

MIL-C-25D
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MILITARY SPECIFICATION
 CAPACITORS, FIXED, PAPER-DIELECTRIC,
 DIRECT CURRENT
 (HERMETICALLY SEALED IN METAL CASES),
 GENERAL SPECIFICATION FOR

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

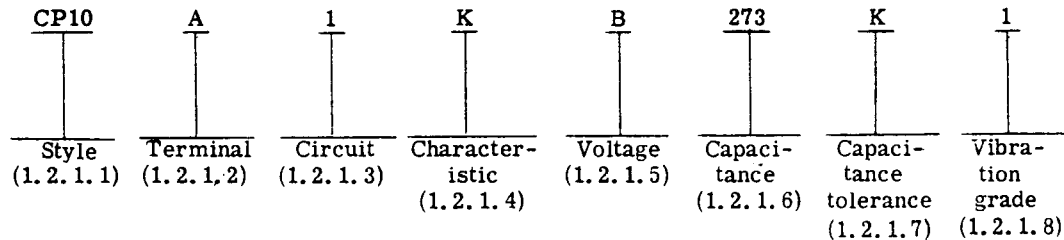
DO NOT USE FOR NEW DESIGN
 FOR REPLACEMENT PURPOSES ONLY

1. SCOPE

1.1 Scope. This specification covers the general requirements for direct-current (dc) paper-dielectric, fixed capacitors hermetically sealed in metal cases, intended primarily for filter, bypass, and blocking purposes where the alternating-current (ac) component of the impressed voltage is small with respect to the dc voltage rating. This specification also covers removable mounting brackets for use with the capacitors.

1.2 Classification.

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



1.2.1.1 Style. The style is identified by the two-letter symbol "CP" followed by a two-digit number; the letters identify direct-current, paper-dielectric, fixed capacitors hermetically sealed in metal cases; the first digit identifies general shape of the case, and the second digit identifies specific details other than case size. Each style designation includes a family of case sizes.

1.2.1.2 Terminal. The terminal is identified by a single letter in accordance with table I.

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TABLE I. Terminal.

Symbol	Type of terminal
A - - - - -	Axial wire leads.
B - - - - -	Solder lug (nonremovable).
C - - - - -	Threaded stud and nuts.
D - - - - -	Pillar insulator for use at altitudes up to 7,500 feet. Furnished with threaded stud and nuts.
E - - - - -	Pillar insulator for use at altitudes up to 50,000 feet.
F - - - - -	Hooked-wire lead.

1.2.1.3 Circuit. The circuit diagram and the number of terminals associated with it is identified by a single symbol as shown in table II.

TABLE II. Circuit diagram and number of terminals.

Symbol	Circuit diagram	Number of terminals
1 - - - - -		2
2 - - - - -		1
3 - - - - -		2
4 - - - - -		3
5 - - - - -		3
6 - - - - -		2

1.2.1.4 Characteristic. The characteristic is identified by a single letter in accordance with table III.

TABLE III. Characteristic.

	Values for characteristic		
	A and B	E and F	K
High ambient test temperature, degrees centigrade $\pm 3^{\circ}$ C - - - - -	85	85	125
Low ambient test temperature, degrees centigrade $\pm 3^{\circ}$ C - - - - -	-55	-55	-55
Life-test dc voltage in percent of the voltage rating at 40° C (see 4.6.15): Watt-second group:			
I:			
1A (0.08 watt-second and less) - - - - -	190	140	140
1B (0.08 + to 0.5 watt-second) - - - - -	190	140	120
II (0.5 + to 5 watt-seconds) - - - - -	170	130	---
III (5 + to 50 watt-seconds) - - - - -	---	110	---
IV (greater than 50 watt-seconds) - - - - -	---	90	---

1.2.1.5 Voltage rating. The dc voltage rating for continuous operation at 40° C, except for characteristic K, which is 85° C, is identified by a single letter in accordance with table IV (see 6.5).

TABLE IV. DC voltage rating.

Symbol	DC voltage rating	Symbol	DC voltage rating
	Volts		Volts
B - -	100	K - -	2,500
C - -	200	L - -	3,000
D - -	250	M - -	4,000
E - -	400	N - -	5,000
F - -	600	P - -	6,000
G - -	1,000	R - -	7,500
H - -	1,500	S - -	10,000
J - -	2,000	T - -	12,500

1.2.1.6 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.

1.2.1.7 Capacitance tolerance. The capacitance, T_c , in percent is identified by a single letter in accordance with table V.

TABLE V. Capacitance tolerance.

Symbol	Capacitance tolerance
	Percent
K - - - -	± 10
L - - - -	± 15
V - - - -	+20
	-10

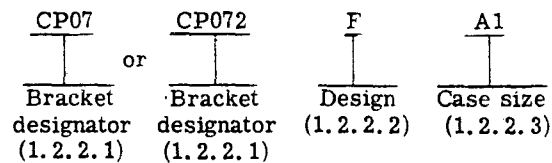
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1.2.1.8 Vibration grade. The vibration grade is identified by a single digit in accordance with table VI.

TABLE VI. Vibration grade.

Symbol	Frequency range (Hz)
1 - - -	10 to 55, incl
3 - - -	10 to 2,000, incl

1.2.2 Type designation for removable mounting brackets. The type designation for removable mounting brackets shall be in the following form, and as specified (see 3.1 and 6.1):



1.2.2.1 Bracket designator. Brackets for direct-current paper-dielectric, fixed capacitors covered by this specification are identified by the two-letter symbol "CP" followed by a two- or three-digit number. The number is formed by a zero followed by the first digit or both digits of the two-digit case designation assigned to the particular case for which the bracket is intended (see 3.1);

1.2.2.2 Design identification. The design of the footed bracket is identified by the letter "F", and of the spade-lug bracket by the letter "S".

1.2.2.3 Case size. The case-size designation corresponds to the case size, as specified (see 3.1).

1.2.3 Voltage rating versus temperature. Capacitors of characteristic K shall have a dc voltage rating for continuous operation at 85° C, and capacitors of all other characteristics shall have a dc voltage rating for continuous operation at 40° C as specified (see 3.1). Voltage derating at other ambient temperatures may be necessary in order to realize equivalent life ^{1/} (see 3.1, 6.4, and 6.4.1).

1.2.3.1 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 Hertz (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 be made, therefore, in the selection of a capacitor.

2. APPLICABLE DOCUMENTS

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

^{1/} The permissible operating voltages, while based on incomplete data, are the capacitor supplier's best estimate to provide a life expectancy of 8,800 hours of continuous operation at high ambient temperatures. Longer life can be expected of all types by operation at still lower voltages; for example, a life expectancy of approximately 44,000 hours may be obtained by operation at 70 percent of the voltage specified in 1.2.3. Also a life longer than 8,800 hours may be expected at the voltage specified in 1.2.3 if the high ambient temperature prevails for only a portion of the whole operating time.

SPECIFICATIONS

MILITARY

MIL-C-39028 - Capacitors, Packaging of.

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

STANDARDS

MILITARY

MIL-STD-105 - Sampling Procedures and Table for Inspection by Attributes.

MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts.

(Copies of specifications, standards, drawings, and publications required by suppliers 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 documents form 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.

NATIONAL BUREAU OF STANDARDS

Handbook H28 - Screw-Thread Standards for Federal Services.

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

AMERICAN SOCIETY FOR TESTING MATERIALS

D92-52 - Flash and Fire Point (Cleveland Open Cup).

(Application for copies should be addressed to the American Society for Testing Materials, 1916 Race Street, Philadelphia, Pa. 19103.)

3. REQUIREMENTS

3.1 Detail requirements for individual capacitor styles. Detail requirements or exceptions applicable to individual styles of capacitors shall be as specified in the applicable specification sheet listed in Supplement 1 to this specification. In the event of any conflict between requirements of this specification and the specification sheet, the latter shall govern (see 6.1).

3.2 Qualification. Capacitors and brackets 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 the bids (see 4.4 and 6.2).

3.3 Material. When a definite material is not specified, a material shall be used which will enable the capacitors and brackets 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.

3.3.1 Insulation, impregnating, and sealing compounds. Compounds used in the impregnation and filling of capacitors shall be chemically inactive with respect to the capacitor unit and the case (see 3.4.1, 6.7, and 6.8). The 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.

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3.3.2 Metals. Metals shall be of a corrosion resisting type, or shall be plated or treated to resist corrosion (see 3.11).

3.4 Design and construction. The capacitors and brackets shall be of the design, construction, and physical dimensions specified (see 3.1).

3.4.1 Case. Each capacitor shall be enclosed in a hermetically-sealed metal case which will protect the capacitor element from moisture and mechanical damage under all of the specified test conditions. The use of exterior cardboard sleeves for insulating purposes shall not be permitted (see 6.10 and 6.11).

3.4.2 Capacitor elements. The capacitor elements shall consist of conducting layers separated by two or more layers of dielectric tissues (paper).

3.4.2.1 Noninductive construction. Capacitors having capacitance and dc voltage ratings equal to or less than 1 microfarad and 3,000 volts, respectively, shall have extended foil construction, tab construction, or an equivalent construction. When tab construction is used, each pair of tabs shall be brought out from opposite foils within one turn of the foil winding from each other, except as specified (see 3.1 and 6.9).

3.4.3 Terminals.

3.4.3.1 Case as terminal. When the case is a terminal, any protective coating applied to the mounting surfaces shall be such as to provide a direct conducting path for an electric current from the case to the surface on which it is mounted.

3.4.3.2 Solder lugs and solder-lug terminals. Solder lugs and solder lug-terminals may be of any shape, providing dimensional limits are met, and shall be coated with solder having a tin content of 40 to 70 percent (see 6.13).

3.4.3.3 Screw terminals. Screw terminals shall be supplied with one nut, one flat washer, and one lockwasher.

3.4.3.4 Wire leads. Leads shall be of copper or copper covered steel. Copper covered steel leads shall have a minimum of 30 percent of the conductivity of electrolytic copper. Leads shall be coated with solder having a tin content of from 40 to 70 percent (see 6.13).

3.4.4 Threaded parts. All threaded parts shall be in accordance with Handbook H28. Where practical, all threads shall be in conformity with the coarse-thread series. The fine-thread series shall be used only for applications that might show a definite advantage through their use. Where a special diameter-pitch combination is required, the thread shall be of American National Form and of any pitch between 16 and 36 which is used in the fine-thread series.

3.4.4.1 Engagement of threaded parts. All threaded parts shall engage by at least three full threads.

3.4.4.2 Locking of screw-thread assemblies. All screw-thread assemblies shall be rendered resistant to loosening under vibration. Lockwashers shall be provided under all nuts.

3.5 Dielectric withstanding voltage. Capacitors shall withstand the dc potentials specified in 4.6.2 without permanent damage or open- or short-circuiting.

3.6 Insulation resistance.

3.6.1 Terminal to terminal. When capacitors are tested as specified in 4.6. the insulation resistance shall be not less than the applicable values specified in table VII (see 1).

3.6.2 Terminals to case. When capacitors are tested as specified in 4.6.3, the insulation resistance, measured between any terminal and the case when the case is not a terminal, shall exceed 3,000 megohms.

TABLE VII. Terminal-to-terminal insulation-resistance measurements.

Capacitance rating	Minimum insulation resistance
Characteristic K	At 25° ± 3°C ^{1/}
0.33 microfarads and less - - - - -	18,000 megohms
Greater than 0.33 microfarads - - - - -	6,000 megohm-microfarads ^{2/}
	At 125° ± 3°C
0.067 microfarads, and less - - - - -	150 megohms
Greater than 0.067 microfarads - - - - -	10 megohm-microfarads ^{2/}
Characteristics A and E	At 25° ± 3°C ^{1/}
0.33 microfarads, and less - - - - -	6,000 megohms
Greater than 0.33 microfarads - - - - -	2,000 megohm-microfarads ^{2/}
	At 85° ± 3°C
0.033 microfarads and less - - - - -	600 megohms
Greater than 0.033 microfarads - - - - -	20 megohm-microfarads ^{2/}
Characteristics B and F	At 25° ± 3°C ^{1/}
0.33 microfarads and less - - - - -	4,500 megohms
Greater than 0.33 microfarads - - - - -	1,500 megohm-microfarads ^{2/}
	At 85°C
0.033 microfarads and less - - - - -	450 megohms
Greater than 0.033 microfarads - - - - -	15 megohm-microfarads ^{2/}

^{1/} For corrections, if measurements are made at other temperatures between 20° and 35°C, see table VIII.

^{2/} Product obtained by multiplying the capacitance in microfarads by the insulating resistance in megohms.

TABLE VIII. Insulation-resistance correction factors.

Degrees centigrade	Correction factor	Degrees centigrade	Correction factor
20 - - - - -	1.42	28 - - - - -	0.82
21 - - - - -	1.33	29 - - - - -	0.76
22 - - - - -	1.24	30 - - - - -	0.71
23 - - - - -	1.16	31 - - - - -	0.67
24 - - - - -	1.08	32 - - - - -	0.63
25 - - - - -	1.00	33 - - - - -	0.59
26 - - - - -	0.94	34 - - - - -	0.55
27 - - - - -	0.87	35 - - - - -	0.51

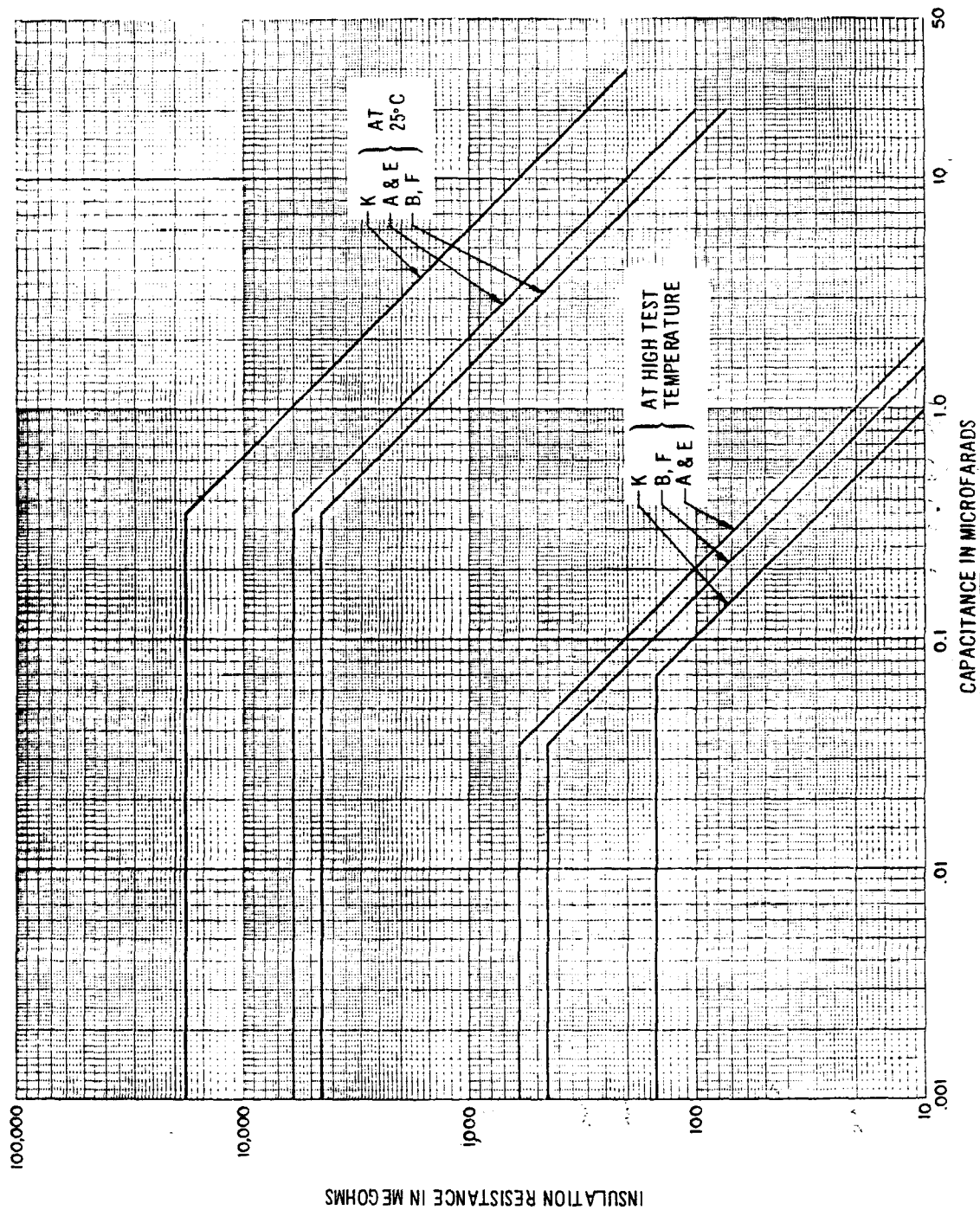


FIGURE 1. Graphical representation of insulation-resistance requirement specified in 3.6.1 and table VII.

3.7 Capacitance. When measured as specified in 4.6.4, the capacitance shall be within the tolerance shown in the type designation (see 3.1).

3.8 Dissipation factor. When measured as specified in 4.6.5, the dissipation factor shall be not more than 1.0 percent.

3.9 Barometric pressure (flashover). Capacitors having terminal A, B, C, E, or F shall withstand the dc potential specified in 4.6.6 without visible damage, external flashover, or open- or short-circuiting (see 3.1).

3.10 Vibration. When capacitors are tested as specified in 4.6.7, there shall be no mechanical damage, and the measurement shall show no evidence of intermittent contacts or open- or short-circuiting.

3.11 Salt spray (corrosion). As a result of the test specified in 4.6.8, there shall be no harmful or extensive corrosion, and at least 90 percent of any exposed metal surface of the capacitor or bracket shall be protected by the finish. For capacitors with painted cases, not more than 10 percent of the surfaces shall be affected by flaking, peeling, or blistering of paint. The marking shall remain legible. There shall be no unwrapping of or mechanical injury to insulating sleeves. In addition, there shall be not more than 10-percent corrosion of the terminal hardware or mounting surface.

3.12 Temperature and immersion cycling. When tested as specified in 4.6.9, capacitors shall meet the following requirements:

Dielectric withstanding voltage:

Insulating sleeves	-----	Not less than 4,000 volts dc.
Terminal to terminal	-----	As specified in 3.5.
Terminal to case (when case is not a terminal)	----	As specified in 3.5

Insulation resistance:

Insulating sleeves	-----	Not less than 100 megohms.
Terminal to terminal	-----	Not less than 30 percent of of the value specified in 3.6.1.
Terminal to case (when case is not a terminal)	----	Not less than 50 percent of the value specified in 3.6.2.

In addition, there shall be no harmful or extensive corrosion of the capacitors or brackets. The marking shall remain legible.

3.13 Solderability ¹²⁵ (axial wire leads only). When capacitors are tested as specified in 4.6.10, the dipped surface of the capacitor lead to be inspected shall be limited to a 1-inch area extending outward from .050 inch of the eyelet, seal, or case. Of this area, at least 95 percent shall be covered with a new, smooth, solder coating. The remaining 5 percent of the surface to be inspected shall show only small pinholes or voids; 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 when their total area exceed 5 percent of the surface to be inspected. In case of dispute, the percent coverage with pinholes or voids shall be determined by actual measurements of these areas, as compared to the total area.

3.14 Terminal strength. When capacitors are tested as specified in 4.6.11, there shall be no mechanical damage to the capacitor or terminals; no part of any terminal shall loosen or rupture. Screw type terminals shall exhibit no perceptible movement relative to the case under the applied torque.

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3.15 Moisture resistance. When tested as specified in 4.6.12, capacitors shall meet the following requirements.

Dielectric withstanding voltage:

Insulating sleeves - - - - - Not less than 4,000 volts dc.
Terminal to terminal - - - - - As specified in 3.5.
Terminal to case (when case is not a terminal) - As specified in 3.5.

Insulation resistance:

Insulation sleeves - - - - - Not less than 100 megohms.
Terminal to terminal - - - - - Not less than 30 percent of the
value specified in 3.6.1.
Terminal to case (when case is not a terminal) - Not less than 50 percent of the
value specified in 3.6.2.

In addition, there shall be no harmful or extensive corrosion of the capacitors or brackets. The marking shall remain legible.

3.16 Seal. When capacitors are tested as specified in 4.6.13, there shall be no evidence of leakage.

3.17 Low ambient temperature and capacitance change with temperature. When tested as specified in 4.6.14, capacitors shall withstand the application of rated dc voltage (see 3.1) without breakdown or flashover. The capacitance change over the operating temperature range shall not exceed the following limits:

Characteristics A and E - - - - ±10 percent.
Characteristics B and F - - - - +10, -30 percent.
Characteristic K - - - - - +7.5, -10 percent.

3.18 Life. When tested as specified in 4.6.15, capacitors shall meet the following requirements:

Insulation resistance at 25°C - - - - Not less than 30 percent of the value
specified in 3.6.1.
Capacitance - - - - - Change not more than 10 percent from
initial value obtained when measured
as specified in 4.6.4, except for
characteristic K, which shall be 5
percent.
Dissipation factor - - - - - Change shall not exceed 1 percent from
~~initial value obtained~~ when measured
as specified in 4.6.5 except for char-
acteristic F which shall be 1.5 percent.

In addition, there shall be no mechanical failure, leakage of impregnant or filling compounds, nor open- or short-circuiting.

3.19 Flashpoint of impregnant or filling compound. When tested as specified in 4.6.16, the flashpoint of impregnant or filling compound shall be no lower than 135°C for characteristics A, B, E, and F; and no lower than 145°C for characteristic K.

3.20 Marking.

3.20.1 Capacitor identification marking. Capacitors shall be marked with the type designation and the manufacturer's name or code symbol. There shall be no space between the symbols which comprise the type designation. If lack of space requires it, the type designation may appear on two lines. In this event, the type designation shall be divided between the circuit symbol and the

characteristic symbols, and shall appear on two lines as shown in the following example:

CP27A1
EF302M1

On multiple-section capacitors, the case adjacent to the common terminal, if the terminal is not the case, shall be marked with a "C". If space permits, the capacitance in microfarads and the rated dc voltage shall also be marked. Paper labels shall not be used.

3.20.2 Bracket identification marking. Bracket shall be marked with the type designation (see 1.2.2), and the manufacturer's name or code symbol. When two type designations are applicable to the same bracket, both designations shall be marked on the bracket.

3.21 Workmanship. Capacitors and brackets 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.

3.21.1 Soldering. Flux for soldering shall be rosin or rosin and alcohol. No acid or acid salts shall be used in preparation for or during soldering. All excess flux or solder shall be removed. Electrical connections shall be mechanically secured before soldering, where possible, and electrically continuous after soldering.

3.21.2 Riveting. The riveting operation shall be performed carefully to insure that the rivet is tight and satisfactorily headed.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. The supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own or any other inspection facilities and services acceptable to 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 Test equipment and inspection facilities. Test equipment and inspection facilities shall be of sufficient accuracy, quality, and quantity to permit performance of the required inspection. The supplier shall establish calibration of inspection equipment to the satisfaction of the Government.

4.1.2 Additional inspection. Nothing specified herein shall preclude the supplier from taking such additional samples and making such additional inspection as he may deem necessary or desirable to assure conformance of the capacitors and brackets to this specification.

4.2 Classification of inspection. The examination and testing of capacitors shall be classified as follows:

- (a) Qualification inspection (see 4.4).
- (b) Quality conformance inspection (see 4.5).
 - (1) Inspection of product for delivery (see 4.5.1).
 - (2) Inspection of preparation for delivery (see 4.5.2).

4.3 Inspection conditions. Unless otherwise specified herein, all inspections shall be made in accordance with the general requirements of MIL-STD-202.

4.4 Qualification inspection. Qualification inspection shall be performed at a laboratory acceptable to the Government (see 6.2).

4.4.1 Sample. The number of sample units comprising a sample of capacitors or brackets, and the amount of impregnant or filling compound to be submitted for qualification inspection shall be as specified in the appendix to this specification.

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4.4.2 Inspection routine.

4.4.2.1 Capacitor submission. Sample capacitors shall be subjected to the examinations and tests specified in table IX, in the order shown. Two specimens of each type represented in a sample shall be subjected to visual and mechanical examination (internal), and the remaining capacitors shall be subjected to the remainder of the group I examination and tests. The capacitors shall then be divided into test groups as specified in table IX and subjected to the tests for their particular group.

4.4.2.2 Bracket submission. Sample brackets shall be subjected to the examination and tests specified in table X, in the order shown. Two specimens of each type represented in a sample shall be subjected to group I tests, and the remaining brackets shall be divided into two groups as specified in table X and subjected to the tests for their particular group. Each type of bracket shall be equally represented in each test group. During these tests, one set of each bracket type shall support a capacitor of the same case designation with which it is normally used (see 3.1). Tests on brackets may be run concurrently with those specified for capacitors in 4.4.2.1. Each bracket shall be considered as a specimen for the purpose of determining defectives.

4.4.2.3 Impregnant or filling compound. The sample of impregnant or filling compound (see 20.1.5) shall be subjected to the flashpoint-of-impregnant or filling-compound test specified in table IX.

4.4.2.4 Capacitors with alternate terminals, insulating sleeve and case materials, and applied finish. Sample capacitors (see 20.1.6 to 20.1.10, inclusive) shall be subjected to the examinations and tests of groups I, II, and III specified in table IX, in the order shown. After completion of the group I tests, the specimens shall be divided into two equal groups and subjected to the tests specified in groups II and III. No defectives shall be allowed for group I, and 1 defective shall be allowed for each of groups II and III.

4.4.3 Defectives. Defectives in excess of those allowed in tables IX and X, as applicable, and 4.4.2.4 shall be cause for refusal to grant qualification. If a multiple-section capacitor has a defect in any section, it shall be considered as one defective.

TABLE IX. Qualification inspection for capacitors.

Examination or test	Requirement paragraph	Method paragraph	Number of specimens to be inspected	Number of defectives ^{1/} allowed		
Flashpoint of impregnant or filling compound - - - - -	3.19	4.6.16	---	0		
<u>Group I</u>						
Visual and mechanical examination (internal):	---	4.6.1	}	}		
Material, design, construction, and physical dimensions - - - - -	3.1 and 3.3 to 3.4.4.2, incl.	---			2	0
Marking ^{2/} - - - - -	3.20	---			}	}
Workmanship - - - - -	3.21 to 3.21.2 incl.	---				
Visual and mechanical examination (external):	---	4.6.1	}	}		
Marking ^{2/} - - - - -	3.20	---			}	}
Workmanship - - - - -	3.21 to 3.21.2 incl.	---				
Dielectric withstanding voltage - - - - -	3.5	4.6.2			25 ^{3/}	1
Insulation resistance - - - - -	3.6	4.6.3	}	}		
Capacitance - - - - -	3.7	4.6.4				
Dissipation factor - - - - -	3.8	4.6.5				
Barometric pressure (flashover) - - - - -	3.9	4.6.6				
<u>Group II</u>						
Vibration - - - - -	3.10	4.6.7	}	}		
Salt spray (corrosion) - - - - -	3.11	4.6.8			6	1
Temperature and immersion cycling - - - - -	3.12	4.6.9				
<u>Group III</u>						
Solderability (axial wire leads only) - - - - -	3.13	4.6.10	}	}		
Terminal strength - - - - -	3.14	4.6.11			}	}
Moisture resistance - - - - -	3.15	4.6.12				
<u>Group IV</u>						
Seal - - - - -	3.16	4.6.13	}	}		
Low ambient temperature and capacitance change with temperature - - - - -	3.17	4.6.14			}	}
Life - - - - -	3.18	4.6.15				

^{1/} A specimen having one or more defects shall be considered as one defective.

^{2/} 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.

^{3/} One additional specimen is included in each sample of 27 specimens to permit substitution for the allowable defective in group I.

^{4/} 18 specimens shall be used for all styles covered by MIL-C-25/1.

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TABLE X. Qualification inspection for brackets.

Examination or test	Requirement paragraph	Method paragraph	Number of specimens to be inspected	Number of defectives ^{1/} allowed
<u>Group I</u>				
Visual and mechanical examination - - - -	3.1, 3.3, 3.3.2, 3.4 and 3.20.2 to 3.21.2 incl	4.6.1	2	1
<u>Group II</u>				
Vibration - - - - -	3.10	4.6.7.1	} 12	} 1
Salt spray (corrosion) - - - - -	3.11	4.6.8		
Temperature and immersion cycling - - -	3.12	4.6.9		
<u>Group III</u>				
Moisture resistance - - - - -	3.15	4.6.12	12	1

^{1/} A specimen having one or more defects shall be considered as a single defective.

4.5 Quality conformance inspection.

4.5.1 Inspection of product for delivery. Inspection of product for delivery shall consist of production inspection, groups A, B, and C.

4.5.1.1 Production inspection. Production inspection shall consist of the tests specified in table XI. in the order shown, and shall be performed on each capacitor.

TABLE XI. Production inspection.

Test	Requirement paragraph	Method paragraph
Seal ^{1/} - - - - -	3.16	4.6.13
Dielectric withstanding voltage - -	3.5	4.6.2
Capacitance - - - - -	3.7	4.6.4

^{1/} At the option of the supplier, this test may be performed before the sleeve is put on.

4.5.1.2 Inspection lot. An inspection lot, as far as practicable, shall consist of capacitors grouped by style and characteristic, as specified (see 3.1). Capacitors of different characteristics having the same impregnant shall be considered as capacitors of the same characteristic.

4.5.1.2.1 Sample. Each voltage rating shall be represented in the sample in the approximate ratio of the voltage ratings represented in the inspection lot.

4.5.1.3 Group A inspection. Group A inspection shall consist of the examinations and tests specified in table XII, in the order shown.

4.5.1.3.1 Sampling plan. Statistical sampling and inspection shall be in accordance with MIL-STD-105 for ordinary inspection. The acceptable quality levels (AQL) shall be as specified in table XII. Major and minor defects shall be as defined in MIL-STD-105.

TABLE XII. Group A inspection.

Examination or test	Requirement paragraph	Method paragraph	AQL percent defective	
			Major	Minor
Visual and mechanical examination - - - -		4.6.1	} 1.0	} 4.0
Materials - - - - -	3.3 to 3.3.2, incl	---		
Body dimensions - - - - -	3.1	---		
Design and construction (other than body dimensions) - - - - -	3.4 to 3.4.4.2, incl	---		
Marking ^{1/} - - - - -	3.20 to 3.20.2, incl	---		
Workmanship - - - - -	3.21 to 3.21.2, incl	---	} 1.0	---
Insulation resistance (at 25°C) - - - - -	3.6	4.6.3		
Capacitance - - - - -	3.7	4.6.4		
Dissipation factor - - - - -	3.8	4.6.5		

^{1/} Marking defects are based on visual examination and shall be charged only for illegible, incomplete, or incorrect marking. Any subsequent electrical defects shall not be used as the basis for determining marking defects.

4.5.1.3.2 Rejected lots. If an inspection lot is rejected, the supplier may withdraw the lot, rework it to correct the defects, or screen out the defective units, as applicable, and reinspect. Such lots shall be separate from new lots and shall be clearly identified as reinspected lots. Rejected lots shall be inspected using tightened inspection.

4.5.1.4 Group B inspection. Group B inspection shall consist of the tests specified in table XIII and shall be performed on sample units that have passed the group A inspection. A different set of sample units shall be selected for each subgroup, and shall be tested in the order shown. Shipment of capacitor lots shall not be accomplished until representative samples of the lot have successfully completed the group B tests.

TABLE XIII. Group B inspection.

Test	Requirement paragraph	Method paragraph
<u>Subgroup 1</u>		
Barometric pressure (flashover) - - - -	3.9	4.6.6
Vibration - - - - -	3.10	4.6.7
Temperature and immersion cycling - - -	3.12	4.6.9
<u>Subgroup 2</u>		
Insulation resistance (at high-test temperature) - - - - -	3.6	4.6.3
Life - - - - -	3.18	4.6.15

4.5.1.4.1 Sampling plan. The sampling plan shall be in accordance with MIL-STD-105 for small-sample inspection. Unless otherwise specified herein, normal inspection shall be used at the start of the contract. The AQL shall be 2.5 (percent defective), and the inspection level shall be S4 for normal and tightened inspection, and S3 for reduced inspection.

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

4.5.1.4.3 Resubmitted lots. If an inspection lot is rejected due to failure to pass group B inspection, the lot shall not be resubmitted to the Government; however, if nonconformance of the lot is due to conditions which will not affect the usability or performance of the capacitors, the lot may be resubmitted if remedial action has been taken.

4.5.1.5 Group C inspection. Group C inspection shall consist of the tests specified in table XIV, in the order shown. They shall be performed on sample units that have passed the group A inspection. Shipment shall not be held up pending completion of the inspection.

TABLE XIV. Group C inspection.

Test	Requirement paragraph	Method paragraph	Number of sample units to be tested	Number of defectives ^{1/} allowed
<u>Initial production every month</u>				
Solderability- - - - -	3.13	4.6.10	} 6	} 1
Terminal strength- - - - -	3.14	4.6.11		
Moisture resistance- - - - -	3.15	4.6.12		
<u>Initial production and every 2 months</u>				
Low ambient temperature and capacitance change - - - - -	3.17	4.6.14	} 6	} 1
Salt spray (corrosion)- - - - -	3.11	4.6.8		

^{1/} A specimen having one or more defects shall be considered as one defective.

4.5.1.5.1 Sampling plan. Sample units shall be selected as specified in 4.5.1.5.1.1 and 4.5.1.5.1.2 from the initial production, processed for acceptance at the start of the contract, and from each month's and each 2-month's production thereafter in accordance with table XIV. A different set of sample units shall be selected for each group of tests. If the number of defectives exceeds those allowed in table XIV, the sample shall be considered to have failed.

4.5.1.5.1.1 Initial production and every month. During the initial production and once each calendar month thereafter, sample units of the same style (any one style covered by a specification sheet may be representative of any other style specified therein) shall be selected irrespective of characteristic, voltage, and capacitance.

4.5.1.5.1.2 Initial production and every 2 months. During the initial production and every 2 months thereafter, sample units of the sample style (any one style covered by a specification sheet may be representative of any other style specified therein) shall be selected in each characteristic, irrespective of voltage and capacitance. These sample units may be in any capacitance tolerance.

4.5.1.5.2 Noncompliance. If a sample fails to pass group C inspection, the supplier shall take corrective action on the materials or processes or both, as warranted, and on all units of product which can be corrected and which were manufactured under essentially the same conditions, with essentially the same materials, processes, etc., and which are considered subject to the same failure. Acceptance of the product shall be discontinued until corrective action acceptable to the Government has been taken. After the corrective action has been taken, additional sample units shall be subjected to group C inspection (all inspections, or the inspections which the sample failed, at the option of the Government). Production inspection, and groups A and B inspection may be reinstated; however, final acceptance shall be withheld until the group C inspection has shown that the corrective action was successful. In the event of failure after reinspection, information concerning the failure and the corrective action taken shall be furnished to the contracting officer.

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

4.5.2 Inspection of preparation for delivery. Sample packages or packs and the inspection of the preservation, packaging, packing, and marking for shipment and storage shall be in accordance with the requirements of section 5 or the documents referenced herein.

4.5.3 Retention of qualification. To retain qualification, the manufacturer shall forward, at 6-month intervals, to the qualifying activity, a summary of the results of groups A and B tests, indicating as a minimum the number of lots which passed and the number which failed, and a summary of the results of group C tests, including the number and type of any part failures. The summary shall include those tests performed during the 6-month period. If the summary of the test results indicates nonconformance with specification requirements, action shall be taken to remove the failing product from the qualified products list. Failure to submit the summary shall result in loss of qualification for that product. In addition to the periodic submission of inspection data, the supplier shall immediately notify the qualifying activity at any time during the 6-month period that the inspection data indicates failure of the qualified product to meet the requirements of the specification.

4.6 Methods of examination and test.

4.6.1 Visual and mechanical examination. Capacitors and brackets 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, 3.3 to 3.4.4.2 inclusive, and 3.20 to 3.21.2 inclusive).

4.6.2 Dielectric withstanding voltage (see 3.5). Capacitors shall be tested in accordance with method 301 of MIL-STD-202, and as detailed in table XV, unless otherwise specified (see 3.1). The surge current shall be limited to between 5 milliamperes and 1 ampere. When necessary, a suitable current-limiting resistor shall be inserted into the circuit. At least 95 percent of the specified potential shall appear across the terminals of the capacitor prior to and during the period of time specified (see 3.5, 6.12, and table XV).

4.6.3 Insulation resistance (see 3.6). Capacitors shall be tested in accordance with method 302 of MIL-STD-202. The following details shall apply:

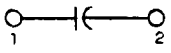
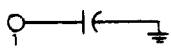
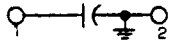
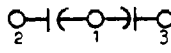
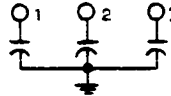

- (a) Test potential - A potential equal to the 40°C rated dc voltage or 500 volts dc, whichever is less, shall be applied.
- (b) Points of measurement:
 - (1) Terminal to terminal - Insulation resistance shall be measured between terminals at the applicable high-test temperature specified in table III and at 25°C, or corrected thereto. For quality conformance inspection, the measurement at the high-test temperature is required only for specimens which shall be subjected to the life test.
 - (2) Terminal to case - When the case is not a terminal, the measurement of the insulation resistance shall be made between each terminal and the case at 25°C, or corrected thereto.

4.6.4 Capacitance (see 3.7). Capacitors shall be tested in accordance with method 305 of MIL-STD-202. The following details shall apply:

- (a) Test frequency - 1,000 ± 100 Hz for capacitors when nominal capacitance does not exceed 1 microfarad and whose rated dc voltage does not exceed 3,000 volts. For capacitors not within these limits, measurements shall be made at a frequency of 60 ± 6 Hz.
- (b) Limit of accuracy - Shall be within ± 2 percent.

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TABLE XV. Dielectric-withstanding-voltage test.

Circuit symbol	Circuit diagram	Test	Test connections	Test voltage ^{1/} (percent of rated dc voltage)	Time test voltage applied (minutes)	Remarks
1		Terminal to terminal	1 to 2	200	2/1	175 percent rated dc voltage after temperature-and immersion-cycling and moisture-resistance test as specified in 4.6.9 and 4.6.12, respectively.
		Terminal to case	1 and 2 to case	400	3/4/1	For capacitors of dc voltage ratings of 600 volts and less.
				200+1,000 volts 400 but not greater than 2,000 volts	3/4/1	For tubular capacitors 1/2-inch diameter and smaller (not including insulating sleeves).
2		Terminal to terminal	1 to case	200	2/1	175 percent rated dc voltage after temperature-and immersion-cycling and moisture resistance test as specified in 4.6.9 and 4.6.12, respectively.
3		Terminal to terminal	1 to 2 or 1 to case	200	2/1	175 percent rated dc voltage after temperature- and immersion-cycling and moisture-resistance test as specified in 4.6.9 and 4.6.12, respectively.
4		Terminal to terminal	1 to 2 and 3 together	200	5/1	175 percent rated dc voltage after temperature-and immersion-cycling and moisture-resistance test as specified in 4.6.9 and 4.6.12, respectively.
			2 to 3	200	5/1	
		Terminal to case	1,2, and 3 to case	400	3/4/1	For capacitors of dc voltage ratings of 600 volts and less.
			200+1,000	3/4/1	For capacitors of dc voltage ratings greater than 600 volts.	
5		Terminal to terminal	1,2, and 3 to case	200	5/1	175 percent rated dc voltage after temperature-and immersion-cycling and moisture-resistance test as specified in 4.6.9 and 4.6.12, respectively.
			1 and 2 to 3	200	5/1	
			1 to 2	200	5/1	
6		Terminal to terminal	1 and 2 to case	200	5/1	175 percent rated dc voltage after temperature-and immersion-cycling and moisture-resistance test as specified in 4.6.9 and 4.6.12, respectively.
			1 to 2	200	5/1	

^{1/} See MIL-C-25/1 for test-voltage variation.^{2/} For quality conformance inspection and at the option of the supplier, either 200 percent of rated dc voltage shall be applied for 15 seconds or 250 percent of rated dc voltage for not less than 1 second.^{3/} For quality conformance inspection, the period of test-voltage application shall be 1 second.^{4/} For quality conformance inspection, applications may be made between each terminal individually and the case, at the option of the supplier.^{5/} For quality conformance inspection, the application may be made for 1 second if the capacitor has passed group A inspection.

4.6.5 Dissipation factor (see 3.8). The dissipation factor of each capacitor shall be measured at a voltage not greater than 20 percent of the rated dc voltage. If the nominal capacitance does not exceed 1 microfarad, and if the rated dc voltage does not exceed 3,000 volts, measurement shall be made at a frequency of $1,000 \pm 100$ Hz. Measurements on capacitors not within these limits shall be made at a frequency of 60 ± 6 Hz.

4.6.6 Barometric pressure (flashover) (see 3.9). Capacitors shall be tested in accordance with method 105 of MIL-STD-202. The following details and exceptions shall apply:

- (a) Method of mounting - Capacitors shall be securely fastened by normal mounting means.
- (b) Test condition - Unless otherwise specified (see 3.1), B.
- (c) Tests during subjection to reduced pressure - Unless otherwise specified (see 3.1), a potential equal to 125 percent of rated dc voltage shall be applied for at least 1 minute between each terminal and every other terminal in turn, and between the case and each terminal not connected to the case. A suitable means shall be used to detect momentary or permanent breakdown.

4.6.7 Vibration (see 3.10).

4.6.7.1 Low frequency (grade 1 only). Capacitors and brackets, as applicable, shall be tested in accordance with method 201 of MIL-STD-202. The following details and exceptions shall apply:

- (a) Tests and measurements prior to vibration - Not applicable.
- (b) Method of mounting - Securely fastened by normal mounting means, except that capacitors without mounting brackets in sizes 1.562-inch long or 0.670-inch in diameter or larger shall be mounted by a supplemental means other than the wire leads. Wire lead capacitors shall be secured 0.500 ± 0.125 inch from the case.
- (c) Duration of vibration - 3 hours (60 minutes in each direction).
- (d) Tests and measurements during vibration - During the last 30 minutes of vibration in each direction, an electrical measurement (see 6.14), shall be made to determine intermittent contacts or open- or short-circuiting.
- (e) Examination after vibration - Capacitors shall be visually examined for evidence of mechanical damage.

4.6.7.2 High frequency (grade 3 only). 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. Wire lead capacitors shall be secured 0.500 ± 0.125 inch from the case.
- (b) Test condition - B.
- (c) Direction and duration 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.
- (d) Measurements - During the last cycle in each direction, an electrical measurement (see 6.14), shall be made to determine intermittent contacts or open- or short-circuiting.
- (e) Examination after vibration - Not applicable.

4.6.8 Salt spray (corrosion) (see 3.11). Capacitors and brackets shall be tested in accordance with method 101, test condition B of MIL-STD-202. After this test, capacitors and brackets shall be examined for evidence of corrosion, unwrapping of or mechanical damage to insulating sleeves, and obliteration of marking. Capacitors with painted cases shall be examined for flaking, peeling, or blistering of paint.

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4.6.9 Temperature and immersion cycling (see 3.12).

4.6.9.1 Temperature cycling. Capacitors and brackets shall be tested in accordance with method 102 of MIL-STD-202. The following details and exceptions shall apply:

- (a) Conditioning prior to first cycle - 15 minutes at room ambient temperature.
- (b) Test condition - D, except that in step 3, specimens shall be tested at the applicable high ambient test temperature (see table III).
- (c) Measurements before and after cycling - Not applicable.

4.6.9.2 Immersion cycling. Following temperature cycling, capacitors and brackets shall be tested in accordance with method 104 of MIL-STD-202. The following details and exceptions shall apply:

- (a) Test condition -C, except that the duration of each immersion shall be 30 minutes. Change from one solution to the other shall be made in not more than 3 seconds.
- (b) Measurements after final cycle - For capacitors with insulating sleeves, dielectric withstanding voltage and insulation resistance shall be measured as specified in 4.6.2 and 4.6.3 respectively. The potential shall be applied between the capacitor case and a piece of metal foil placed around the capacitor sleeve. The metal foil shall be of such dimension as to allow 0.125 ± 0.016 -inch insulating surface exposure on both ends. In addition, dielectric withstanding voltage and insulation resistance at 25° C of all capacitors shall be measured as specified in 4.6.2 and 4.6.3, respectively. Insulating sleeves shall be removed for the latter measurements.
- (c) Visual examination - After this test, capacitors and brackets shall be visually examined for corrosion and obliteration of marking.

4.6.10 Solderability (axial wire leads only) (see 3.13). 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) Special preparation of terminations - None; To be tested in an "as received" condition.
- (c) Depth of immersion in flux and solder - Both leads to be immersed to within 0.125 inch of the eyelet, seal or case.

4.6.11 Terminal strength (see 3.14). Capacitors shall be tested in accordance with method 211 of MIL-STD-202. The following details and conditions shall apply:

- (a) Axial wire lead terminals - Test conditions A and D (pull test and twist test, respectively).
 - (1) Pull, applied force, test condition A - As specified in table XVI, capacitor clamped by one lead and pull test load applied to the other lead (one pull only).
 - (2) Twist, test condition D - As specified in table XVI.
- (b) Terminals other than axial wire leads - Test conditions A and E (pull test and torque test, respectively).
 - (1) Pull, applied force, test condition A - As specified in table XVI.
 - (2) Torque, test condition E - As specified in table XVI.

TABLE XVI. Terminal strength.

Type of terminal	Thread size		Condition A (pull)	Condition D (twist) rotation	Condition E (torque) pound-inches
	min	max	pounds		
Axial wire - - - - -	---	---	4.5	3	---
Solder lug - - - - -	---	---	5	---	2
Threaded stud and nut - - - -	No. 10-32	No. 10-24	10	---	10
	No. 12-24	5/16-18	10	---	15
	3/8-16	1/2-13	10	---	20

4.6.12 Moisture resistance (see 3.15). Capacitors and brackets 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 as specified 4.6.7.1(b), except during measurement.
- (b) Initial measurements - Not applicable.
- (c) Polarization voltage - 100 volts 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) Loading voltage - Not applicable.
- (e) During step 7, capacitors shall be removed from the humidity chamber at the same time each day.
- (f) Final measurements - For capacitors with insulating sleeves, dielectric withstanding voltage and insulation resistance shall be measured as specified in 4.6.2 and 4.6.3, respectively; the potential shall be applied between the capacitor case and a piece of metal foil placed around the capacitor sleeve. The metal foil shall be of such dimension as to allow 0.125 ± 0.016 -inch insulating surface exposure on both ends. In addition, the dielectric withstanding voltage and insulation resistance at 25°C of all capacitors shall be measured as specified in 4.6.2 and 4.6.3, respectively. Insulating sleeve shall be removed for the latter measurements.
- (g) Visual examination - After this test, capacitors and brackets shall be visually examined for corrosion and obliteration of marking.

4.6.13 Seal (see 3.16 and 6.6).

4.6.13.1 Liquid-impregnated capacitors and solid-impregnated capacitors. Liquid- and solid-impregnated capacitors, while at room ambient temperature, shall be immersed for a minimum of 1 minute in oil or water maintained at a temperature within 5°C of either 90°C or the highest temperature for which a derated voltage rating is specified (see 3.1), whichever is lower. Characteristic K capacitors, while at room ambient temperature, shall be immersed in oil at 125°C for a minimum of 1 minute.

4.6.13.2 Liquid-filled capacitors. Liquid-filled capacitors shall be placed with the terminals facing sideways (not upward), and brought to a case temperature within 5°C of either 90°C or the highest ambient temperature for which a derated voltage rating is specified (see 3.1), whichever is lower. After 10 minutes at this case temperature, the capacitors shall be turned through 180° onto another surface with the terminals still sideways and kept in this position for 10 minutes with the case temperature maintained within the same limits. Capacitors which show liquid seepage shall be cleaned and cooled to room ambient temperature. While still at room ambient temperature, the capacitors shall be immersed, with terminals upward, for 1 minute in oil or water maintained at a temperature within 5°C of either 90°C or the highest ambient temperature for which a derated voltage rating is specified (see 3.1), whichever is lower.

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4.6.14 Low ambient temperature and capacitance change with temperature (see 3.17).

4.6.14.1 Low ambient temperature. Capacitors shall be placed in a chamber maintained at $-55^{\circ} \pm 3^{\circ}\text{C}$, and a rated dc voltage shall be applied at this condition for 48 ± 4 hours. The air within the conditioning chamber shall be circulated.

4.6.14.2 Capacitance change with temperature. At the conclusion of the test specified in 4.6.14.1, capacitance measurements shall be made as specified in 4.6.4, except that the measurement shall be made at $-55^{\circ} \pm 3^{\circ}\text{C}$, $25^{\circ} \pm 5^{\circ}\text{C}$, the applicable high-test temperature, and $25^{\circ} \pm 5^{\circ}\text{C}$. The -55°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. Initial 25°C measurement shall be used as the reference measurement to determine the percent of capacitance change at the low and high-test temperatures. Capacitors shall then be visually examined for evidence of breakdown, arcing, and other visible mechanical damage.

4.6.15 Life (see 3.18). Unless otherwise specified (see 3.1), capacitors shall be subjected to the life-test dc voltage specified in table III at the high ambient test temperature specified in table III for 250 ± 8 hours. During the test, capacitors shall be separated by a distance of not less than 1 inch. Adequate circulation of air shall be provided to prevent the temperature within 6 inches of any capacitance from departing more than $\pm 3^{\circ}\text{C}$ from the nominal ambient temperature of the chamber. Radiation shall not be used as a means of heating the chamber. The surge current shall be limited to between 5 milliamperes and 1 ampere. Where necessary, a suitable current-limiting resistor shall be inserted into the circuit. After the test, capacitors shall be returned to standard test conditions, and the insulation resistance and capacitance shall be measured as specified in 4.6.3 and 4.6.4, respectively.

4.6.16 Flashpoint of impregnant or filling compound (see 3.19). The flash-point of impregnant or filling compound shall be measured as specified in ASTM Publication D92-52, 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

5.1 Preparation. 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 type designation (see 1.2.1, 1.2.2, and 3.1).
- (c) Whether removable mounting brackets are to be supplied with the capacitors (see 3.1 and 4.4.2.2.).
- (d) Levels of preservation and packaging and packing, and applicable marking (see section 5).
- (e) Number of unit packs if other than that specified in section 5.
- (f) Class of fiber (see section 5).

6.1.1 Indirect shipments. The preservation, packaging, packing and marking requirements specified in section 5 herein apply only to direct purchases by or direct shipment to the Government and are not intended to apply to contracts or orders between the supplier and prime contractor.

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 suppliers is directed 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 Air Force - 11; however, information pertaining to qualification of products may be obtained from the Defense Electronics Supply Center (DESC-E), 1507 Wilmington Pike, Dayton, Ohio 45401.

6.3 Government verification inspection. Verification inspection by the Government shall be limited to the amount deemed necessary to determine compliance with the contract or order, and shall be limited in severity to the definitive quality assurance provisions established in this specification and the contract or order. The amount of verification inspection by the Government shall be adjusted to make maximum utilization of the suppliers quality control system and the quality history of the product.

6.4 Voltage derating with temperature. The applicable dc voltage-derating factor depends upon the characteristic and the energy content of the capacitor fully charged. Voltage-derating factors for various temperatures are determined from the curves shown. The permissible operating voltages, while based on incomplete data, are the capacitor supplier's best estimate to provide a life expectancy of 8,800 hours of continuous operation at high ambient-temperatures. Longer life can be expected of all types by operation at still lower voltages; for example, a life expectancy of approximately 44,000 hours may be obtained by operation at 70 percent of the voltage specified in 1.2.3. Also, a life longer than 8,800 hours may be expected at the voltage specified in 1.2.3, if the high ambient temperature prevails for only a portion of the total operating time (see 1.2.3 and 3.1).

6.4.1 DC capacitors. The energy content of a dc capacitor when fully charged is determined by use of the following formula:

$$W = \frac{CV^2}{2}$$

Where: W = energy content in watt-seconds.

C = nominal capacitance in farads.

V = rated dc voltage in volts at 40° C.

When the characteristic and watt-second group have been determined $\frac{1}{2}$, the voltage-derating factors for the applicable temperatures are as specified (see 1.2.3 and 3.1).

$\frac{1}{2}$ Watt-second grouping:

Group I:

Group IA: 0 to 0.08 watt-second.

Group IB: 0.08 to 0.5 watt-second.

Group II: 0.5 watt-second to 5 watt-seconds.

Group III: 5 to 50 watt-seconds.

Group IV: 50 watt-seconds and greater.

6.5 DC voltage. A dc voltage is a unidirectional voltage in which the changes in value are either zero or so small that they may be neglected (see 1.2.1.5).

6.6 Black (ultra-violet) light. Black (ultra-violet) light shall not be used during the seal test (see 4.6.14).

6.7 Liquid-filled capacitor. 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 the expansion of the liquid under temperature variations (see 3.3.1).

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6.8 Liquid-impregnated capacitor. A liquid impregnated capacitor is a capacitor in which the impregnant is dominantly contained within the foil-and-paper winding, but does not occupy substantially all of the case volume not required by the capacitor element and its connections (see 3.3.1).

6.9 Noninductive construction. Noninductive construction means a construction which reduces, but usually does not eliminate completely, the effective inductance of the capacitor. This result is obtained by so routing the currents in the electrodes that the magnetic fields tend to cancel each other, or by making the current paths very short (see 3.4.2.1).

6.10 Magnetic-case capacitor. A magnetic-case capacitor is a capacitor in which some part of the case or bracket is made of magnetizable material.

6.11 Non-magnetic-case capacitor. A non-magnetic-case capacitor is a capacitor in which no part of the case or bracket is made of magnetizable material; however, the end-seal may be made of a material having a ferrous-metal content in order to effect a glass-to-metal seal.

6.12 Dielectric withstanding voltage (terminal to case) for tubular capacitors covered by MIL-C-25/1. Tubular capacitors of characteristic K are designed with thinner insulation between roll and case than other styles covered by this general specification. The dielectric withstanding voltage (terminal to case) is, therefore, less for these styles (see 4.6.2).

6.13 Solder coating. Coating of solder lugs and wire leads should be such that lugs and wire leads can withstand extended storage without deterioration of soldering qualities.

6.14 Vibration (final measurement). During the last 30 minutes of vibration in each direction, an electrical signal of ± 0.2 kHz at a level of 1 ± 0.5 volts shall be placed across the capacitor and measured with a suitable alternating-current recording device for the purpose of determining the presence of open circuits, short circuits, or intermittent contacts.

6.15 Standard capacitor types. Equipment designers should refer to MIL-STD-198 "Capacitors, Selection and Use of" for standard capacitor types and selected values chosen from this specification. MIL-STD-198 provides a selection of standard capacitors for new equipment design.

6.16 Superseded styles. Styles CP63 and CP65, formerly covered by this specification have been superseded by CP91 capacitors and CP091 brackets.

Custodians:
Army - EL
Navy - EC
Air Force - 11

Preparing activity:
Air Force - 11

(Project 5910-0824)

Review activities:
Army - EL, MI, MU
Navy - EC, AS, OS
Air Force - 11, 17, 85
DSA - ES

User activities:
Army -
Navy - MC
Air Force - 19

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 and brackets covered by this specification. The procedure for extending qualification of the required sample to other capacitors and brackets covered by this specification is also outlined herein.

20. SUBMISSION

20.1 Sample.

20.1.1 Single-type-capacitor submission. A sample consisting of 27 specimens (except for types covered by MIL-C-25/1, which will be 33 specimens) of each type for which qualification is sought shall be submitted (see 30.1).

20.1.2 Single-type-bracket submissions. A sample consisting of 26 specimens of each type for which qualification is sought shall be submitted (see 30.2).

20.1.3 Combined capacitor submission (see 30.3). A maximum of two types of capacitors, 14 specimens (except for types covered by MIL-C-25/1, which will be 17 specimens) of each type within a style group, may be represented in a combined submission. Styles are grouped as specified in table XVII. Both types shall have the same impregnant or filling compound. In view of the relatively few specimens of each type, design, etc., represented, a combined submission will be treated similarly to a single-type submission, and the failure of one type, design, etc., will disqualify the entire submission. However, when two or more combined submissions of the same capacitor type have been made, and these combined submissions were disqualified in each instance because of failures of the same capacitor type, the results of the tests on the other types may be combined and treated as a single-type submission, provided that:

- (a) The combined-test results show compliance with specification requirements and the correct number of specimens were tested.
- (b) The capacitors are of the identical types or of the same type except for characteristic (the same impregnant or filling compound shall be used for both characteristics), and that no design changes were made in the interval between the two submissions.
- (c) Qualification is considered only for the less stringent characteristic when capacitors were tested in accordance with the requirements for two different characteristics.
- (d) The combined results are from tests conducted within 6 months of each other.

TABLE XVII. Style groups.

Style group	Styles
A - - - -	CP04, CP05, CP08, CP09, CP10, CP11, CP12, CP13
B - - - -	CP25, CP26, CP27, CP28, CP29
C - - - -	CP40, CP41
D - - - -	CP53, CP54, CP55
E - - - -	CP67, CP69, CP91
F - - - -	CP70, CP72
G - - - -	CP75, CP76, CP77, CP78
H - - - -	CP80, CP81, CP82

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20.1.3.1 Watt-second groups. Two adjacent watt-second groups may be represented. The maximum watt-second rating in the highest voltage shall be submitted in each watt-second group for which qualification is sought. For determination of the watt-second group into which any capacitor falls, the watt-second rating shall be computed on the basis of nominal capacitance and voltage values.

20.1.3.2 Insulated and uninsulated types. Both insulated and uninsulated types in any applicable style group may be represented.

20.1.3.3 Mounting. Two methods of mounting (brackets or leads, or both) may be represented.

20.1.3.4 Terminals. Two types of terminals may be represented.

20.1.3.5 Design and construction. Two designs or constructions may be represented.

20.1.3.6 Combined characteristics. When qualification is sought for the same impregnant or filling compound used for two characteristics, both characteristics may be represented in a submission; however, the characteristic to be tested shall be as specified in table XVIII.

TABLE XVIII. Combined characteristics.

Characteristics represented	Characteristics to be tested
K and E - - - -	K
E and F - - - -	E

20.1.4 Combined-type-bracket submission. A maximum of two types of brackets, 13 specimens of each type, of the same bracket designator and case-size designation may be represented in a combined submission. The submission may comprise either two designs or two constructions (see 30.4)

20.1.4.1 CP07 and CP072 bracket submissions. If overall qualification for CP07 or CP072 brackets is sought, the brackets submitted, in any one design and construction, shall be of the same case-size designation as those covered for overall qualification of style CP70 and CP72 capacitor. If overall qualification for more than one design or construction is sought, the submission shall be in accordance with 20.1.4 (see 30.4.1).

20.1.5 Impregnant or filling compound. A minimum of 200 cubic centimeters of each impregnant or filling compound used in the capacitors, or a certification of the flashpoint of impregnant or filling compound measured in accordance with 4.6.4 shall be submitted (see 30.5).

20.1.6 Alternate terminals. When qualification for a specific type of capacitor has been granted in accordance with 30.1 and qualification is sought for an alternate terminal design, 14 capacitors of the same type with the alternate terminal design for which qualification is sought may be submitted (see 30.6).

20.1.7 Alternate insulating-sleeve material. When qualification is sought for an alternate material to be used as the insulating sleeve for capacitor styles CP05, CP09, CP26, and CP28, 14 capacitors of two qualified types in these styles, in the highest characteristic and of the highest capacitance value and voltage rating, with the alternate insulating sleeve for which qualification is sought, may be submitted (see 30.7).

20.1.8 Alternate case material. When qualification for specific types of capacitors has been granted and qualification is sought for an alternate case material, 14 capacitors of the same type within the combined-style group utilizing the alternate case material may be submitted (see 30.8). For the purpose of establishing qualification of alternate case material, capacitors within certain style groups (see 20.1.3), may be considered jointly, as follows:

- (a) Style groups A and B.
- (b) Style groups C, D, and E.
- (c) Style groups F, G, and H.

Where qualification has been established for capacitors enclosed in nonferrous case material, qualification may be granted for ferrous case material, providing certification is furnished for the following:

- (a) The material and applied finish of the ferrous cases shall be the same as those previously approved for some other capacitor style.
- (b) The design and construction of the ferrous cases shall be the same as that of the approved nonferrous case of the same capacitor styles.
- (c) No change shall be made in the basic design of the capacitors other than the case material.

20.1.9 Alternate applied finish. When qualification for specific types of capacitors has been granted in accordance with 30.1 and qualification is sought for an alternate applied finish, 14 capacitors of the same type utilizing the alternate finish may be submitted (see 30.9).

20.1.10 Combined alternate case material and applied finish. When qualification is sought for an alternate case material utilizing an applied finish for which qualification has been granted, and, concurrent with this, when qualification is sought for an alternate finish applied to a case material for which qualification has been granted, 7 capacitors of each construction but the same capacitor style may be submitted (see 30.10).

20.2 Test data. When specifically requested, each submission shall be accompanied by test data covering the nondestructive tests specified in table IX which have been performed on the submitted specimens. All test data shall be submitted in duplicate.

20.3 Description of items. The supplier 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 and foil; material, thickness and applied finish of the case; and details of the terminal assemblies.

30. EXTENT OF QUALIFICATION

30.1 Single-type-capacitor submission. Each single-type-capacitor submission shall confer eligibility for qualification for the combination of style, terminal, circuit, and characteristic represented, except as specified below. The voltage-rating qualification shall be restricted to those ratings equal to and less than the rating represented in the submission in the watt-second group represented. The watt-second-rating range of qualification shall be in accordance with table XIX, except that when specified (see 3.1), watt-second group I is limited to capacitors having dc voltage ratings of 1,000 volts or less, and watt-second group II includes capacitors having a watt-second rating of 0 to 0.5 which are not included in watt-second group I.

- (a) Capacitors with nonremovable brackets may also represent capacitors without brackets which are otherwise identical.
- (b) Terminal C may also represent terminal B, provided the two terminals are similar in design, except for the modification necessary to make the lug nonremovable on the latter terminal.
- (c) A circuit may also represent other circuits, as listed below:

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Circuit tested	Circuits also represented
1 - - - - -	2, 3
3 - - - - -	2
4 - - - - -	1, 2, 6
5 - - - - -	1, 2, 4, 6
6 - - - - -	1, 2

- (d) Any capacitance tolerance may also represent all other available capacitance tolerances.
- (e) Any one of styles CP53, CP54, or CP55 may also represent the other two of these styles.
- (f) Style CP69 may also represent styles ^PCP67 and ^PCP91 if the thickness dimension of style CP91 corresponds with the thickness dimension of style CP69 submitted.
- (g) Any one of styles CP75, CP76, CP77, or CP~~67~~⁷⁷ may also represent the other three of these styles.
- (h) Any one of styles CP80, CP81, or CP82 may also represent the other two of these styles.
- (i) The specimens to which qualification is extended shall be of the same basic design and shall utilize the same materials, finish, impregnant or filling compound as the qualified specimens.
- (j) Insulated styles may represent other insulated styles within the same style group (see table XVII).
- (k) Watt-second group IB may represent watt-second group IA, except that for capacitor styles CP04, CP05, CP09, CP10, CP11, CP12, and CP13, capacitors of watt-second group IB rated at greater than 400 volts may not represent capacitors of watt-second group IA rated at 400 volts or less. The watt-second-range of qualification shall be in accordance with table XIX.
- (l) For style group E (see table XVII), 1,000-volt specimens of the highest watt-second rating may represent 1,500-volt specimens of lower watt-second ratings; however, the submission of 1,500 volt specimens is preferred.
- (m) For style group D (see table XVII), capacitor type CP55B5-G254-1 may represent all types; however, submission in accordance with the other provisions of this procedure is preferred.

TABLE XIX. Watt-second range of qualification.

Watt-second group of the submission	Range of qualification
I 0 to 0.5 watt-seconds -	All watt-second ratings up to 120 percent of that of the submission.
II 0.5 to 5 watt-seconds -	All watt-second ratings up to 120 percent of that of that of the submission but ≥ 0.40 watt-second.
III 5 to 50 watt-seconds - -	All watt-second ratings up to 120 percent of that of the submission but ≥ 4.0 watt-seconds.
IV 50 watt-seconds and greater - - - - -	All watt-second ratings up to 120 percent of that of the submission but ≥ 40 watt-seconds.

30.2 Single-type bracket submission. Each single-type-bracket submission shall confer eligibility for qualification of the combinations of bracket designator, design, and case size represented in the submission with the following provisions:

- (a) Any one case-size designation may also represent smaller case-size designations except that a maximum of 14 case-size designations smaller than the submission may be qualified.
- (b) The brackets to which qualification is extended shall be of the same basic design and shall utilize the same materials and finish as the brackets which comprise the submission.

30.3 Combined capacitor submission. Each combined capacitor submission shall confer eligibility for qualification of the combinations of style, terminal, circuit, and characteristics represented. The voltage-rating qualification shall be restricted to those ratings equal to and less than those represented in each watt-second group of the submission. The watt-second-rating range of qualification for each watt-second group represented in the combined submission shall be in accordance with table XIX, except that when specified (see 3.1), watt-second group I is limited to capacitors having dc voltage rating of 1,000 volts or less, and watt-second group II includes capacitors having a watt-second rating of 0 to 0.5 which are not included in watt-second group I. The provisions applying in the single-type submission (see 30.1), shall also apply to the combined-type submission.

30.4 Combined-type bracket submission. Each combined-type-bracket submission shall confer eligibility for qualification of the combinations of bracket designator, and design or construction, or both, represented in the submission subject to the same provisions specified in 30.2.

30.4.1 CP07 and CP072 bracket submission. Notwithstanding the limitation imposed by 30.2(a), bracket submissions as specified in 20.1.4.1 shall confer eligibility for qualification of all case-size designations and constructions of the submissions in the design or designs submitted.

30.5 Impregnant or filling compound. The qualification of a flashpoint of the impregnant or filling compound with any submission may be extended to permit the use of the same impregnant or filling compound with any other submission.

30.6 Alternate terminals. Each submission of capacitors employing an alternate terminal shall confer eligibility for qualification of the terminal submitted in accordance with the existing qualification of the style tested.

30.7 Alternate insulating sleeve material. Submission of any qualified type of styles CP05, CP09, CP26, or CP28 utilizing alternate insulating-sleeve material (see 20.1.7), shall confer eligibility for qualification of the insulating-sleeve material used on that style and any of the other styles limited to the specific types for which the supplier already has qualification.

30.8 Alternate case material. Submission of any qualified type of styles CP04, CP08, CP10, CP11, CP12, CP13, CP25, CP27 or CP29 utilizing alternate case material (see 20.1.8) shall confer eligibility for qualification of the case material used for all tubular styles, both insulated and uninsulated, for which the supplier already has qualification. Submission of any qualified type of styles CP40, CP41, CP53, CP54, CP55, CP67, CP69, or CP91 utilizing an alternate case material shall confer eligibility for qualification of the case material used on that style and other styles limited to the specific types for which the supplier already has qualification. Submission of any qualified type of styles CP70, CP72, CP75, CP76, CP77, CP78, CP80, CP81, or CP82 utilizing alternate case material shall confer eligibility for qualification of the case material used on that type of that style limited to the watt-second-rating range of qualification in accordance with table XIX and to the specific types for which the supplier already has qualification.

30.9 Alternate applied finish. Submission of any qualified type of uninsulated tubular capacitor utilizing an alternate applied finish (see 20.1.9) shall confer eligibility for qualification of that style and any other tubular styles, both insulated and uninsulated, limited to specific types for which the supplier already has qualification. Submission of any other qualified capacitors of cylindrical, bath-tub, or rectangular style utilizing an alternate applied finish shall confer eligibility for qualification

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of all other capacitors of these styles limited to the specific types for which the supplier already has qualification.

30.10 Combined alternate case material and applied finish. A combined submission of any qualified style of capacitor utilizing an alternate applied finish on a qualified case material, as well as an alternate case material with a qualified finish (see 20.1.10), shall confer eligibility for qualification of the materials and finishes in the same manner as if capacitors utilizing one or the other of the alternate constructions had been submitted separately.

30.11 Combined submissions. Example of combined capacitor submission and combined bracket submissions are specified in tables XX and XXI, respectively.

TABLE XX. Examples of combined capacitor submissions. ^{1/}

Styles	Types to be submitted	Number of capacitors to be submitted ^{2/}	Watt-second group	Watt-second rating	DC voltage rating
					Volts
CP04, CP05, CP10- - - -	CP05A1KE105K-	17	IA	0.08	400
	CP10A1KE105K-	17	IA	0.08	400
CP08, CP09, CP12- - - -	CP09A1KE474K-	17	IA	0.04	400
	CP12A1KE105K-	17	IA	0.08	400
CP11, CP13 - - - - -	CP11A1KE474K-	17	IA	0.04	400
	CP13A1KE105K-	17	IA	0.08	400
CP04, CP05, CP10- - - -	CP05A1KG474K-	17	IB	0.235	1,000
	CP10A1KG474K-	17	IB	0.235	1,000
CP08, CP09, CP12- - - -	CP09A1KG474K-	17	IB	0.235	1,000
	CP12A1KG474K-	17	IB	0.235	1,000
CP11, CP13 - - - - -	CP11A1KF684K-	17	IB	0.122	600
	CP13A1KF684K-	17	IB IA	0.122	600
CP25, CP26, CP27, - - -	CP28A1EG104K1	14	I	0.11	1,500
CP28, CP29	CP29A1EH104K1	14	I	0.11	1,500
CP40, CP41 - - - - -	CP40C2EG105K1	14	I	0.5	1,000
	CP41B1EH105K1	14	II	1.1	1,500
CP53, CP54, CP55- - - -	CP55B4EG504-1	14	I	0.5	1,000
	CP55B5EG254-1	14	I	0.38	1,000
CP67, CP69, CP91- - - -	CP69B5EG104-1	27	I	0.15	1,000
	CP69B6EG254-1	14	I	0.25	1,000
	CP91B6EH503-1	14	II	0.11	1,500
CP70 - - - - -	CP70B1EG105K1	14	I	0.5	1,000
	CP70E1EG105K1	14	I	0.5	1,000
	CP70E1ER105K1	14	II	2.84	1,500
	CP70E1EN405K1	14	III	50	5,000
	CP70D1ET205K1	14	IV	156	12,500
	CP70D1ET504K1	14	III	39	12,500
CP72 - - - - -	CP72B1EG105K1	14	I	0.5	1,000
	CP72D1ER105K1	14	II	2.84	1,500
	CP72E1EN205K1	14	III	25	5,000
	CP72E1FK126K1	14	III	38	2,500
CP75, CP76, CP77, - - -	CP76F1AF505-1	14	II	0.9	600
CP78	CP78F4AD754-1	14	I	0.047	250
	CP75F1AH103-1	14	II	0.01	1,500
	CP76F1AF255-1	14	I	0.45	600
CP80, CP81, CP82 - - -	CP80C1BG105L1	14	I	0.5	1,000
	CP82C1BH305L1	14	II	3.4	1,500

^{1/} This table is set up as a guide. For other combinations or characteristics, or both, reference is made to the specification sheet.

^{2/} The bracketed numerals indicate combinations which will provide the maximum extension of qualification, if submitted separately.

TABLE XXI. Examples of combined bracket submissions. ^{1/}

Bracket designators	Types to be submitted	Number of brackets to be submitted ^{2/}	
CP091 - - - - -	CP091FA6 ✓	{ 13	
	CP091SA6 ✓		
CP07 - - - - -	CP07FM2	{ 26	
	CP07SJ11		
	CP07FJ5	{ 13	
	CP07SJ5		
	CP07FE2	{ 13	
	CP07SE2		
	CP07FB2	{ 13	
	CP07SB2		
	CP072 - - - - -	CP072FB2	{ 13
		CP072SB2	
CP072FE2		{ 13	
CP072SE2			
CP072FJ5		{ 13	
CP072SJA//			

^{1/} This table is set up as a guide. For other combinations, reference is made to the specification sheet.

^{2/} The bracketed numerals indicate combinations which will provide the maximum extension of qualification, if submitted separately.

30.12 Qualification of grades. Qualification of grade 3 may be the basis of qualification of grade 1, provided that the design of the capacitors is the same.