3.6	4.7.2	} 115	} 1
Preconditioning - - - - -	3.7	4.7.3		
Burn-in (when specified, see 3.1) - - - - -	3.8	4.7.4		
AC conditioning (when specified, see 3.1) - - - - -	3.9	4.7.5		
Insulation resistance (at 25° C) - - - - -	3.10	4.7.6		
Dielectric withstanding voltage - - - - -	3.11	4.7.7		
Barometric pressure (reduced) - - - - -	3.12	4.7.8		
Capacitance - - - - -	3.13	4.7.9		
Dissipation factor (at 25° C) - - - - -	3.14	4.7.10		
<u>Group II</u>				
Resistance to soldering heat - - - - -	3.15	4.7.11	} 12	} 1
Vibration, high frequency - - - - -	3.16	4.7.12		
Shock (specified pulse) - - - - -	3.17	4.7.13		
Terminal strength - - - - -	3.18	4.7.14		
<u>Group III</u>				
Solderability - - - - -	3.19	4.7.15	6	0
<u>Group IV</u>				
Low-temperature conditioning and capacitance change with temperature - - - - -	3.20	4.7.16	} 12	} 1
Thermal shock and immersion - - - - -	3.21	4.7.17		
<u>Group V</u>				
Moisture resistance - - - - -	3.22	4.7.18	} 80	} 1
Life (rated conditions) - - - - -	3.23	4.7.19		
Life (accelerated conditions) - - - - -	3.23	4.7.19		
<u>Group VI</u>				
Fungus <u>5/</u> - - - - -	3.24	4.7.20	4	0

1/ One additional sample unit is included in each sample size to permit substitution for the failure allowed in group I.

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

3/ Nondestructive examinations and tests.

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

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

**4.5 Verification of qualification.** Every six months, the manufacturer shall compile a summary of the results of quality conformance inspections and, where applicable, extended failure rate (FR) test data, in the form of a verification of qualification report, and forward it to the qualifying activity as the basis of continued qualification approval. In addition, within 30 days of the end of the reporting date, the manufacturer shall immediately notify the qualifying activity whenever the FR data indicates that the manufacturer has failed to maintain his qualified FR level. Continuation shall be based on evidence that, over the six month period, the following has been met:

- a. Verification by the qualifying activity that the manufacturer meets the requirements of MIL-STD-790.
- b. The manufacturer has not modified the design of the item.
- c. The specification requirements for the item have not been amended so as to affect the character of the item.
- d. Lot rejection for group A inspection does not exceed 15 percent or one lot, whichever is greater.
- e. The requirements for group B inspection are met.
- f. The records of all FR tests combined substantiate that the "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) and "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.

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

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

#### **4.6 Quality conformance inspection.**

**4.6.1 Inspection of product for delivery.** Inspection of product for delivery shall consist of group A inspection.

**4.6.1.1 Inspection lot.** An inspection lot shall be as defined in MIL-STD-105, and shall consist of capacitors of the same style and characteristic, from the same production line or lines, produced under essentially the same conditions, and offered for inspection during a single work week. Each lot shall be kept separate from every other lot. The sample selected from the lot shall be representative of the capacitance value and applicable voltage ratings (see 20.3) produced during that period.

**4.6.1.2 Group A inspection.** Group A inspection shall consist of the inspections specified in table XI, in the order shown.

**4.6.1.2.1 Sampling plan.** Subgroup 1 tests shall be performed on each capacitor offered for acceptance. Statistical sampling and inspection for subgroups 2, 3, and 4 shall be in accordance with MIL-STD-105. The acceptable quality level (AQL) and limiting quality (LQ) where  $P_a = 10$  percent shall be as specified in table XI. At the option of the contractor, 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. The preconditioning test shall not be repeated for the purpose of re-inspection. (When possible, this test shall be witnessed by the Government at the time it is performed by the contractor.)

TABLE XI. Group A inspection.

Inspection	Requirement paragraph	Test method paragraph	AQL (percent defective)	
			Major	Minor
<b>Subgroup 1</b>				
Preconditioning - - - - -	3.7	4.7.3	} 100% inspection AQL Not applicable	
Burn-in (when specified, see 3.1) - - -	3.8	4.7.4		
Insulation resistance (at +25°C) - - - -	3.10	4.7.6		
Dielectric withstanding voltage - - - - -	3.11	4.7.7		
<b>Subgroup 2</b>				
Capacitance - - - - -	3.13	4.7.9	} 1.0 (AQL) 7.6 (LQ)	---
Dissipation factor (at 25°C) - - - - -	3.14	4.7.10		
<b>Subgroup 3</b>				
Visual and mechanical examination, external - - - - -	3.1, 3.5, 3.25, and 3.26	4.7.1	2.5 (AQL) 13.0 (LQ)	4.0(AQL) 18.0(LQ)
<b>Subgroup 4</b>				
Insulation resistance (at high operating temperature) - - - - -	3.10	4.7.6	} 2.5 (AQL) 13.0 (LQ)	---
Dissipation factor (at high operating temperature) - - - - -	3.14	4.7.10		
Barometric pressure (reduced)- - - - -	3.12	4.7.8		

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

- a. Tests conducted by the manufacturer during production shall be clearly identical to, or more stringent than, that specified for subgroup 1.
- b. Manufacturer subjects 100 percent of the product supplied under this specification to his production tests.
- c. The parameters measured and the failure criteria shall be the same as, or more stringent than, those specified herein.
- d. The lot rejection criteria is the same as, or more stringent than, that specified herein.
- e. 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.
- f. Once approved, the manufacturer shall not change the test procedures or criteria without prior notification and concurrence by the qualifying activity.

4.6.1.2.3 **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, 3, or 4 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 except preconditioning (see 4.6.1.2.1) 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 5 percent of the capacitors be discarded, the lot shall be rejected, and shall not be resubmitted for reinspection.

4.6.2 Periodic inspection. Periodic inspection shall consist of group B inspection. Except where the results of this inspection show noncompliance with the applicable requirements (see 4.6.2.1.1.4) delivery of products which have passed group A inspection shall not be delayed pending the results of group B inspection.

4.6.2.1 Group B inspection. Group B inspection shall consist of the tests specified in table XII, in the order shown, and shall be performed on sample units selected from lots that have passed group A inspection. Test data obtained therefrom shall be reviewed as a part of the complete verification of qualification. Maximum and minimum case sizes shall be represented, as far as practical, in at least the approximate ratio of production.

4.6.2.1.1 Sampling plan.

4.6.2.1.1.1 Subgroups 1, 1A and 1C (all FR levels). Twelve (characteristics M and N) or twenty-two (characteristics Q, R, S and T) sample units shall be taken from production every three months and subjected to the applicable tests for their particular subgroup. Allowable failures shall be as specified in table XII.

4.6.2.1.1.2 Subgroups 2 and 2A (all FR levels). Seventeen sample units shall be taken from production every six months and subjected to the applicable tests for their particular subgroup. Allowable failures shall be as specified in table XII.

4.6.2.1.1.3 Subgroup 1B (all FR levels). A minimum of 10 sample units shall be selected from each inspection lot produced during a one-month period. Allowable failures shall be as specified in MIL-STD-690. The accumulated data shall be used for maintenance and extension of FR qualification.

TABLE XII. Group B inspection.

Inspection	Requirement paragraph	Test method paragraph	Number of sample units to be inspected	Number of failures allowed <sup>1/</sup>
<u>Subgroup 1 (every 3 months)</u> Solderability - - - - -	3.19	4.7.15	6	0
<u>Subgroup 1A (every 3 months)</u> Low-temperature conditioning and capacitance change with temperature - Thermal shock and immersion - - - - -	3.20 3.21	4.7.16 4.7.17	} 6	} 1
<u>Subgroup 1B (every month)</u> Moisture resistance - - - - - Life (at accelerated conditions) - - - - -	3.22 3.23	4.7.18 4.7.19.2	} 10 min	
<u>Subgroup 1C (every 3 months) 2/ 3/</u> Life at 125° C (proof test) characteristics Q, R, S and T - - - - -	3.23	4.7.19.3.2	10	1
<u>Subgroup 1D (every 3 months)</u> AC conditioning (when specified, see 3.1) - - - - -	3.9	4.7.5	(See 3.1)	5%
<u>Subgroup 2 (every 6 months)</u> Resistance to soldering heat - - - - - Vibration, high frequency - - - - - Shock (specified pulse) - - - - - Terminal strength - - - - -	3.15 3.16 3.17 3.18	4.7.11 4.7.12 4.7.13 4.7.14	} 12	} 0
<u>Subgroup 2A (every 6 months)</u> Resistance to solvents - - - - -	3.6	4.7.2	5	0

<sup>1/</sup> A sample unit having one or more defects shall be considered as a single failure.

<sup>2/</sup> Proof test data is not used in FR level determination.

<sup>3/</sup> Life at 150° C (proof test) for characteristic T.

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

4.6.2.1.1.5 Noncompliance. If a sample fails to pass group B inspection, the manufacturer shall notify the qualifying activity and the cognizant inspection activity of such failure and take corrective action on the materials or processes, or both, as warranted, and on all units of product which can be corrected and which were manufactured under essentially the same conditions, with essentially the same materials, processes, etc., and which are considered subject to the same failure. Acceptance and shipment 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 inspection may be re-instituted; however, final acceptance and shipment shall be withheld until the group B inspection has shown that the corrective action was successful. In the event of failure after reinspection, information concerning the failure shall be furnished to the cognizant inspection activity and the qualifying activity.

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

#### 4.7 Methods of inspection.

4.7.1 Visual and mechanical examination. Capacitors shall be examined to verify that the materials, design, construction, physical dimensions, marking, and workmanship are in accordance with the applicable requirements (see 3.1, 3.4, 3.5, 3.25, and 3.26).

4.7.2 Resistance to solvents (see 3.6). Capacitors shall be tested in accordance with method 215 of MIL-STD-202. The following exceptions shall apply:

- a. Brushing is not required.
- b. Solvent solution (b) Trichloroethane.

4.7.3 Preconditioning (see 3.7). Capacitors shall be exposed to a saturated steam atmosphere of 5 lb<sub>f</sub>/in<sup>2</sup> (gage pressure) for a period of 90 minutes. The terminals shall not be welded, soldered, or disfigured to perform the seal part of this test. Capacitors shall be examined for unwrapping of case material or other damage to the case.

4.7.4 Burn-in (when specified, see 3.1) (see 3.8). Capacitors shall be tested as follows:

- a. DC - 140 percent of dc rated voltage shall be applied for 48 hours, minimum at +125°C +4, -0°C.
- b. AC - 140 percent of rated RMS voltage shall be applied for 16 hours, minimum at +125°C +4, -0°C and 400 ± 10 Hz.

4.7.5 AC conditioning (when specified, see 3.1) (see 3.9). Capacitors shall be exposed to the voltages, currents, frequencies, and temperature specified (see 3.1) for 240 +48, -0 hours.

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

- a. Test potential - Equal to rated voltage (or derated voltage if applicable), or 500 volts, dc, whichever is less (see 3.1).
- b. Points of measurement - Terminal to terminal.
- c. Electrification time - Not to exceed 2 minutes.

4.7.7 Dielectric withstanding voltage (see 3.11). Capacitors shall be tested in accordance with method 301 of MIL-STD-202. The following details and exception shall apply:

- a. Magnitude and duration of test voltage - 200 percent of rated voltage for 10 to 60 seconds, or 250 percent of rated voltage for 1 to 5 seconds.

MIL-C-55514B

- b. Nature of potential - DC.
- c. Points of application of test voltage - Between terminals.
- d. Limiting value of surge current - Shall not exceed 50 milliamperes (ma).
- e. Examination after test - Capacitors shall be examined for evidence of damage, arcing, or breakdown.

4.7.8 Barometric pressure (reduced) (see 3.12). Capacitors shall be tested in accordance with method 105 of MIL-STD-202. The following details shall apply:

- a. Method of mounting - Normal mounting means.
- b. Test condition - D (100,000 ft).
- c. Test during subjection to reduced pressure - 150 percent of rated voltage (characteristics M, Q, and S), or 140 percent of rated voltage (characteristics N, R and T) shall be applied between the terminals for not less than 1 minute.
- d. Examination after test - Capacitors shall be visually examined for evidence of damage.

4.7.9 Capacitance (see 3.13). Capacitance shall be measured in accordance with method 305 of MIL-STD-202. The following details shall apply:

- a. Test frequency - 1 kilohertz (kHz)  $\pm$  100 hertz (Hz).
- b. Limit of accuracy - Within  $\pm$  0.5 percent.

4.7.10 Dissipation factor (see 3.14) The dissipation factor shall be measured at an ac voltage not greater than 20 percent of the rated voltage (or 10 volts, whichever is less (see 3.1)), at a frequency of 1 kHz  $\pm$  100 Hz. Measurement accuracy shall be within  $\pm$  2 percent.

4.7.11 Resistance to soldering heat (see 3.15). 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 - Within 0.250 inch of the seal or case.
- b. Test condition - B.
- c. Cooling time prior to measurement after test - 10  $\pm$  1 minutes.
- d. Measurement after test - Capacitance and dissipation factor at 25° C shall be measured as specified in 4.7.9 and 4.7.10, respectively.

4.7.12 Vibration, high frequency (see 3.16). Capacitors shall be tested in accordance with method 204 of MIL-STD-202. The following details and exceptions shall apply:

- a. Mounting of specimens - Securely fastened so that the body is restrained from movement. The terminals shall be soldered to rigidly supported stud-terminals, so spaced that the length of each terminal from the capacitor body to the edge of the supporting stud-terminal is 0.500  $\pm$  .125 inch.
- b. Electrical-load conditions - During the test, rated voltage (see 3.1) shall be applied between the terminals of the capacitor.
- c. Test condition - D (20G).
- d. Direction and duration of motion - Unless otherwise specified (see 3.1), 4 hours in each of two mutually perpendicular directions (total 8 hours), one parallel and the other perpendicular to the cylindrical axis.
- e. Measurements during vibration - During the last cycle in each direction, an electrical measurement shall be made to detect intermittent contacts of 0.5 ms or greater duration or open- or short-circuiting.
- f. Examination after test - While still mounted on the vibration jig, capacitors shall be visually examined for evidence of mechanical damage.

4.7.13 Shock (specified pulse) (see 3.17). Capacitors shall be tested in accordance with method 213 of MIL-STD-202. The following details and exception shall apply:

- a. Mounting - Rigidly mounted by the body.
- b. Test condition - I (100G's pk).
- c. Electrical loading during shock - During the test, 125 percent of rated voltage (see 3.1) shall be applied between the terminals of the capacitor.
- d. Measurements during shock - During the test, a cathode-ray oscilloscope or other comparable means capable of detecting intermittent contacts of 0.5 ms duration or greater shall be used as an indicating device in determining any electrical failures.
- e. Examination after test - Capacitors shall be visually examined for evidence of breakdown, arcing, fractures, or any other visible mechanical damage.

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

Test condition - A (axial and radial) - 5 pounds; C (radial only) - 5 pounds; and D (axial only).

4.7.15 Solderability (see 3.19). Capacitors shall be tested in accordance with method 208 of MIL-STD-202. The following details shall apply:

- a. The 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.

4.7.16 Low-temperature conditioning and capacitance change with temperature (see 3.20).

4.7.16.1 Low-temperature conditioning. Capacitors shall be placed in a chamber maintained at  $-55^{\circ} \pm 3^{\circ}\text{C}$ . Rated voltage (see 3.1), shall be applied at this condition for  $48 \pm 4$  hours. The air within the conditioning chamber shall be circulated.

4.7.16.2 Capacitance change with temperature. Capacitance shall be measured as specified in 4.7.9, at the temperatures and in the order shown in table XIII.

TABLE XIII. Capacitance measurements.

Step	Temperature
1	$-55^{\circ}\text{C} \pm 3^{\circ}\text{C}$
2	$+25^{\circ}\text{C} \pm 5^{\circ}\text{C}$
3	$+85^{\circ}\text{C} \pm 3^{\circ}\text{C}$
4	$+125^{\circ}\text{C} \pm 3^{\circ}\text{C}$ 1/ 2/ 3/
5	$+150^{\circ}\text{C} \pm 3^{\circ}\text{C}$ 4/
6	$+25^{\circ}\text{C} \pm 5^{\circ}\text{C}$

- 1/ Not applicable to characteristics M and N capacitors.
- 2/ When measuring insulation resistance at  $+125^{\circ}\text{C}$ , the applicable derated voltage shall be used (see 3.1).
- 3/ Voltage derating not applicable for characteristic T capacitors.
- 4/ Not applicable to characteristics M, N, Q, R and S capacitors.

NOTE: The capacitance measurement at each temperature shall be recorded when two successive readings, taken at 5-minute intervals, indicate no change in capacitance.

In addition (for qualification testing only), insulation resistance and dissipation factor shall be measured at high test temperature(s) (steps 3 and 4 of table XIII), as specified in 4.7.6 and 4.7.10, respectively. Capacitors shall then be visually examined for evidence of breakdown, arcing, and other visible mechanical damage.

4.7.17 Thermal shock and immersion (see 3.21).

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

- a. Test condition - A, except that during step 3, capacitors shall be conditioned at high operating temperature (see 3.1).
- b. Measurements before and after cycling - Not applicable.

4.7.17.2 Immersion. Within 4 to 24 hours after completion of temperature cycling, capacitors shall be tested in accordance with method 104 of MIL-STD-202. The following details shall apply:

- a. Test condition - B.
- b. Measurement after final cycle - Dielectric withstanding voltage and insulation resistance at 25°C shall be measured as specified in 4.7.5 and 4.7.4, respectively.

4.7.18 Moisture resistance (see 3.22). Capacitors shall be tested in accordance with method 106 of MIL-STD-202. The following details and exceptions shall apply:

- a. Mounting - Capacitors shall be mounted by their normal mounting means. Except during measurements, the terminals shall be secured 0.500 ± 0.125-inch from point of egress to test jig.
- b. Initial measurements - Not applicable.
- c. Number of cycles - 20.
- d. Polarization voltage - During steps 1 to 6 inclusive, a dc potential of 100 volts or rated voltage, whichever is less (see 3.1), 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.
- e. Loading voltage - Not applicable.
- f. Final measurements - After the final cycle, capacitors shall be conditioned at 25°C ± 5°C at a relative humidity of 50 ± 5 percent for a period of at least 22 hours, but not more than 24 hours. Dielectric withstanding voltage, insulation resistance, dissipation factor, and capacitance shall be measured at 25°C as specified in 4.7.7, 4.7.6, 4.7.10 and 4.7.9 respectively.

4.7.19 Life (see 3.23).

4.7.19.1 2,000 hour (qualification inspection). Capacitors shall be tested in accordance with method 108 of MIL-STD-202. The following details and exceptions shall apply:

- a. Method of mounting and distance between specimens - Rigidly mounted by the body with a distance of not less than 1-inch separation between units.
- b. Test temperature and tolerance -  $+85 \pm \frac{4}{0}^{\circ}\text{C}$ .
- c. Operating conditions - DC rated voltage shall be applied to the capacitors being tested under rated conditions; characteristics N, R and T capacitors shall be subjected to 125 percent of the 85°C rated voltage; characteristics M, Q, and S capacitors shall be subjected to 140 percent of the 85°C rated voltage for units tested under accelerated conditions. The surge current shall be limited to 1 ampere. When necessary, a suitable current-limiting resistor shall be inserted into the circuit. Means shall be provided to assure that the full required voltage is applied to the capacitor when current-limiting resistors are used. Radiation shall not be used as a means of heating the chamber.

- d. Test condition - F (2,000  $\begin{smallmatrix} +72 \\ -0 \end{smallmatrix}$  hours).
- e. Measurements after exposure - Capacitors shall be returned to the inspection conditions specified in 4.3, and shall be visually examined for deformation of body, obliteration of markings, and leakage of filling compound, when applicable. Insulation resistance (at 25°C), capacitance, and dissipation factor (at 25°C), shall then be measured as specified in 4.7.8, 4.7.9 and 4.7.10, respectively.

4.7.19.2 2,000 hour (group B inspection) (see 3.23). Except as specified in the following, capacitors shall be tested as specified in 4.7.19.1:

- a. Test duration - 2,000  $\begin{smallmatrix} +72 \\ -0 \end{smallmatrix}$  hours at accelerated conditions only.

4.7.19.3 Extended life (see 3.23).

4.7.19.3.1 Following 2,000-hour qualification test. Capacitors tested under rated conditions shall be continued on test for an additional 8,000  $\begin{smallmatrix} +96 \\ -0 \end{smallmatrix}$  hours; measurements during and after exposure shall be accomplished after 2,000  $\begin{smallmatrix} +96 \\ -0 \end{smallmatrix}$  hours and every 2,000  $\begin{smallmatrix} +96 \\ -0 \end{smallmatrix}$  hours thereafter until a combined total of 10,000  $\begin{smallmatrix} +96 \\ -0 \end{smallmatrix}$  hours have elapsed.

4.7.19.3.2 125°C proof test. Except as specified in the following, capacitors shall be tested as specified in 4.7.19.1:

- a. Test temperature and tolerance - 125°C  $\begin{smallmatrix} +4 \\ -0 \end{smallmatrix}$  C.
- b. Operating conditions - Characteristic R capacitors shall be subjected to 125 percent of the derated voltage (see table III 1/). Characteristics Q and S capacitors shall be subjected to 140 percent of the derated voltage (see table III 1/).

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

## 5. PACKAGING

5.1 Packaging requirements. The requirements for packaging shall be 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 type designation (see 3.1).
- c. Required levels of preservation and packaging and packing, and special marking (see section 5).
- d. Marking requirement for failure rate level (see 3.25.4).

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 these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts for the products covered by this specification. The activity responsible for the Qualified Products List is U. S. Army Electronics Research and Development Command, DRDEL-ED, Department of the Army, Adelphi, MD 20783; however, information pertaining to qualification of products may be obtained from the Defense Electronics Supply Center (DESC-E), Dayton, OH 45444.

6.3 Application information. Capacitors procured under provisions of this specification will experience failure at a rate depending almost exclusively upon the manner in which the capacitors are used. For military applications, in view of their limited long term moisture resistant characteristics, these capacitors should be used in potted or encapsulated circuit packaging systems.<sup>1/</sup> In any case, the procuring activity should review the specific application. Where the capacitors are not incorporated in an encapsulated or potted circuit package, hermetically-sealed plastic film capacitors of MIL-C-19978 are recommended. In addition, the life of the capacitors specified herein is primarily dependent upon the operating temperature and applied voltage. They should not be used above rated voltage or temperature.

6.3.1 Mounting. Capacitors covered by this specification should be mounted by a bracket or clamp, or they should be potted when vibration or shock are likely to be encountered in service. When a bracket or clamp is used, care should be taken to assure that the capacitor body is not deformed.

6.4 AC component. The rating given is the steady state dc voltage, or the sum of the dc voltage and the peak ac voltage, provided that the peak ac voltage does not exceed 20 percent of the rating at 60 Hz, 15 percent at 120 Hz, or 1 percent at 10,000 Hz. Where heavy transient or pulse currents are encountered, the requirements of this specification are not sufficient to guarantee satisfactory performance, and due allowance must therefore be made in the selection of a capacitor.

6.5 Interchangeability. Capacitors specified as style CTM, characteristic V of MIL-C-27287/1 (USAF) are directly replaceable by style CFR02AM of MIL-C-55514/1A in the same 85°C voltage rating, capacitance value, tolerance and in FRL-M.

NOTE: Even though style CTM units are voltage derated to 125°C, and style CFR02 units are rated only to 85°C, units are unilaterally interchangeable.

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

<sup>1/</sup> For Navy use, these units shall only be used in potted or encapsulated circuit packaging systems.

**Custodians:**

Army - ER  
Navy - EC  
Air Force - 11

**Review activities:**

Army -  
Navy - OS  
Air Force - 11, 17, 99  
DLA - ES

**User activities:**

Army -  
Navy - AS, MC  
Air Force - 19

**Preparing activity:**

Army - ER

**Agent:**

DLA - ES

(Project 5910-1289)

## APPENDIX

## QUALIFICATION-SUBMITTAL PLANS

## 10. SCOPE

10.1 Scope. This appendix details the qualification-submittal plans for capacitors to be subjected to the qualification inspection specified in this specification. These plans specify the sample size, sampling criteria, and limits of coverage for the type of qualification sought.

## 20. SUBMISSION

20.1 Sample single-type. The following details shall apply:

- a. Sample size - 122.
- b. Sampling criteria - Sample units of the same style, rated voltage, terminal, characteristic, capacitance, and capacitance tolerance.
- c. Limits of coverage - Qualification coverage will be limited to the type submitted.

20.1.2 Single-voltage. The following details apply:

- a. Sample size - 122.
- b. Sampling criteria - Sample units of the same style, same characteristic, highest capacitance, tightest tolerance, and same voltage rating. <sup>1/</sup> <sub>2/</sub>
- c. Limits of coverage - Qualification coverage will be extended to all lower capacitance values and broader tolerances in the style, characteristic and voltage rating represented.

20.1.3 Combined voltage. The following details apply:

- a. Sample size and voltage - 122 (61 each of any two adjacent voltages).
- b. Sampling criteria - Sample units of the same style, characteristic, highest capacitance, and lowest tolerance. <sup>1/</sup> <sub>2/</sub>
- c. Limits of coverage - Qualification coverage will be extended to all lower capacitance values and broader tolerances in the style, characteristic and both voltage ratings represented.

20.1.4 Complete style. For complete style, submission shall be in accordance with table XIV.

<sup>1/</sup> Styles with more than one characteristic available will require separate submission for each characteristic.

<sup>2/</sup> (Note: When axial and radial terminals apply to the same sample group, capacitors shall be divided equally between the two terminals types.)

TABLE XIV.

Style	Type designation	Sample size
CFR02	CFR02AMB105GM	61
	CFR02AMC105GM	61
	CFR02AME105GM	61
	CFR02AMF104GM	61
	CFR02AQB105FM	61
	CFR02AQC105FM	61
CFR03	CFR03AMB225GM	61
	CFR03RMC225GM	61
	CFR03AME225GM	122
CFR04	CFR04AMC104GM	61
	CFR04RME104GM	61
	CFR04AQB104FM	61
	CFR04RQC104FM	61
	CFR04AQE104FM	122
	CFR04ASA105FM	61
	CFR04RSA105FM	61
CFR05	CFR05ARA506FM	61
	CFR05ARB206FM	61
	CFR05ARC106FM	61
	CFR05ARE505FM	61
	CFR05ATA506FM	61
	CFR05ATB206FM	61
	CFR05ATC106FM	61
	CFR05ATE505FM	61
CFR06	CFR06ARA506FM	61
	CFR06RRB206FM	61
	CFR06ANC106FM	61
	CFR06RNE335FM	61
	CFR06ATA506FM	61
	CFR06ATC106FM	61
	CFR06RTB206FM	61
	CFR06RTE106FM	61
CFR07	CFR07AMA205FM	61
	CFR07AMB104FM	61
CFR08	CFR08AMA394JM	61
	CFR08AMD563JM	61
CFR09	CFR09ARA188FM	61
	CFR09ARB108FM	61
	CFR09ARH505FM	61
	CFR09ARC395FM	61

## 30. DATA REQUIREMENTS

30.1 Description of items. The contractor shall submit a detailed description of the materials and constructional features of the capacitors being subjected to qualification inspection, including information as to whether they are impregnated or filled, the type and quantity of the impregnant or filling compound; the type, thickness, and the number of layers of plastic film and foil or metallization; the material, thickness, and applied finish of the case, as well as details on the end seal and terminal assembly.

30.2 Certification of materials. The contractor shall submit certification, in duplicate, that the materials used in his components are in accordance with the applicable specification requirements.

**INSTRUCTIONS:** In a continuing effort to make our standardization documents better, the DoD provides this form for use in submitting comments and suggestions for improvements. All users of military standardization documents are invited to provide suggestions. This form may be detached, folded along the lines indicated, taped along the loose edge (*DO NOT STAPLE*), and mailed. In block 5, be as specific as possible about particular problem areas such as wording which required interpretation, was too rigid, restrictive, loose, ambiguous, or was incompatible, and give proposed wording changes which would alleviate the problems. Enter in block 6 any remarks not related to a specific paragraph of the document. If block 7 is filled out, an acknowledgement will be mailed to you within 30 days to let you know that your comments were received and are being considered.

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

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(See Instructions - Reverse Side)

1. DOCUMENT NUMBER

2. DOCUMENT TITLE

3a. NAME OF SUBMITTING ORGANIZATION

4. TYPE OF ORGANIZATION (Mark one)

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b. ADDRESS (Street, City, State, ZIP Code)

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER (Last, First, MI) - Optional

b. WORK TELEPHONE NUMBER (Include Area Code) - Optional

c. MAILING ADDRESS (Street, City, State, ZIP Code) - Optional

8. DATE OF SUBMISSION (YYMMDD)

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