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SUPERSEDING
MIL-C-11693B
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MILITARY SPECIFICATION

CAPACITORS, FEED THROUGH, RADIO-INTERFERENCE REDUCTION, AC AND DC (HERMETICALLY SEALED IN METAL CASES), ESTABLISHED AND NON-ESTABLISHED RELIABILITY GENERAL SPECIFICATION FOR

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

1. SCOPE

1.1 Scope. This specification covers the general requirements for established reliability (ER) and non-ER capacitors designed for operation with alternating current (ac) and direct current (dc), paper, metallized paper, and metallized plastic dielectric, radio-interference-reduction, feed-through capacitors, hermetically sealed in metal cases (see 6.6.1), for use primarily in broadband, radio-interference suppression application. Capacitors meeting the established reliability requirements specified herein have a maximum failure rate of 1%/1000 hours. This failure rate is established with a 90% confidence limit based on the life test parameters specified and are maintained at a 10-percent producer's risk. An acceleration factor of 5:1 has been used to relate the life test data obtained at 140 percent of rated voltage (ac or dc) at the applicable high test temperature to the rated voltage at the applicable high test temperature. Styles CZ20, CZ25, CZ32, and CZ33 contained herein, of which are of a metallized construction and should be used only in circuitry in which high values of insulation resistance are not essential, and in which occasional momentary breakdowns can be tolerated (see 6.6.2).

1.2 Classification.

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

CZR23	B	K	B	473	M
ER style	Current	Characteristic	Voltage	Capacitance	Failure rate level
1.2.1.1	1.2.1.2	1.2.1.3	1.2.1.4	1.2.1.5	1.2.1.6

CZ23	B	K	B	473
NON-ER style	Current	Characteristic	Voltage	Capacitance
1.2.1.1	1.2.1.2	1.2.1.3	1.2.1.4	1.2.1.5

1.2.1.1 Style. The style is identified by either the three-letter symbol "CZR" or the two-letter symbol "CZ" followed by a two-digit number. The letters identify ac and dc, radio-interference reduction feed through capacitors, hermetically sealed in metal cases. The symbol "CZR" identifies established reliability (ER) capacitors; the symbol "CZ" identifies capacitors for which no specific reliability requirements are specified (non-ER). The first digit following the letter symbols identifies the general shape of the case, and the second digit identifies specific details other than case size. Each style designation may include a family of case sizes.

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1.2.1.2 Current. The current rating is identified by a single letter in accordance with table I.

TABLE I. Current rating.

Symbol	Current rating in amperes (dc or ac-rms)
A	5
B	10
D	20
F	50
H	100
K	300

1.2.1.3 Characteristic. The characteristic is identified by a single letter in accordance with table II.

TABLE II. Characteristic.

	Values for characteristics			
	P	K	E	W
High ambient test temperature, degrees centigrade ±3°C	150	125	85	85
Low ambient test temperature, degrees centigrade ±3°C	-55	-55	-55	-55
Life-test voltage (see 4.7.24), in percent of rated ac or dc voltage rating	140	140	140	140
Capacitance tolerance (percent)	-10+30	±10	±10	±20
	≥0.25 μF			
	-10+50			
	<0.25 μF			

1.2.1.4 Voltage. The voltage rating is identified by a single letter in accordance with table III.

TABLE III. Voltage rating.

Symbol	Voltage rating	
	Volts, dc	Volts, ac 1/
B	100	---
C	200	---
E	400	---
F	600	---
J	1,200	---
U	---	250

1/ Rated frequency of operation for ac capacitors shall be as specified (see 3.1).

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1.2.1.5 Capacitance. The nominal capacitance value expressed in picofarad (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.

1.2.1.6 Failure rate level. The failure rate level of 1.0 percent per 1,000 hours is identified by a symbol M, and is based on operation at rated working voltage and maximum rated temperature.

2. APPLICABLE DOCUMENTS

2.1 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.
MIL-C-45662 - Calibration System Requirements.

(See supplement 1 for list of applicable 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-220 - Method of Insertion-Loss Measurement.
MIL-STD-690 - Failure Rate Sampling Plans and Procedures.
MIL-STD-790 - Reliability Assurance Program for Electronic Parts Specifications.
MIL-STD-1285 - Marking Requirements for Electrical and Electronic Parts.
MS35333 - Washer, Lock, Flat Internal.
MS35335 - Washer, Lock External Tooth.

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

2.2 Other publications. The following 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.)

AMERICAL SOCIETY FOR TESTING MATERIALS

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

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

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3. REQUIREMENTS

3.1 Specification sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheets (see 6.1).

3.2 Qualification. Capacitors furnished under this specification shall be a product which has been tested and has passed the qualification tests specified in 4.4, and has been listed on or approved for listing on the applicable qualified products list (see 6.2).

3.3 Reliability (applicable to ER capacitors only). Reliability of ER capacitors furnished under this specification shall be established and maintained in accordance with the procedures and requirements specified in MIL-STD-790, and with details specified in 4.1.2 and 4.4.4.

3.4 Material. The material for each part 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 Impregnating and filling compounds. Compounds used in the impregnation and filling of capacitors shall be chemically inactive with respect to the capacitor element and the case (see 3.5.1). The compound 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.

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 hermetically sealed metal case which will prevent leakage of the impregnant or filling compound, and will protect the capacitor element from moisture and mechanical damage under all test conditions specified herein.

3.5.2 Finish. All exposed metal surfaces shall be suitably protected against corrosion by plating, or other means (see 3.22). The resultant finish shall form a good electrical conductor and shall be free from defects that may affect its protective value.

3.5.3 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. Aluminum nuts shall not be used.

3.5.3.1 Engagement of threaded parts. All threaded parts shall engage by at least two full threads.

3.6 Flashpoint of impregnant or filling compound. When measured as specified in 4.7.2, the flashpoint of the impregnant or filling compound shall be not lower than 200° C for characteristic P, 145° C for characteristic K, and 135° C for characteristics E and W.

3.7 Seal. When capacitors are tested as specified in 4.7.3, there shall be no evidence of leakage.

3.8 Terminal strength. When capacitors are tested as specified in 4.7.4, no part of the terminal shall loosen or rupture, and there shall be no other damage. Stud-type terminals shall exhibit no perceptible movement relative to the case, under the applied torque.

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3.9 Temperature rise (applicable only to film-dielectric capacitors). When capacitors are tested as specified in 4.7.5, the temperature rise shall not exceed the value specified (see 3.1).

3.10 Dielectric withstanding voltage. When capacitors are tested as specified in 4.7.6, there shall be no visible damage, flashover, breakdown or open- or short-circuiting (see 6.6.2).

3.11 Insulation resistance. When measured as specified in 4.7.7, the insulation resistance for characteristic-P capacitors shall be not less than the applicable value specified (see 3.1); for characteristic-K, -E, and -W, the insulation resistance (megohms) or megohm-microfarads shall be not less than the applicable value specified in table IV and shown on figure 1. For measurements made at temperatures between 20° and 35° C, the applicable correction factor specified in table V shall be applied (see 6.6.2).

TABLE IV. Insulation resistance measurements.

Capacitance rating	Minimum insulation resistance
Characteristic K	At 25° C
0 to 0.33 microfarads	18,000 megohms
Greater than 0.33 microfarads	6,000 megohm-microfarads 1/
	At 125° C
0 to 0.067 microfarads	150 megohms
Greater than 0.067 microfarads	10 megohm-microfarads 1/
Characteristic E	At 25° C
0 to 0.33 microfarads	6,000 megohms
Greater than 0.33 microfarads	2,000 megohm-microfarads 1/
	At 85° C
0 to 0.033 microfarads	600 megohms
Greater than 0.033 microfarads	20 megohm-microfarads 1/
Characteristic W	At 25° C
0 to 0.33 microfarads	1,500 megohms
Greater than 0.33 microfarads	500 megohm-microfarads 1/
	At 85° C
0 to 0.033 microfarads	150 megohms
Greater than 0.033 microfarads	5 megohm-microfarads 1/

1/ Product obtained by multiplying the capacitance in microfarads (μF) by the insulation resistance.

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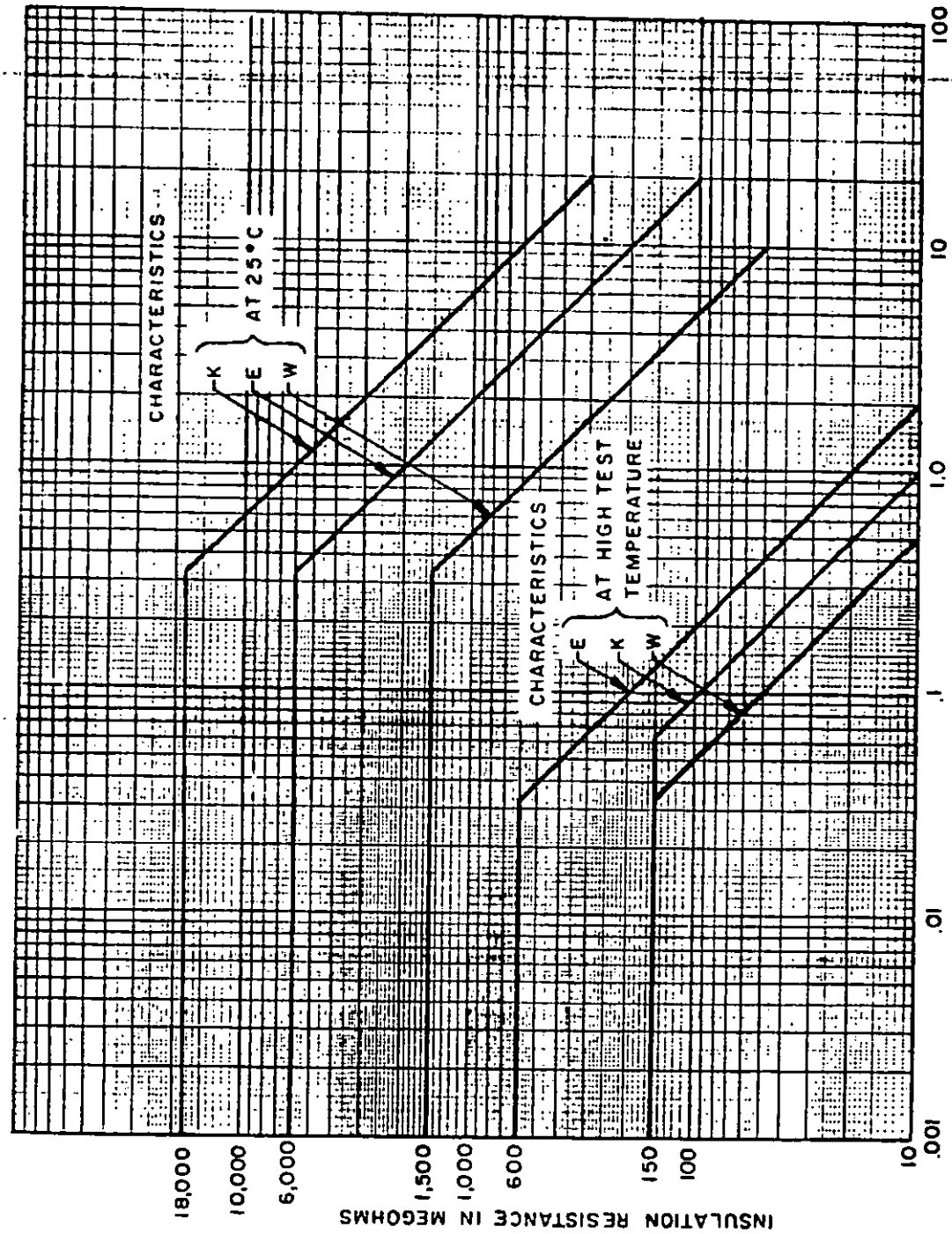

FIGURE 1. Insulation-resistance curve for characteristics -K, -E, and -W.

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TABLE V. Insulation-resistance correction factors.

Degrees centigrade	Correction factor 1/	Degrees centigrade	Correction factor 1/
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

1/ These correction factors are to be applied to the required values, not to the measured values.

3.12 Voltage drop (applicable only to film-dielectric capacitors). When capacitors are tested as specified in 4.7.8, the voltage drop shall not exceed the value specified (see 3.1).

3.13 Capacitance.

3.13.1 Characteristic P. When measured as specified in 4.7.9, the capacitance of characteristic-P capacitors shall be not less than 90 percent nor greater than 120 percent of the specified nominal value, for capacitors rated at 0.25 μF and greater; for capacitors rated at less than 0.25 μF, the capacitance shall be not less than 90 percent nor greater than 150 percent of the specific nominal value (see 3.1).

3.13.2 Characteristics K and E. When measured as specified in 4.7.9, the capacitance of characteristic-K and -E capacitors shall be not less than 90 percent nor greater than 110 percent of the specified nominal value (see 3.1).

3.13.3 Characteristic W. When measured as specified in 4.7.9, the capacitance of characteristic-W capacitors shall be not less than 80 percent nor greater than 120 percent of the specified nominal value (see 3.1).

3.14 Dissipation factor. When measured as specified in 4.7.10, the dissipation factor shall be not more than 1.0 percent.

3.15 Insertion loss. When measured as specified in 4.7.11 or 4.7.11.1, the insertion loss shall be not more than 6 decibels (dB). Dips below the value shown on figure 2 (unless otherwise specified (see 3.1)) for an ideal capacitor of the same nominal capacitance value are permissible when tested at frequencies from 0.15 megahertz (MHz) up to that frequency at which the insertion loss of the capacitor under test becomes 60 dB; however, at higher frequencies up to 1,000 MHz the insertion loss shall not fall below 60 dB. Deviations in the nature of dips in the curve will be permitted. Such dips indicate a drop in insertion loss below that of an ideal capacitor followed by a rise in insertion loss, as frequency is increased faster than the rise that is characteristic of an ideal capacitor. Such dips are also characteristic of all extended-foil capacitors.

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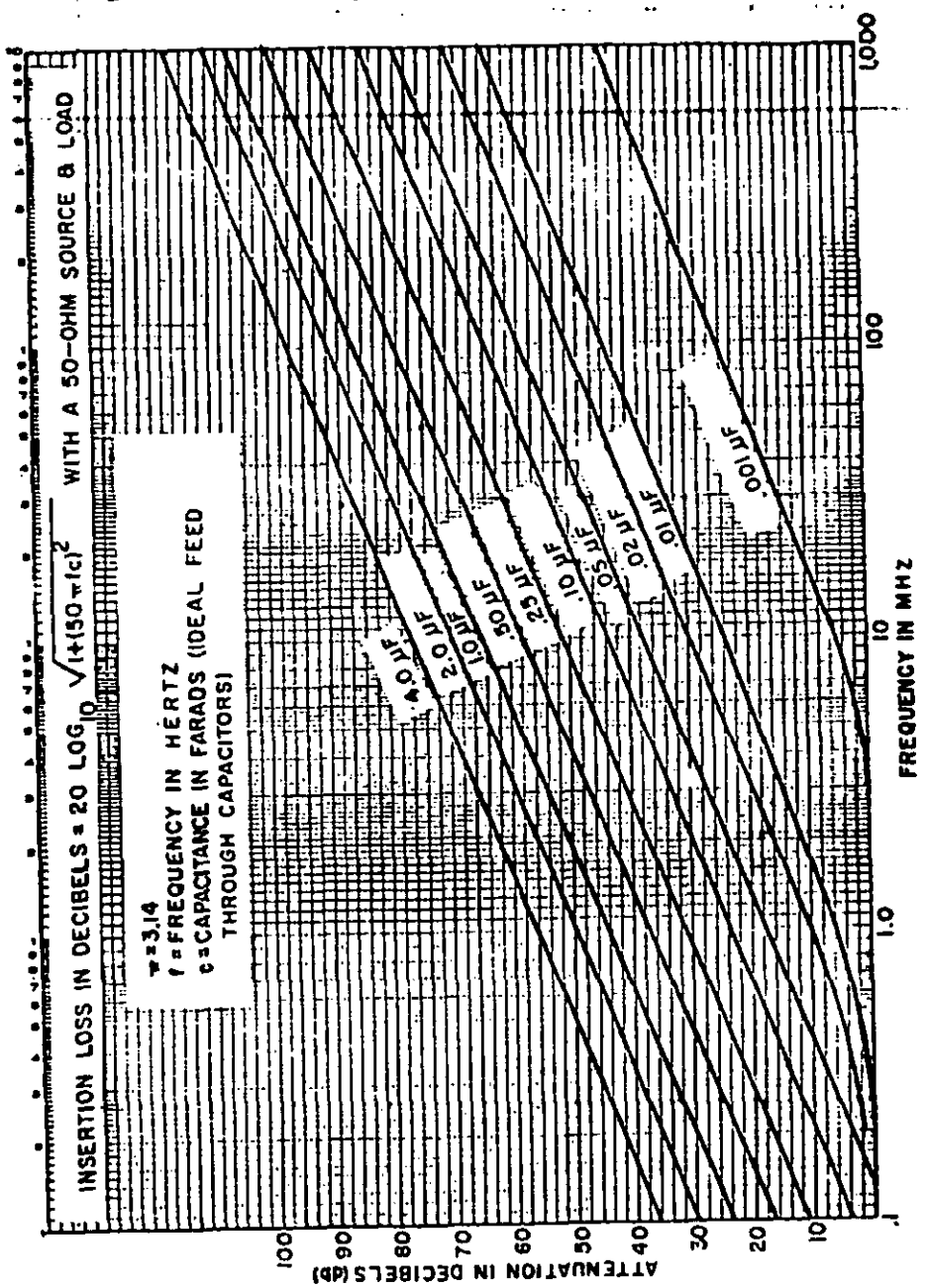

FIGURE 2. Insertion-loss versus frequency for an ideal capacitor.

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3.16 Overload (applicable only to film-dielectric capacitors). When capacitors are tested as specified in 4.7.12, the insulation resistance at 25° C and the voltage drop shall be as specified in 3.11 and 3.12, respectively, and there shall be no physical damage to the capacitors.

3.17 DC resistance. When measured as specified in 4.7.13, the dc resistance shall not exceed the value specified (see 3.1).

3.18 Resistance to soldering heat (solderable terminals only). When capacitors are tested as specified in 4.7.14, there shall be no damage to the capacitors or the terminal insulators which will cause electrical failure of the capacitors, or which will cause hermetically sealed capacitors to leak. Chipping of terminal insulators alone shall not be cause for failure unless the chipping extends to the outer periphery.

3.19 Shock (specified pulse). When capacitors are tested as specified in 4.7.15, there shall be no intermittent contacts of 0.5 millisecond (ms) or greater duration, open or short-circuiting and no mechanical damage to the capacitors. After completion of the shock test, the units shall be subjected to the abbreviated insertion loss test (see 4.7.11.1). The change at any frequency shall be not more than 3 dB from the initial value obtained when measured as specified (see 3.1), except for those frequencies at which the initial value is 60 dB or greater, which may exceed 3 dB provided the insertion loss does not drop below 60 dB.

3.20 Vibration, low frequency. When capacitors are tested as specified in 4.7.16, there shall be no intermittent contacts of 0.5 ms or greater duration, open or short-circuiting, and no mechanical damage to the capacitors.

3.21 Vibration, high frequency. When capacitors are tested as specified in 4.7.17 there shall be no intermittent contacts of 0.5 ms or greater duration, open or short-circuiting and no mechanical damage to the capacitors.

3.22 Salt spray (corrosion). When capacitors are tested as specified in 4.7.18, there shall be no harmful or extensive corrosion and at least 90 percent of any exposed metallic surfaces of the capacitor shall be protected by the finish. In addition, there shall be not more than 10-percent corrosion of the terminal hardware or mounting surface. Marking shall remain legible after the test.

3.23 Temperature cycling and immersion. When tested as specified in 4.7.19, capacitors shall meet the following requirements:

Dielectric withstanding voltage	As specified in 3.10.
Insulation resistance (at 25° C)	Not less than the value specified (see 3.1).
Capacitance	Change not more than the value specified (see 3.1) from the initial value obtained when measured as specified in 4.7.9.
Dissipation factor	Shall not exceed 1.5 percent.
Insertion loss (abbreviated)	Change at any frequency not more than 3 dB from the initial value obtained when measured as specified in 4.7.11.1 except that for those frequencies at which the initial value is 60 dB or greater, the change may exceed 3 dB provided the insertion loss does not drop below 60 dB.
Visual examination	There shall be no harmful or extensive corrosion and at least 90 percent of any exposed metal surfaces of the capacitor shall be protected by the finish. In addition, there shall be not more than 10-percent corrosion of the terminal hardware or mounting surface. Marking shall remain legible after the test.

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3.24 Solderability (wire leads only). When capacitors are tested as specified in 4.7.20, the dipped surface of the capacitor leads shall be at least 95 percent covered with a new continuous solder coating, free from pinholes or voids. The remaining 5 percent of the lead surface shall show only small pinholes or voids. These shall not be concentrated in one area. Bare base material and areas where the solder dip failed to cover the original coating are indications of poor solderability and shall be cause for failure. In case of dispute, the percentage covered by pinholes or voids shall be determined by actual measurement of those areas, as compared to the total area.

3.25 Resistance to solvents. When capacitors are tested as specified in 4.7.21, there shall be no evidence of mechanical damage, and the marking shall remain legible.

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

Dielectric withstanding voltage	As specified in 3.10.
Insulation resistance (at 25° C)	Not less than the value specified (see 3.1).
Capacitance	Change not more than the value specified (see 3.1) from the initial value obtained when measured as specified in 4.7.9.
Dissipation factor	Shall not exceed 1.5 percent.
Visual examination	There shall be no harmful or extensive corrosion and at least 90 percent of any exposed metal surfaces of the capacitor shall be protected by the finish. In addition, there shall be not more than 10-percent corrosion of the terminal hardware or mounting surface. Marking shall remain legible after the test.

3.27 Low temperature and capacitance change at reduced temperature. When capacitors are tested as specified in 4.7.23, there shall be no evidence of breakdown, flashover, or fracture, with the exception that, momentary breakdowns (see 6.6.2), can be tolerated in capacitors with metalized construction (see 1.1). The capacitance change at -55° ±3°C shall not exceed 15 percent of the value measured at 25°C.

3.28 Life. When tested as specified in 4.7.24, capacitors shall meet the following requirements:

Insulation resistance (at 25° C)	Not less than the value specified (see 3.1).
Capacitance	Change not more than the value specified (see 3.1) from the initial value obtained when measured as specified in 4.7.9.
Dissipation factor	Shall not exceed 1.5 percent.
Insertion loss (abbreviated)	Unless otherwise specified (see 3.1), change at any frequency not more than 3 dB from the initial value obtained when measured as specified in 4.7.11.1, except that for those frequencies at which the initial value is 60 dB or greater, the change may exceed 3 dB provided the insertion loss does not drop below 60 dB.

There shall be no mechanical failure or leakage of impregnant or filling compound.

3.29 Marking. Capacitors shall be marked with the type designation (Jan brand when applicable (see 3.29.2) trade mark [TM] and/or source code, date code, voltage and current ratings. The marking shall be placed on the exposed cylindrical surface of the case and shall remain legible after all environmental tests. Other markings which in any way interfere with, obscure, or confuse those specified herein are prohibited. There shall be no space between the symbols which comprise the type designation. If space limitation requires it, the type designation may appear on two lines. In this event, the type designation shall be divided between the current symbol and the characteristic symbol as shown in the following examples:

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CZ28B		CZR23B	
KB473		KB473M	
JAN TM		JAN TM	
12345		12345	Source code
7011	or	7011	Date code
100 Volt		100 Volt	
20 Amps		20 Amps	

NOTE: The trade mark may appear anyplace on the capacitor. Successful qualification is a prerequisite for "JAN" branding.

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

3.29.2 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 detail specifications shall bear the certification mark "JAN", except that capacitors too small to bear the certification mark "JAN" shall bear the letter "J". Capacitors furnished under contracts or orders which either permit or require deviation from the conditions or requirements specified herein and in applicable detail specifications shall not bear "JAN" or "J". In the event a capacitor sample fails to meet the requirements of this specification and the applicable detail specifications, 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".

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

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

3.30.1.1 Terminal. Solder lugs and solder lug terminals may be of any shape provided dimensional limits are met. All terminals shall be coated with solder having a tin content of 40 to 70 percent.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Test equipment and inspection facilities. Test and measuring equipment and inspection facilities of sufficient accuracy, quality and quantity to permit performance of the required inspection shall be established and maintained by the supplier. The establishment and maintenance of a calibration system to control the accuracy of the measuring and test equipment shall be in accordance with MIL-C-45662.

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4.1.2 Reliability assurance program (applicable to ER parts only). 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) 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.

4.4 Qualification inspection. 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 VI and the appendix to this specification.

4.4.2 Test routine. The specimens will be subjected to the qualification inspection specified in table VI in the order shown. Two specimens in a sample will be subjected to visual and mechanical examination (internal). The remaining specimens will be subjected to the subsequent examinations and tests in group 1. The specimens will then be divided into the remaining groups specified in table VI, and subjected to the tests for their particular group.

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

4.4.4 FR qualification (applicable to ER parts only). FR qualification shall be in accordance with table VI.

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TABLE VI. Qualification inspection.

Examination or test	Requirement paragraph	Method paragraph	NON-ER Number of specimens to be inspected	NON-ER Number of defectives allowed 1/	ER Number of specimens to be inspected	ER Number of defectives allowed
Group I						
Flashpoint of impregnant or filling compound	3.6	4.7.2	---			
Visual and mechanical examination (internal):	---	4.7.1				
Material, design, construction, and workmanship	3.1, 3.4 to 3.5.3.1 incl. 3.30 to 3.30.1.1, incl.	---	2	0	2	0
Visual and mechanical examination (external):	---	4.7.1				
Physical dimensions, marking, 2/ and workmanship	3.1, 3.5, and 3.29 to 3.30.1.1, incl.	---				
Seal	3.7	4.7.3				
Terminal strength	3.8	4.7.4				
Temperature rise (applicable only to film-dielectric capacitors)	3.9	4.7.5				
Dielectric withstanding voltage	3.10	4.7.6				
Insulation resistance	3.11	4.7.7	33 3/	1	61 3/	1
Voltage drop (applicable only to film-dielectric capacitors)	3.12	4.7.8				
Capacitance	3.13	4.7.9				
Dissipation factor	3.14	4.7.10				
Insertion loss	3.15	4.7.11				
Overload (applicable only to film-dielectric capacitors)	3.16	4.7.12				
DC resistance	3.17	4.7.13				
Group II						
Resistance to soldering heat (solderable terminals only)	3.18	4.7.14	6		6	
Salt spray (corrosion)	3.22	4.7.18				
Temperature cycling and immersion	3.23	4.7.19				
Group III				1		1
Shock (specified pulse)	3.19	4.7.15				
Vibration, low frequency	3.20	4.7.16	6	1	6	1
Vibration, high frequency	3.21	4.7.17				
Moisture resistance	3.26	4.7.22				
Group IV						
Solderability	3.24	4.7.20	4	1	4	1
Resistance to solvents	3.25	4.7.21	4		4	
Group V						
Low temperature and capacitance change at reduced temperature	3.27	4.7.23	12	1	40	1
Life (accelerated) 4/	3.28	4.7.24				

1/ A specimen having one or more defects will be considered as a single defective.
2/ Marking will be considered as a defect only if it becomes illegible as a result of any of the tests of the specification.
3/ One additional specimen is included in each sample of 31 or 59 specimens as applicable to permit substitution for the allowable defective in group I.
4/ The decision as to whether or not the NON-ER product is to be included on the qualified products list shall be made at the end of the 240-hour life test and at the conclusion of the 2,000-hour life test for the ER parts.

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4.5 Retention of qualification. To retain qualification, the supplier shall forward a report at 6-month intervals to the qualifying activity. The qualifying activity shall establish the initial reporting date. The report shall consist of:

(a) A summary of the results of the tests performed for inspection of product for delivery (group A), indicating as a minimum the number of lots that have passed and the number that have failed. The results of tests of all reworked lots shall be identified and accounted for.

(b) A summary of the results of tests performed for periodic inspection (group B), including the number and mode of failures. The summary shall include results of all periodic inspection tests performed and completed during the 6-month period. If the summary of the test results indicates nonconformance with specification requirements, and corrective action acceptable to the qualifying activity has not been taken, action may be taken to remove the failing product from the qualified products list.

Failure to submit the report within 30 days after the end of each 6 month period may result in loss of qualification for the 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 this specification.

In the event that no production occurred during the reporting period, a report shall be submitted certifying that the company still has the capabilities and facilities necessary to produce the item. If during 3 consecutive reporting periods there has been no production, the manufacturer may be required, at the discretion of the qualifying activity, to submit (the products, a representative product of each type, grade, class, etc.) to testing in accordance with the qualification inspection requirements.

Retention of qualification of ER style will also retain qualification of similar non-ER style; e.g. CZR23 and CZ23.

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 consist of all capacitors of the same style, current and voltage ratings produced under essentially the same conditions, and offered for inspection at the same time. ER parts shall be kept separate from non-ER parts.

4.6.1.2 Group A inspection. Group A inspection shall consist of the examinations and tests specified in table VII in the order shown.

4.6.1.2.1 Sampling plan. Subgroup 1 tests shall be performed on each ER capacitor offered for inspection. Statistical sampling and inspection for subgroup 2 for ER capacitors and subgroups 1 and 2 for non-ER capacitors shall be in accordance with MIL-STD-105. Major and minor defects shall be as defined in MIL-STD-105.

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TABLE VII. Group A inspection.

Examination or Test	Requirement paragraph	Method paragraph	NON-ER AQL (% Defec.) Major	NON-ER AQL (% Defec.) Minor	ER AQL (% Defec.) Major	ER AQL (% Defec.) Minor
Subgroup 1						
Seal	3.7	4.7.3	0.65		Not applicable (100% inspection)	
Dielectric withstanding voltage	3.10	4.7.6				
Insulation resistance	3.11	4.7.7				
Voltage drop (applicable only to film dielectric capacitors)	3.12	4.7.8				
Capacitance	3.13	4.7.9				
Dissipation factor	3.14	4.7.10				
Insertion loss (abbreviated)	3.15	4.7.11.1				
DC resistance	3.17	4.7.13				
Subgroup 2						
Visual and mechanical examination (external)	---	4.7.1	0.65	4.0	0.65	4.0
Material	3.4 and 3.4.1	---				
Physical dimensions	3.5	---				
Design and construction (other than physical dimensions	3.5 to 3.5.3.1 (incl.)	---				
Marking 1/	3.29	---				
Workmanship	3.30 and 3.30.1	---				

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

4.6.1.2.2 Manufacturers production inspection for ER parts only. If the manufacturer performs tests similar to those specified in subgroup 1, table VII, 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 must 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% of the product supplied under this specification to his production tests.
(c) The parameters measured and the failure criteria shall be the same or more stringent than those specified herein.
(d) The lot rejection criteria is the same or more stringent than that specified herein.
(e) The manufacturer shall make available to the Government all records of all detail test data resulting from production tests.

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4.6.1.2.3 Rejected lots. If an inspection lot is rejected, the supplier may rework it to correct the defects, or screen out the defective units, and resubmit for reinspection. Resubmitted lots shall be inspected using tightened inspection. Such lots shall be separate from new lots, and shall be clearly identified as reinspected lots. If during the 100 percent inspection of subgroup 1 (ER parts only), screening requires that over 5 percent of the capacitors be discarded, the lot shall be rejected and shall not be resubmitted.

4.6.2 Periodic inspection. Periodic inspection shall consist of group B. Except where the results of these inspections show noncompliance with the applicable requirements (see 4.6.2.1.6), delivery of products which have passed group A shall not be delayed pending the results of these periodic inspections.

4.6.2.1 Group B inspection. Group B inspection shall consist of the tests specified in table VIII, in the order shown, and shall be performed on sample units selected from lots that have passed group A inspection. Test data obtained shall be reviewed as a part of the complete retention of qualification.

4.6.2.1.1 Sampling plan. Sample units shall be representative of capacitors produced.

4.6.2.1.2 Subgroup 1, 2, 3, and 4 (ER and non-ER parts). Eighteen sample units shall be taken from production each month and subjected to the applicable tests for their particular subgroup. Allowable failures shall be as specified in table VIII.

4.6.2.1.3 Subgroup 5 (non-ER parts). Six sample units shall be taken from production every month and subjected to the applicable tests for their particular subgroup. Allowable failures shall be as specified in table VIII.

4.6.2.1.4 Subgroup 6 (ER parts only). Six sample units shall be selected from lots produced during a 3-month period. Allowable failures shall be as specified in table VIII. The accumulated life test data shall be used for maintenance of ER qualification, and shall be verified for failure rate level maintenance with 90 percent confidence level, at one-year intervals.

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

4.6.2.1.6 Noncompliance (applicable to both ER and non-ER parts). If a sample fails to pass group B 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, 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 Government). Group A inspection may be reinstituted; however, final acceptance shall be withheld until the group B reinspection has shown that the corrective action was successful. In the event of failure after reinspection, information concerning the failure and corrective action taken shall be furnished to the 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.

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TABLE VIII. Group B inspection.

Test	Requirement paragraph	Method paragraph	Number of sample units to be inspected	Number of defectives allowed NON-ER	Number of defectives allowed ER
Monthly					
Subgroup 1					
Terminal strength	3.8	4.7.4	6	1	1
Insertion loss	3.15	4.7.11			
Temperature rise (film dielectric only)	3.9	4.7.5			
Overload (film dielectric only)	3.16	4.7.12			
Subgroup 2					
Resistance to soldering heat (soldered terminals only)	3.18	4.7.14	6	1	1
Salt spray (corrosion)	3.22	4.7.18			
Temperature cycling and immersion	3.23	4.7.19			
Subgroup 3					
Shock (specified pulse)	3.19	4.7.15	6	1	1
Vibration (low frequency)	3.20	4.7.16			
Vibration (high frequency)	3.21	4.7.17			
Moisture resistance	3.26	4.7.22			
Quarterly					
Subgroup 4					
Solderability	3.24	4.7.20	3	1	1
Resistance to solvents	3.25	4.7.21	3		
Subgroup 5 (NON-ER parts only)					
Low temperature and capacitance change at reduced temperature	3.27	4.7.23	6	1	N/A
Insulation resistance (at the high ambient temperature)	3.11	4.7.7			
Life (250 hours)	3.28	4.7.24.2.1			
Subgroup 6 (ER parts only)					
Low temperature and capacitance change at reduced temperature	3.27	4.7.23	6	N/A	1 1/
Insulation resistance (at the high ambient temperature)	3.11	4.7.7			
Life (2,000 hours)	3.28	4.7.24.2.2			

1/ The number of defects is also governed by the requirement of 4.5, wherein the qualified product must meet the 90 percent failure rate plan on an annual basis.

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4.7 Methods of examination and test.

4.7.1 Visual and mechanical examination. Capacitors shall be examined to verify that the materials, design, construction, physical dimensions, marking, and workmanship are in accordance with the applicable requirements (see 3.1, 3.4 to 3.5.3.1, incl., and 3.29 to 3.30.1.2, incl.).

4.7.2 Flashpoint of impregnant or filling compound (see 3.6). This test is applicable only to liquid impregnants and filling compounds and to solid impregnants having a melting point of less than 135° C. The flashpoint of the impregnant or filling compound shall be measured as specified in Publication D92-57, except that fire point and precision do not apply. "Impregnant or filling compound" shall be substituted for the word "oil" throughout the test method.

4.7.3 Seal (see 3.7).

4.7.3.1 Solid-filled, liquid-impregnated, and characteristics P and K capacitors. While at room temperature, capacitors whose filling material will be solid at the high ambient test temperature, and liquid-impregnated capacitors in which no filling compound is used, shall be immersed for at least 1 minute in oil or water maintained at a temperature of $5^{\circ}\ ^{+5^{\circ}}_{-0^{\circ}}$ C above the high ambient test temperature.

4.7.3.2 Liquid-filled capacitors. Capacitors whose filling material will be liquid at the high ambient test temperature, shall be placed with the terminals facing horizontal and brought to a case temperature of $5^{\circ}\ ^{+5^{\circ}}_{-0^{\circ}}$ C above the high ambient test temperature. After 10 minutes at this case temperature, the capacitors shall be turned through 180° onto another surface with the terminals still horizontal and kept in this position for 10 minutes with the case temperature maintained within the same limits. An oil spot or spots appearing on the paper or any oil impregnant appearing on the outside of the case is considered evidence of leakage.

4.7.4 Terminal strength (see 3.8). Capacitors shall be tested in accordance with method 211 of MIL-STD-202. The following details and exceptions shall apply:

(a) Pull test - applies to all terminals.

(1) Test condition letter - A.
(2) Method of holding - normal mounting means.
(3) Applied force - 5 pounds $^{+3}_{-0}$ ounces.
(4) Duration of applied force - 30 $^{+5}_{-0}$ seconds.

(b) Torque - threaded or tapped stud type terminals only.

(1) Test condition letter - E.
(2) Torque applied to nuts or screws shall be as specified in table IX.
(3) Applications - A total of five tightenings shall be applied.

TABLE IX. Torque.

Screw size	Torque (pound-inches)
8-32	14
10-32	18
1/4-28	24
5/16-24	50
3/8-24	100
7/16-20	150
1/2-28	200

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4.7.5 Temperature rise (applicable only to film-dielectric capacitors, see 3.9). Capacitors shall be suspended by their terminals and shall be energized with rated current. Lead wires shall be of copper, 6 inches long, and the size shall be No. 24 AWG. After thermal stability has been reached and while the capacitor is still energized, the maximum hotspot on the capacitor case shall be determined by the use of thermocouples.

4.7.6 Dielectric withstanding voltage (see 3.10).

4.7.6.1 For qualification inspection. Capacitors shall be tested in accordance with method 301 of MIL-STD-202. The following details shall apply:

(a) Magnitude and nature of test voltage - 200 percent of the rated dc voltage, or a dc potential equivalent to 300 percent of the rated ac voltage (see 3.1), whichever is applicable. For dc capacitors, the ac ripple shall not exceed 2 percent.
(b) Duration of application of test voltage - 1 minute ±5 seconds.
(c) Points of application of test voltage - Between the case and either terminal.
(d) Limiting value of surge current - Between 5 milliamperes and 1 ampere.
(e) Measurement during and after dielectric withstanding voltage - after the test, capacitors shall be visually examined for external evidence of damage, arcing, or breakdown.

4.7.6.2 For acceptance inspection. Capacitors shall be tested as specified in 4.7.6.1 except that, at the option of the manufacturer, a test voltage of 250 percent of the rated dc voltage, or a dc potential equivalent to 300 percent of the rated ac voltage (see 3.1), whichever is applicable, may be applied for a period of not less than 1 second.

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

(a) Test potential - A potential equal to the rated voltage (see 3.1) or 500 volts dc, whichever is less.
(b) Special conditions - Capacitors shall be tested at the applicable high ambient test temperature (see table II), and at 25° C or corrected thereto.
(c) Points of measurement - Between either terminal and the case.

4.7.8 Voltage drop (applicable only to film-dielectric capacitors) (see 3.12). The voltage drop shall be determined in accordance with figure 3. Measurements shall be made by using a dc reading meter.

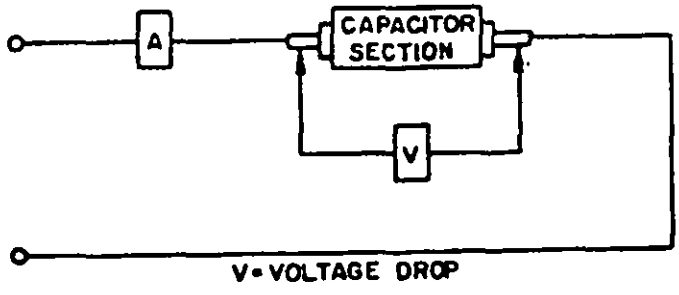

FIGURE 3. Measurement of voltage drop at rated current.

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

(a) Test frequency - 1 kHz ±100 Hz for capacitors whose nominal capacitance is 1 μF or or less, and 60 ±6 Hz for capacitors whose nominal capacitance is more than 1 μF.
(b) Limit of accuracy - Within ±2 percent.

4.7.10 Dissipation factor (see 3.14). The dissipation factor of each capacitor shall be measured at a root-mean-square (rms) voltage not greater than 20 percent of the rated voltage, ac or dc, whichever is applicable (see 3.1). Measurement shall be made at a frequency of 1 kHz ±100 Hz for capacitors whose nominal capacitance is 1 μF or less, and at a frequency of 60 ±6 Hz for capacitors whose nominal capacitance is more than 1 μF. Measurement accuracy shall be within ±0.1 percent absolute.

4.7.11 Insertion loss (see 3.15). Capacitors shall be tested in accordance with MIL-STD-220. Measurements shall be taken at a sufficient number of frequencies to permit the construction of a smooth accurate curve of insertion loss versus frequency over a frequency range of 0.15 to 1,000 MHz, inclusive. Suggested frequencies are as follows: 0.15, 0.5, 1, 2, 4, 8, 14, 20, 40, 80, 120, 200, 300, 400, and 1,000 MHz.

4.7.11.1 Insertion loss (abbreviated) (see 3.15). Capacitors shall be tested as specified in 4.7.11 except that measurements shall be made only at the frequencies specified (see 3.1).

4.7.12 Overload (applicable only to film-dielectric capacitors) (see 3.16). Capacitors shall be suspended by their terminals in free air at an ambient temperature of 20° C minimum. A current equal to 140 percent of rated current shall then be applied for 15 minutes. After the capacitor has returned to room temperature, the insulation resistance at 25° C and the voltage drop shall be measured as specified in 4.7.7 and 4.7.8, respectively. Capacitors shall then be examined for physical damage.

4.7.13 Dc resistance (see 3.17). The dc resistance shall be measured directly using a Kelvin bridge or indirectly using the voltmeter-ammeter method, ammeter-potentiometer method, or other suitable means. The point of contact shall be along the lead, where the lead is normally connected in an actual circuit, except that for axial-wire leads, the contact shall be made 5/8 ± 1/8 inch from the insulator. The maximum allowable measurement error shall be 5 percent.

4.7.14 Resistance to soldering heat, solderable terminals only (see 3.18). 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 .062 ±.031 inch of the seal or case.
(b) Test condition - B.
(c) Cooling time prior to measurement after test - 1 hour.
(d) Measurement after test - capacitance to ground and coil continuity.

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

(a) Mounting - securely fastened by normal mounting means. When applicable, leads and connecting wires must be supported to prevent damage to the capacitor.
(b) Test condition - Non ER - G (50g, peak); ER - I (100g, peak).
(c) Electrical load during shock - during the test, a potential of 125 percent of rated voltage (see 3.1) shall be applied to 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 mechanical damage.

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4.7.16 Vibration, low frequency (see 3.20) (Non-ER only). Unless otherwise specified, see 3.1. Capacitors shall be tested in accordance with method 201 of MIL-STD-202. The following details shall apply:

(a) Method of mounting - Securely fastened by normal mounting means (see 3.1).
(b) Duration of vibration - 2-1/2 hours, except that for acceptance inspection, the duration shall be 1-1/2 hours.
(c) Direction of motion - 1-1/4 hours perpendicular to the cylindrical axis, and 1-1/4 hours parallel to the cylindrical axis. For acceptance inspection, motion may be applied in either of the two specified directions.
(d) Electrical load condition. During the test rated voltage (see 3.1) shall be applied to each capacitor.
(e) Measurements during vibration - During the last half hour of vibration in each direction, a signal of 1 ±0.2 kHz at a level of 1 ±0.2 volts shall be placed across the capacitor and measured with a suitable ac current recording device for the purpose of determining the presence of open- or short-circuit, or intermittent contacts of 0.5 ms or greater duration.
(f) Examination after test - capacitors shall be visually examined for evidence of mechanical damage.

4.7.17 Vibration, high frequency (see 3.21) (ER only). When specified, see 3.1, capacitors shall be tested in accordance with method 204 of MIL-STD-202. The following details shall apply:

(a) Mounting - securely fastened by normal mounting means. When applicable, leads and connecting wires must be so supported to exclude spurious resonances.
(b) Electrical load conditions - during the test, a potential of 125 percent of rated voltage (see 3.1) shall be applied between the terminal and case of the capacitor.
(c) Test condition letter - B (15g).
(d) 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.
(e) Measurements during vibration - during the last half hour of vibration in each direction, a signal of 1 ±0.2 kHz at a level of 1 ±0.2 volts shall be placed across the capacitor and measured with a suitable device to determine open- or short-circuiting or intermittents of 0.5 ms or greater duration.
(f) Examination after test - capacitors shall be visually examined for evidence of mechanical damage.

4.7.18 Salt spray (corrosion) (see 3.22). Capacitors shall be tested in accordance with method 101, test condition B, of MIL-STD-202. After this test, capacitors shall be visually examined for corrosion and obliteration of marking.

4.7.19 Temperature cycling and immersion (see 3.23).

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

(a) Test-condition letter - D, except that in step 3, capacitors shall be tested at the applicable high ambient test temperature (see table II).
(b) Measurements before and after cycling - Not applicable.

4.7.19.2 Immersion cycling. 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 letter - B.
(b) Measurements after final cycle - Dielectric withstanding voltage, insulation resistance at 25° C, capacitance, dissipation factor, and insertion loss (abbreviated) shall be measured as specified in 4.7.6, 4.7.7, 4.7.9, 4.7.10 and 4.7.11.1, respectively. These measurements shall be made within 2 hours

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after capacitors are removed from the immersion tank, except that no time limit is specified for the insertion-loss measurement. If the capacitors fail the insulation-resistance test, they may be tetested for insulation resistance after a total maximum drying period of 24 hours.

(c) Visual examination - Capacitors shall be examined for corrosion and obliteration of marking.

4.7.20 Solderability (wire leads only) (see 3.24). 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) Special preparation of the terminations - prior to the application of the flux and solder dip, 50 percent of the capacitors shall be subjected to aging by immersion in a noncorrosive container of distilled water. For characteristic K and P capacitors, the distilled water shall be boiling. For characteristic E and W capacitors, the distilled water shall be maintained at 85° C. The immersion period shall be one hour. No aging shall be required on the remaining 50 percent of the capacitors.
(c) Depth of immersion in flux and solder - Both leads shall be immersed to within 0.05 inches from the point of egress.

4.7.21 Resistance to solvents (see 3.25). Capacitors shall be tested in accordance with method 215 of MIL-STD-202. The following details shall apply:

(a) Portion of specimen to be brushed - That portion on which marking is present.
(b) Number of specimens to be tested - As specified in applicable inspection tables.
(c) Permissible extent of damage - As specified in 3.25.

4.7.22 Moisture resistance (see 3.26). Capacitors shall be tested in accordance with method 106 of MIL-STD-202. The following details and exceptions shall apply:

(a) Initial measurements - Not applicable.
(b) Polarization voltage - The dc potential shall be applied to either terminal and the case of 50 percent of the capacitors. No potential shall be applied to the remaining 50 percent of the capacitors.
(c) Final measurements - Upon completion of step 6 of the final cycle, the dielectric withstanding voltage, insulation resistance at 25° C, capacitance, and dissipation factor shall be measured as specified in 4.7.6, 4.7.7, 4.7.9 and 4.7.10, respectively, at a relative humidity of 50 ±5 percent.
(d) Visual examination - Capacitors shall be examined for corrosion and obliteration of marking.

4.7.23 Low temperature and capacitance change at reduced temperature (see 3.27).

4.7.23.1 Low temperature. Capacitors shall be placed in a chamber maintained at -55° ±3° C, and rated voltage at the rated frequency shall be applied at this condition for 48 ±4 hours (see 3.1). The air within the conditioning chamber shall be circulated.

4.7.23.2 Capacitance change at reduced temperature. At the conclusion of the test specified in 4.7.23.1 but before the capacitors are removed from the conditioning chamber, the capacitance shall be measured as specified in 4.7.9 except that the measurement shall be made at -55° ±3° C. This measurement shall be compared with a measurement made at room ambient temperature. After exposure, capacitors shall be visually examined for evidence of breakdown, flashover, or fractures.

4.7.24 Life (see 3.28).

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4.7.24.1 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 - Suspended by their terminals with a distance of not less than 1.5 inches separation between units.
(b) Test temperature and tolerance - The applicable high temperature specified in table II (see 3.1).
(c) Operating conditions - A potential of 140 percent of the rated ac or dc voltage shall be applied between the terminal and the case. AC voltages shall be of the maximum rated frequency ±4 Hz (see 3.1). Rated current shall be flowing through the feed through conductors (see 3.1).
(d) Test condition - F (2,000 $^{+96}_{-0}$ hours) for ER parts and 240 $^{+48}_{-0}$ for non-ER parts.
(e) Measurements after exposure - Capacitors shall be returned to the inspection conditions specified in 4.3, and shall be visually examined for leakage of impregnant or filling compound and deformation of case. Insulation resistance at 25° C, capacitance, dissipation factor, and insertion loss (abbreviated) shall then be measured as specified in 4.7.7, 4.7.9, 4.7.10 and 4.7.11, respectively, (see 3.28).

4.7.24.2 Life (Quality conformance inspection).

4.7.24.2.1 240 hour (group B inspection) (see 3.28). Capacitors shall be tested as specified in 4.7.24.1, except that the duration of the test shall be 240 $^{+48}_{-0}$ hours.

4.7.24.2.2 2,000 hour (group B inspection) (see 3.28) (ER parts only). Except as specified in the following, capacitors shall be tested as specified in 4.7.24.1:

Test duration - 2,000 $^{+96}_{-0}$ hours.

5. PREPARATION FOR DELIVERY

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

6. NOTES

6.1 Ordering data.

(a) Title, number, and date of this specification.
(b) Title, number, and date of the applicable specification sheet and the complete type designation (see 1.2.1 and 3.1).
(c) Levels of preservation and packaging and packing, and applicable marking (see sec. 5).
(d) Direct Governmental purchases should specify machine nuts and washers.

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 called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be elibible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the qualified products list is the Electronics Command; however, information pertaining to qualification of products may be obtained from the Defense Electronics Supply Center (DESC-E), Dayton, Ohio 45401. 2/

2/ SD-6, "Provisions Governing Qualification," is issued for the information of applicants requesting qualification of products. Copies of this publication may be obtained from the Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.

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6.3 Radio interference. Radio interference is defined as undesired conducted or radiated electrical disturbances, including transients, within the range of frequencies covered by this specification, which may interfere with the operation of electrical or electronic communication equipment or other electronic equipment.

6.4 Insertion loss for ideal capacitors. The insertion loss of ideal capacitors for capacitance values from 0.001 to 100 µF, inclusive, and frequency range from 0.01 to 1,000 megahertz, inclusive, may be determined from figure 4 (see 4.7.11 and 4.7.11.1).

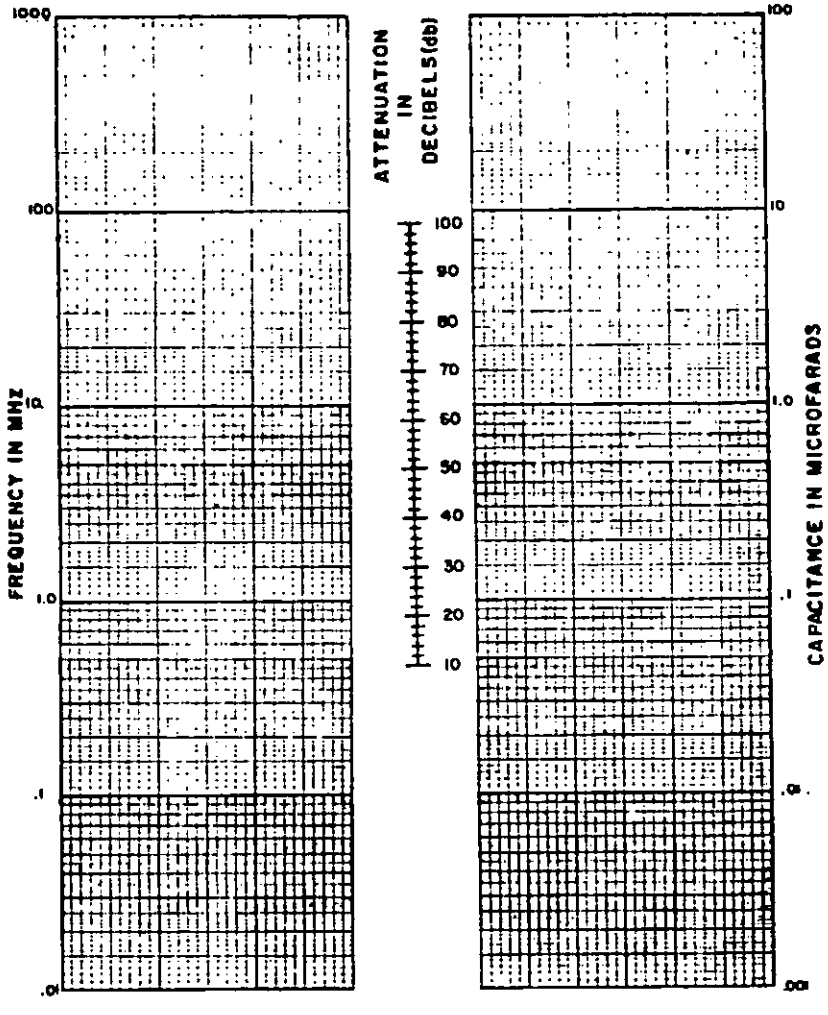

FIGURE 4. Insertion-loss chart for ideal capacitors.

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6.5 Lockwasher. External tooth-type lockwashers shall be used for all applications (see 3.1), except where space limitations, appearance, or other special conditions necessitate the use of internal tooth- or split-type lockwashers. Internal tooth-type lockwashers shall not be used with binder head screws. Screws or nuts with captive lockwashers will be permitted, provided that replacement with common-type screws and lockwashers or nuts and lockwashers may be readily effected. Soldering lug and lockwasher combinations shall not be used.

6.6 Definitions.

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

6.6.2 Momentary breakdown. Momentary breakdown is defined as a single or a series of rapidly succeeding capacitor discharges evidenced by abrupt decreases in insulation resistance of values below the limit specified in 3.11 and followed by restoration of the insulation resistance to a value above this limit.

6.7 Supersession data. ER capacitors of this specification shall unilaterally supersede similar non ER items (CZR23 for CZ23) of MIL-C-11693B and MIL-C-11693C and shall also supersede similar items from MIL-C-39011, Capacitors, Feed Through, Radio-Interference Reduction, ER. It is not intended that new FSN's be established between MIL-C-11693B and 11693 (non-ER) comparable items. Styles made "Inactive for Design, etc." during this revision must meet requirements of MIL-C-11693B.

6.8 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.

Custodians:
Army - EL
Navy - EC
Air Force - 17

Review activities:
Army -
Navy - EC
Air Force - 11, 80
DSA - ES

User activities:
Army -
Navy -
Air Force -

Preparing activity:
Army - EL

Agent:
DSA - ES

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APPENDIX

PROCEDURE FOR QUALIFICATION INSPECTION

10. SCOPE

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

20. SUBMISSION

20.1 Sample.

20.1.1 Single-type submission. A sample consisting of 36 specimens of the type for which qualification is sought shall be submitted (see 30.1). Each sample shall be accompanied with the following information:

(a) Attenuation curves in accordance with MIL-STD-220.
(b) Either a certification of the flashpoint of the impregnant or filling compound as determined in accordance with 4.7.2 or a minimum of 200 cubic centimeters of the impregnant or filling compound used in the capacitors.

20.1.2 Combined-type submission. A maximum of two types in each style for which qualification is sought, consisting of 18 specimens of the highest watt-second rating or volt-ampere reactive, as applicable in the highest voltage rating and 18 specimens of the lowest capacitance value in any voltage rating, shall be submitted. Each sample shall be accompanied by the information required in 20.1.1(a) and 20.1.1(b), above. Table X is an example of a combined-type submission (see 30.2).

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

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

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TABLE X. Example of combined-type submission.

Style	Type to be submitted	Number of specimens to be submitted	Watt-second rating 1/	Volt-amperes reactive 2/	Voltage, volts
CZ13	CZ13APU103	18	---	0.236	250 ac
CZ13	CZ13APU254	18	---	5.9	250 ac
CZ20	CZ20DWB254	18	0.00125	---	100 dc
CZ20	CZ20DWB754	18	0.00375	---	100 dc
CZ23	CZ23BKF103	18	0.0018	---	600 dc
CZ23	CZ23BKF474	18	0.0846	---	600 dc
CZ24	CZ24BKF103	18	0.0018	---	600 dc
CZ24	CZ24BKF474	18	0.0846	---	600 dc
CZ31	CZ31DWF104	18	0.018	---	600 dc
CZ31	CZ31DWF504	18	0.09	---	600 dc
CZ50	CZ50AWJ102	18	0.0072	---	1200 dc
CZ50	CZ50AWJ104	18	0.72	---	1200 dc
CZR23	CZR23BKF474M	32	0.0846	---	600 dc
CZR24	CZR24BKF103M	32	0.0018	---	600 dc
CZR33	CZR33FWB205M	63	0.01	---	100 dc
CZR42	CZR42HEV104M	63	---	15.6	250 ac

1/ For dc capacitors the watt-second rating will be determined by the following formula:

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

Where:

W = energy content in watt-seconds.
C = nominal capacitance in farads.
E = dc voltage rating in volts.

2/ For ac capacitors the power rating will be determined by the following formula:

$$VAR = 2\pi FCE^2$$

Where:

VAR = volt-amperes reactive.
F = frequency in cycle per second.
C = nominal capacitance in farads.
E = ac voltage rating in volts.

20.4 Test data. Each submission shall be accompanied by test data covering the non-destructive tests listed in table VI which have been performed on the submitted specimens. The performance of the destructive tests by the manufacturer on a duplicate set of specimens is encouraged, although not required. All test data shall be submitted in duplicate.

20.5 Description of items. The manufacturer shall submit a detailed description of the materials and constructional features of the capacitors being submitted for inspection, including information on whether they are liquid-filled or liquid-impregnated; the type and quantity of the impregnant or filling compound; the type, thickness, and number of layers of capacitor tissue and electrode material; and the material, thickness, and applied finish of the case.

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30. EXTENT OF QUALIFICATION

30.1 Single-type submission. Qualification will be restricted to the type submitted.

30.2 Combined-type submission. Qualification of the types submitted will be extended to types whose watt-second and voltage ratings are not greater than the highest watt-second and voltage ratings submitted, and whose capacitance values are not less than the lowest capacitance value submitted. In addition, submission and qualification of a type or types in one characteristic automatically carries with it qualification of the lower characteristics, provided the units are of the same style, material, impregnant or filling compound and construction (e.g. qualification of characteristic K provided the basis for qualification of characteristics K and E).
Qualification of ER parts will give qualification of non-ER parts of the same dielectric, construction, voltage ratings, current ratings and capacitance values.

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SPECIFICATION ANALYSIS SHEET

Form Approved
Budget Bureau No. 22-R255

INSTRUCTIONS: This sheet is to be filled out by personnel, either Government or contractor, involved in the use of the specification in procurement of products for ultimate use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured with a minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity. Comments and suggestions submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or serve to amend contractual requirements.

SPECIFICATION MIL-C-11693C CAPACITORS, FIXED THROUGH, RADIO-INTERFERENCE REDUCTION, AC AND DC ESTABLISHED AND NON-ESTABLISHED RELIABILITY

ORGANIZATION

CITY AND STATE

CONTRACT NUMBER

MATERIAL PROCURED UNDER A

☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?

A. GIVE PARAGRAPH NUMBER AND WORDING.

B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES

2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID

3. IS THE SPECIFICATION RESTRICTIVE?

☐ YES ☐ NO *(If "yes", in what way?)*

4. REMARKS *(Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity)*

SUBMITTED BY *(Printed or typed name and activity - Optional)*

DATE

DD FORM 1426 JAN 64

REPLACES EDITION OF 1 OCT 54 WHICH MAY BE USED.

ESC-PM 1068-68