NOTE: The document identifier and heading has been changed on this page to reflect that this is a performance specification. There are no other changes to this document. The document identifier on subsequent pages has not been changed, but will be changed the next time this document is revised.

INCH-POUND

MIL-PRF-20H
27 February 1992
SUPERSEDING
MIL-C-20G
5 November 1976

PERFORMANCE SPECIFICATION

CAPACITOR, FIXED, CERAMIC DIELECTRIC (TEMPERATURE COMPENSATING), ESTABLISHED RELIABILITY AND NON-ESTABLISHED RELIABILITY, GENERAL SPECIFICATION FOR

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

1. SCOPE

1.1 Scope. This specification covers the general requirements for established reliability (ER) and non-ER, temperature compensating, fixed capacitors for use primarily where compensation is necessary for circuit applications due to temperature changes, in bypass and coupling applications. Capacitors meeting the ER requirements specified herein have a failure rate level ranging from 1.0 percent per 1,000 hours to 0.001 percent per 1,000 hours. These failure rate levels are established at a 90-percent confidence level based on the life test parameters specified and are maintained at a 10-percent producer's risk. An acceleration factor of 8:1 has been used to relate the life test data at 200 percent of rated voltage at the applicable high test temperature to the rated voltage at the applicable high test temperature.

A part per million (PPM) quality system is used for documenting and reporting the average outgoing quality of ER capacitors supplied to this specification. Statistical process control (SPC) techniques are required in the manufacturing process to minimize variation in production of ER capacitors supplied to the requirements of this specification.

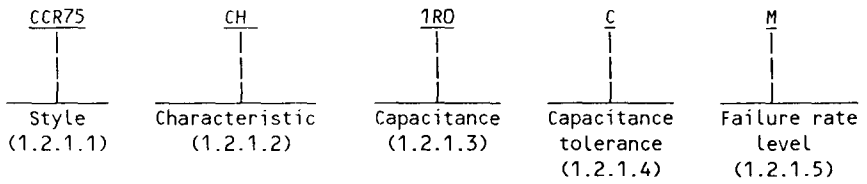
Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Defense Electronics Supply Center, ATTN: DESC-ELDM, 1507 Wilmington Pike, Dayton, OH 45444-5765, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 5910

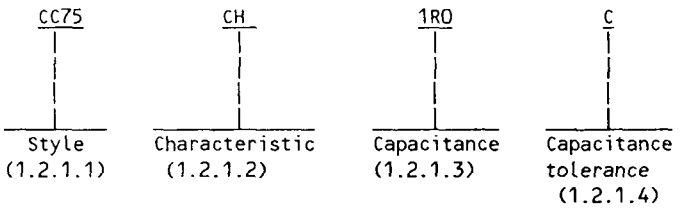
1.2 Classification.

1.2.1 Part or Identifying Number (PIN). The PIN shall be in the following form, and as specified (see 3.1 and 6.2).

ER



NON-ER



1.2.1.1 Style. The style is identified by either the three-letter symbol "CCR" (ER parts) or by the two-letter symbol "CC" (non-ER parts) followed by a two-digit number. The letters identify temperature compensating, ceramic dielectric, fixed capacitors, and the number identifies the shape and dimensions of the capacitor.

1.2.1.2 Characteristic. The characteristic is identified by a two-letter symbol in accordance with table I. The first letter identifies the nominal temperature coefficient; the second letter identifies the approximate tolerance envelope for the temperature coefficient (F = ±15 PPM/°C; G = ±30 PPM/°C; H = ±60 PPM/°C; J = ±120 PPM/°C; and K = ±250 PPM/°C) (see figures 1 through 9, and 6.5).

1.2.1.3 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. When the nominal value is less than 10 pF, the letter "R" shall be used to indicate the decimal point and the succeeding digit(s) of the group shall represent significant figure(s). For example, 1R0 indicates 1.0 pF; R75 indicates 0.75 pF; and 0R5 indicates 0.5 pF.

TABLE I. Characteristic.

Symbol	Nominal temperature coefficient	Symbol	Nominal temperature coefficient
	PPM/°C		PPM/°C
AH	100 ±60	PH	-150 ±60
AJ	100 ±120	PJ	-150 ±120
AK	100 ±250	PK	-150 ±250
CF	0 ±15	RF	-220 ±15
CG	0 ±30	RG	-220 ±30
CH	0 ±60	RH	-220 ±60
CJ	0 ±120	RJ	-220 ±120
CK	0 ±250	RK	-220 ±250
CX	1/	SG	-330 ±30
HF	-30 ±15	SH	-330 ±60
HG	-30 ±30	SJ	-330 ±120
HH	-30 ±60	SK	-330 ±250
HJ	-30 ±120	TG	-470 ±30
HK	-30 ±250	TH	-470 ±60
LF	-80 ±15	TJ	-470 ±120
LG	-80 ±30	TK	-470 ±250
LH	-80 ±60	UG	-750 ±30
LJ	-80 ±120	UH	-750 ±60
LK	-80 ±250	UJ	-750 ±120
PF	-150 ±15	UK	-750 ±250
PG	-150 ±30		

1/ Not practically measurable.

1.2.1.4 Capacitance tolerance. The capacitance tolerance is identified by a single letter in accordance with table II.

TABLE II. Capacitance tolerance.

Symbol	Capacitance tolerance
	(±)
B	0.1 pF
C	0.25 pF
D	0.5 pF
F 1/	1 percent
G 1/	2 percent
J	5 percent
K	10 percent

1/ For nominal capacitance of 10 pF or less, the capacitance tolerances shall be ±1.0 pF (F) and ±2.0 pF (G).

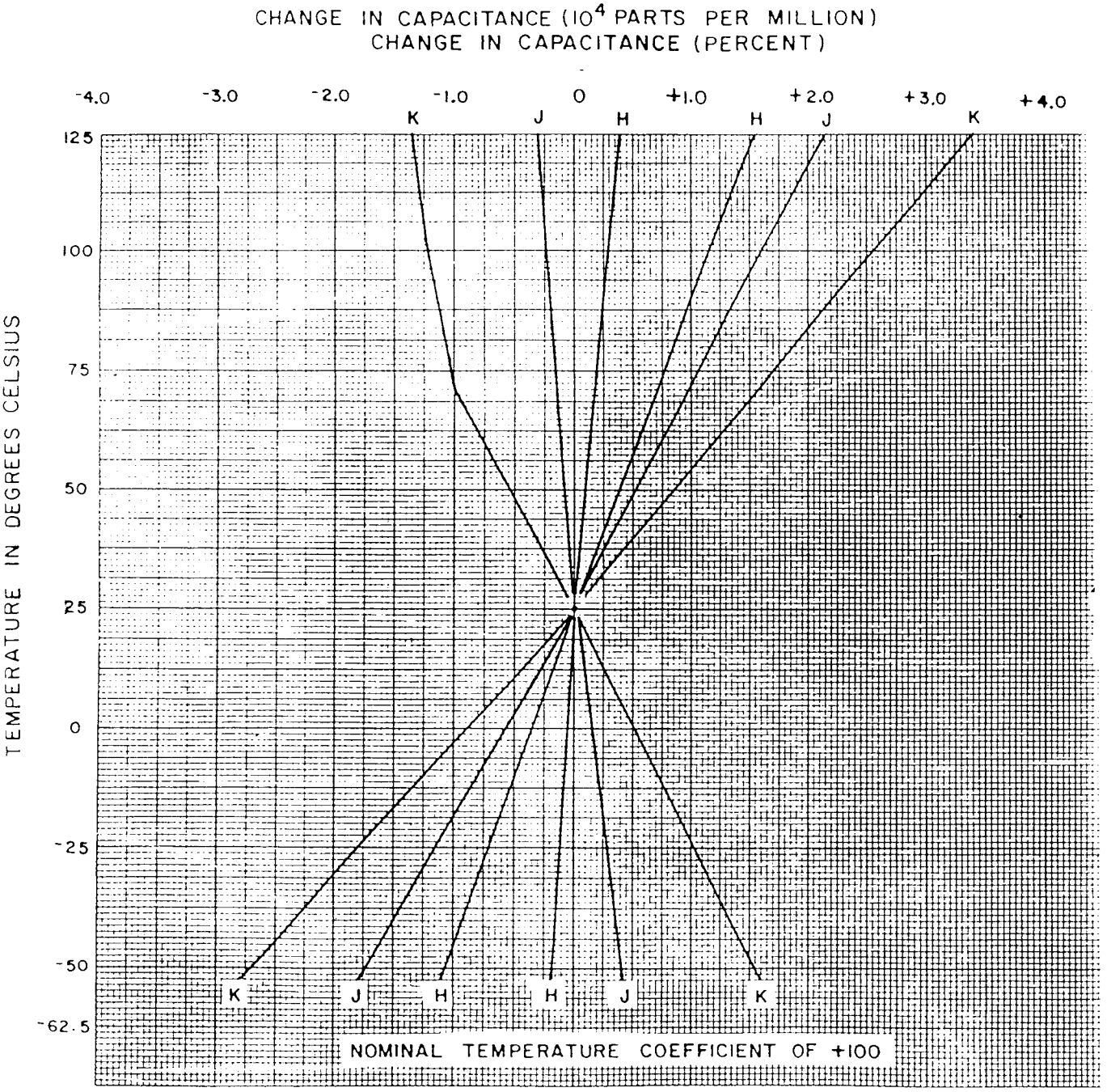


FIGURE 1. Tolerance envelopes for temperature coefficient A.

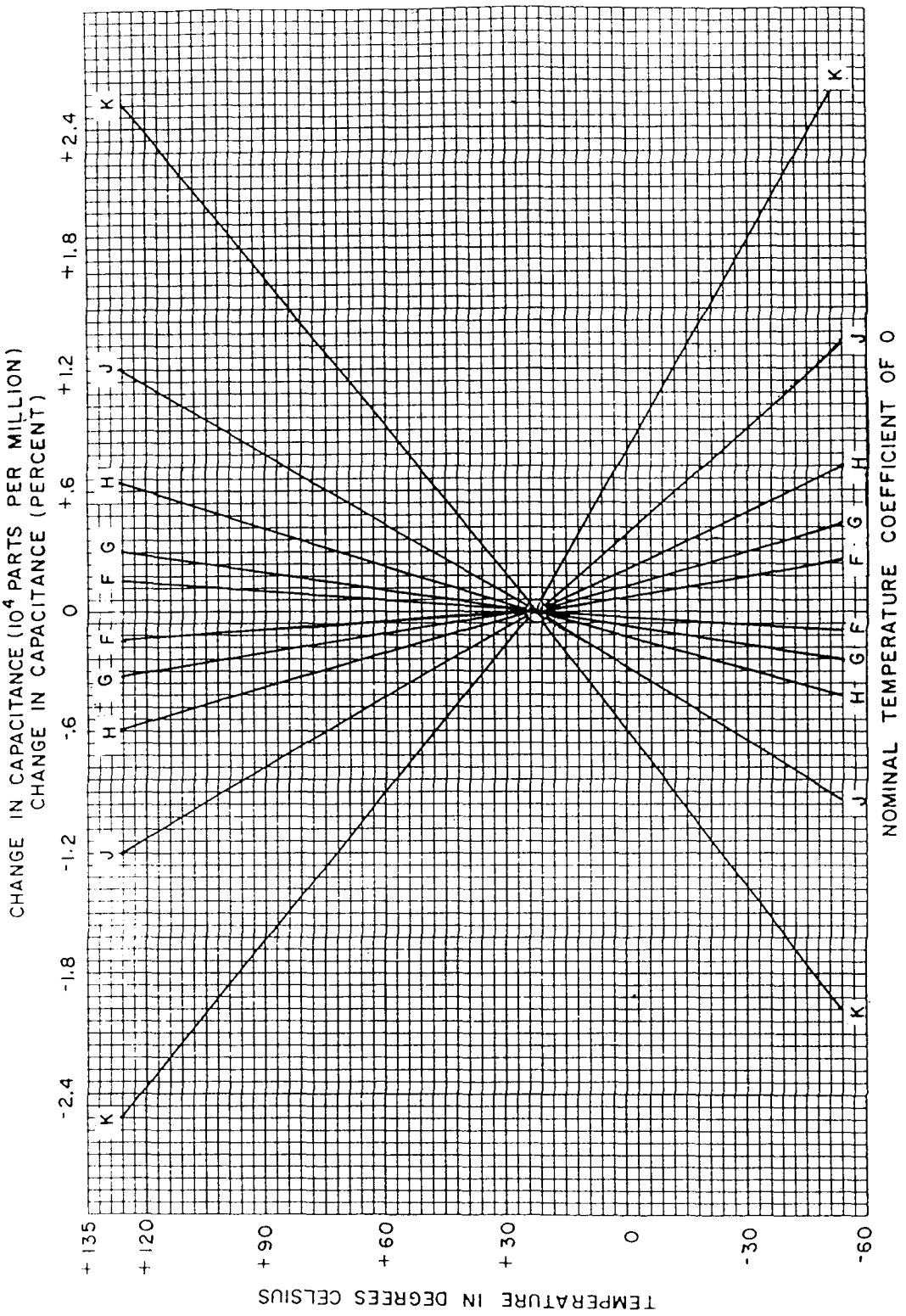


FIGURE 2. Tolerance envelopes for temperature coefficient C.

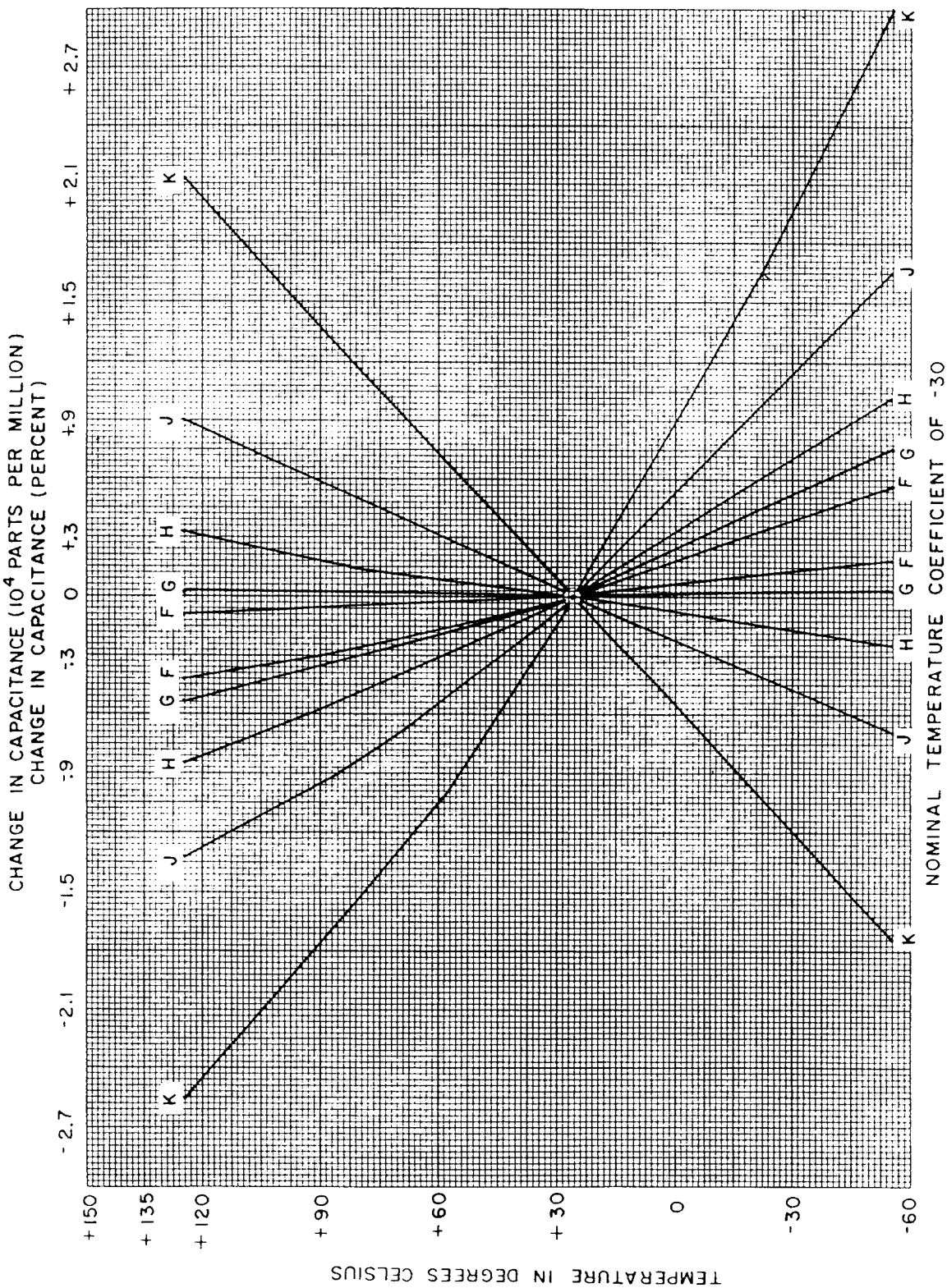


FIGURE 3. Tolerance envelopes for temperature coefficient H.

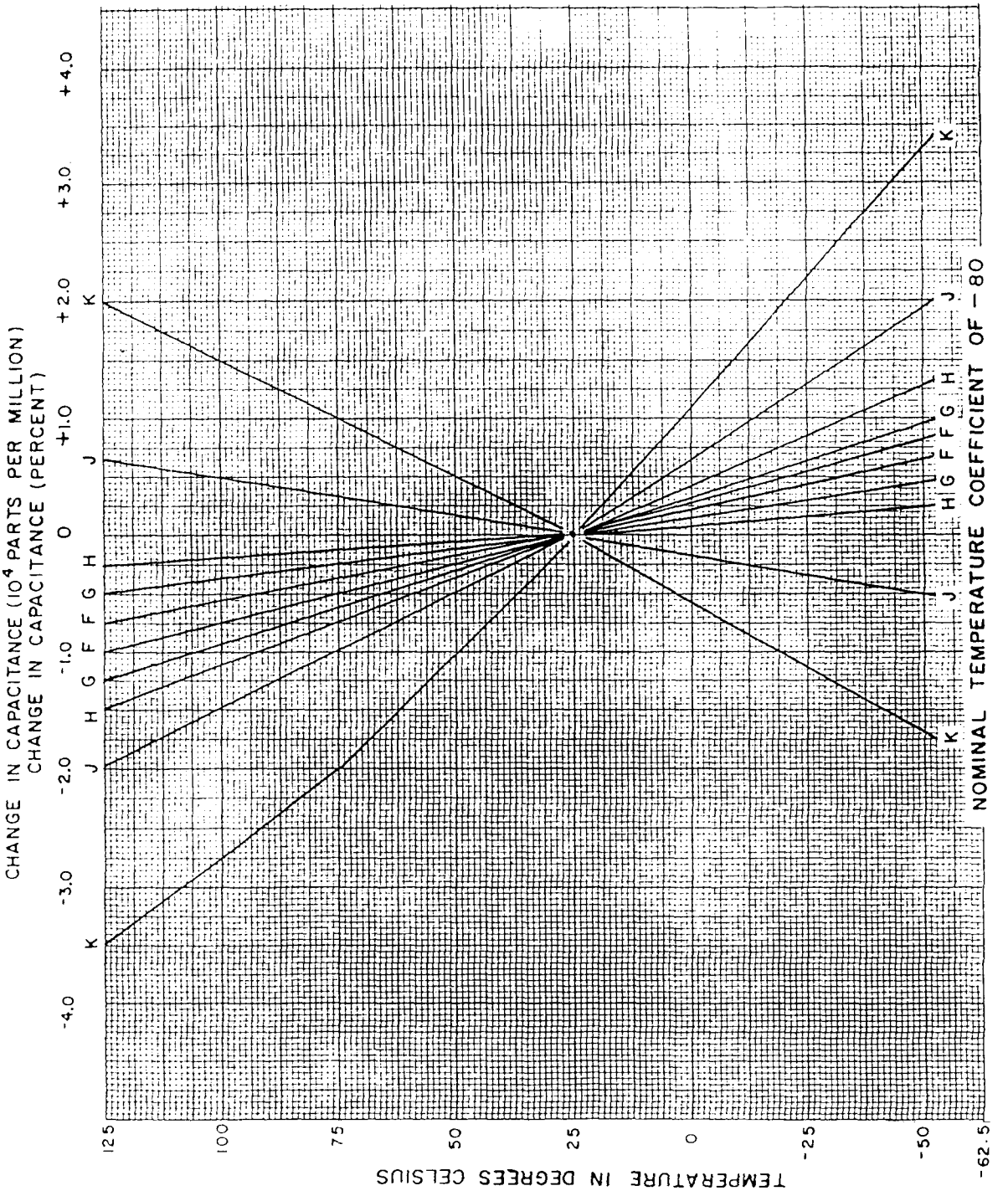


FIGURE 4. Tolerance envelopes for temperature coefficient L.

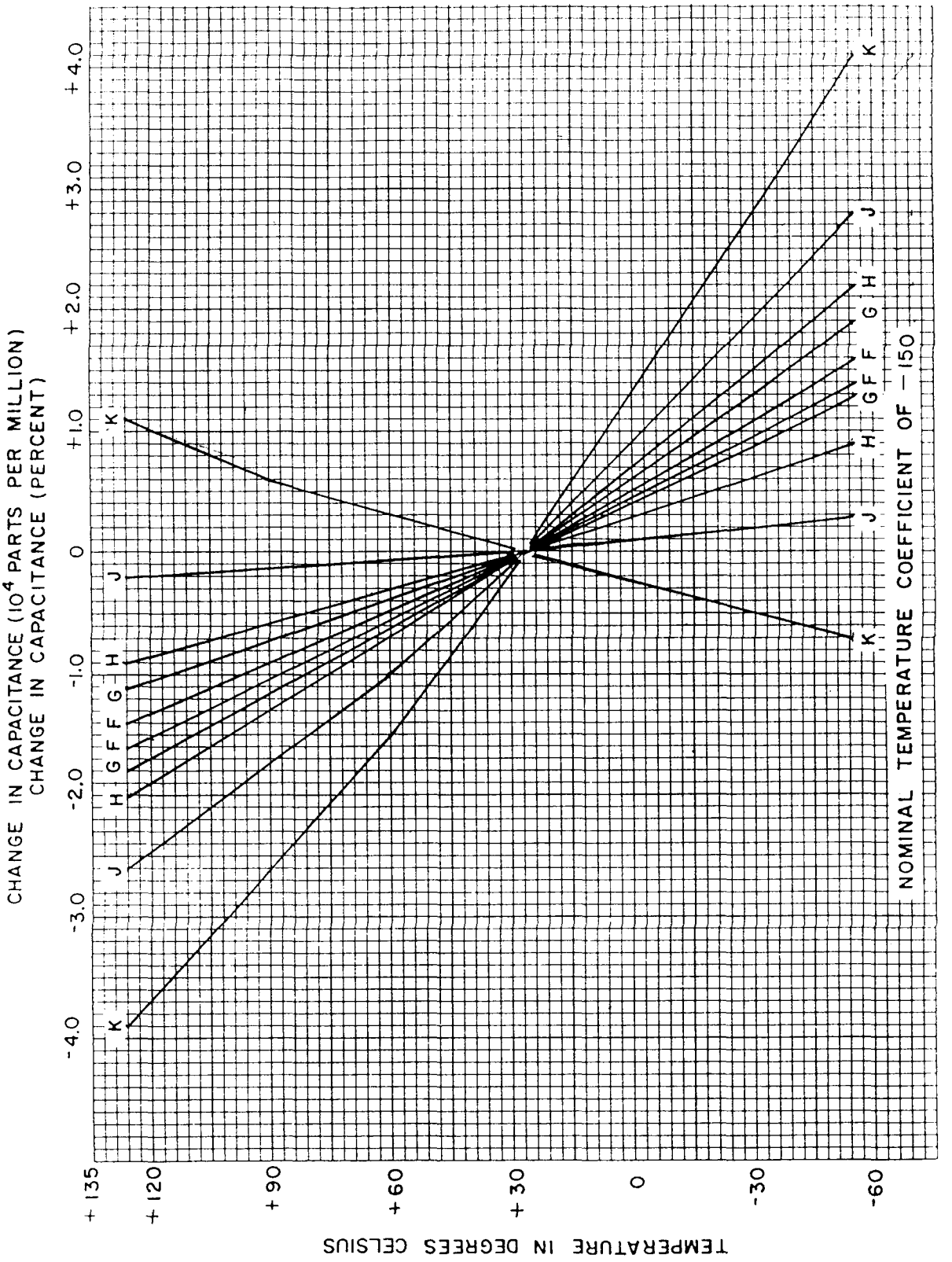


FIGURE 5. Tolerance envelopes for temperature coefficient P.

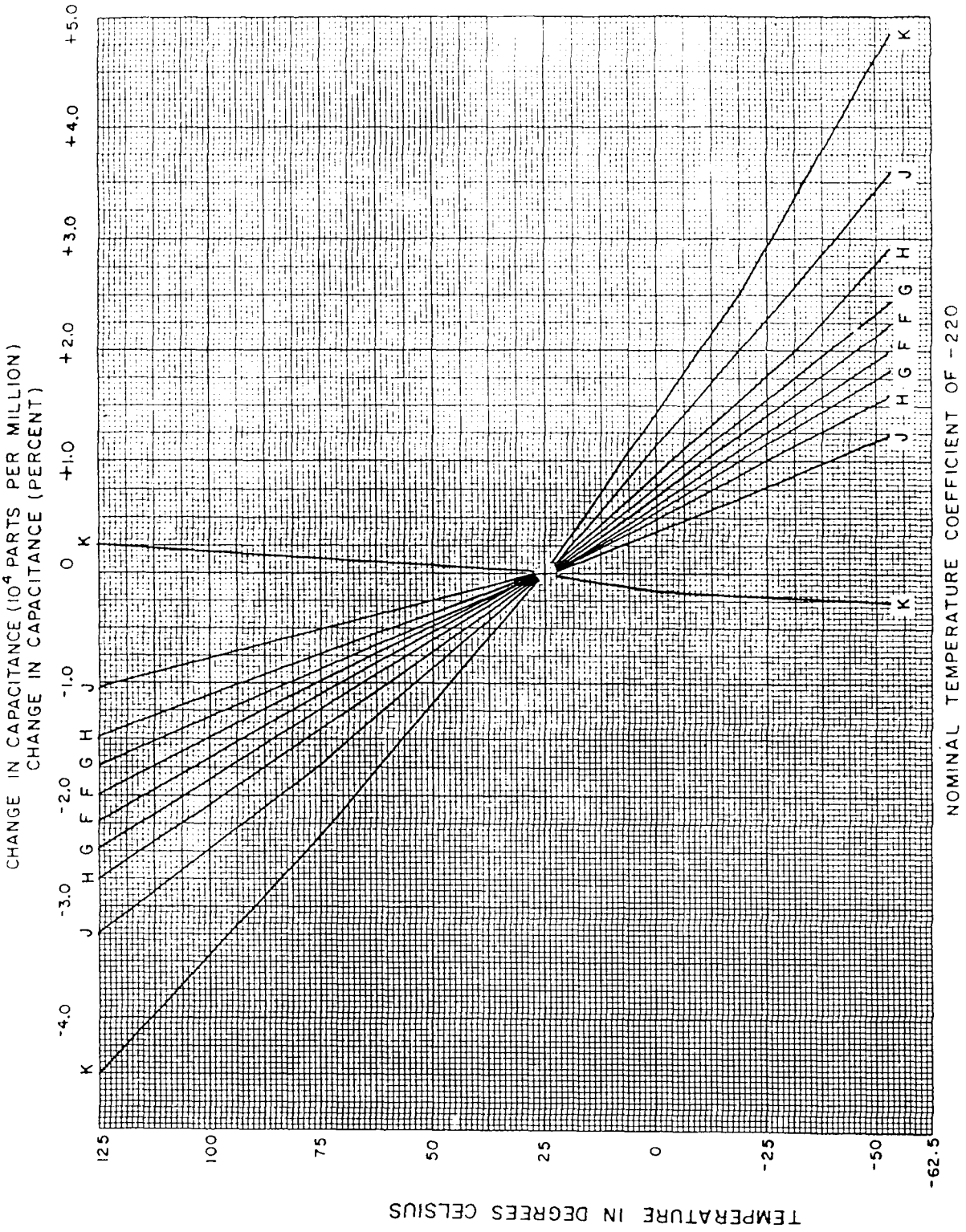


FIGURE 6. Tolerance envelopes for temperature coefficient R.

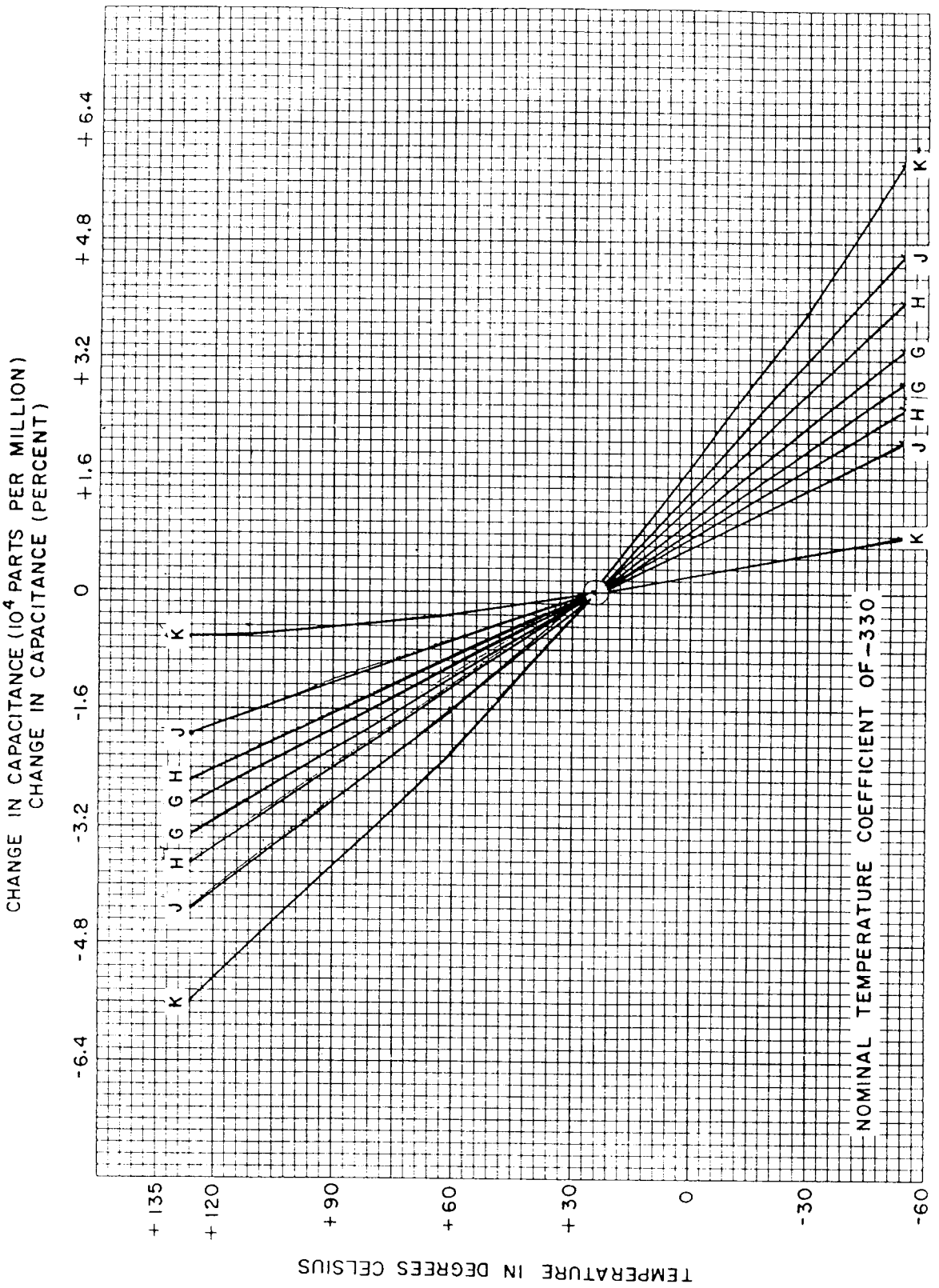


FIGURE 7. Tolerance envelopes for temperature coefficient S.

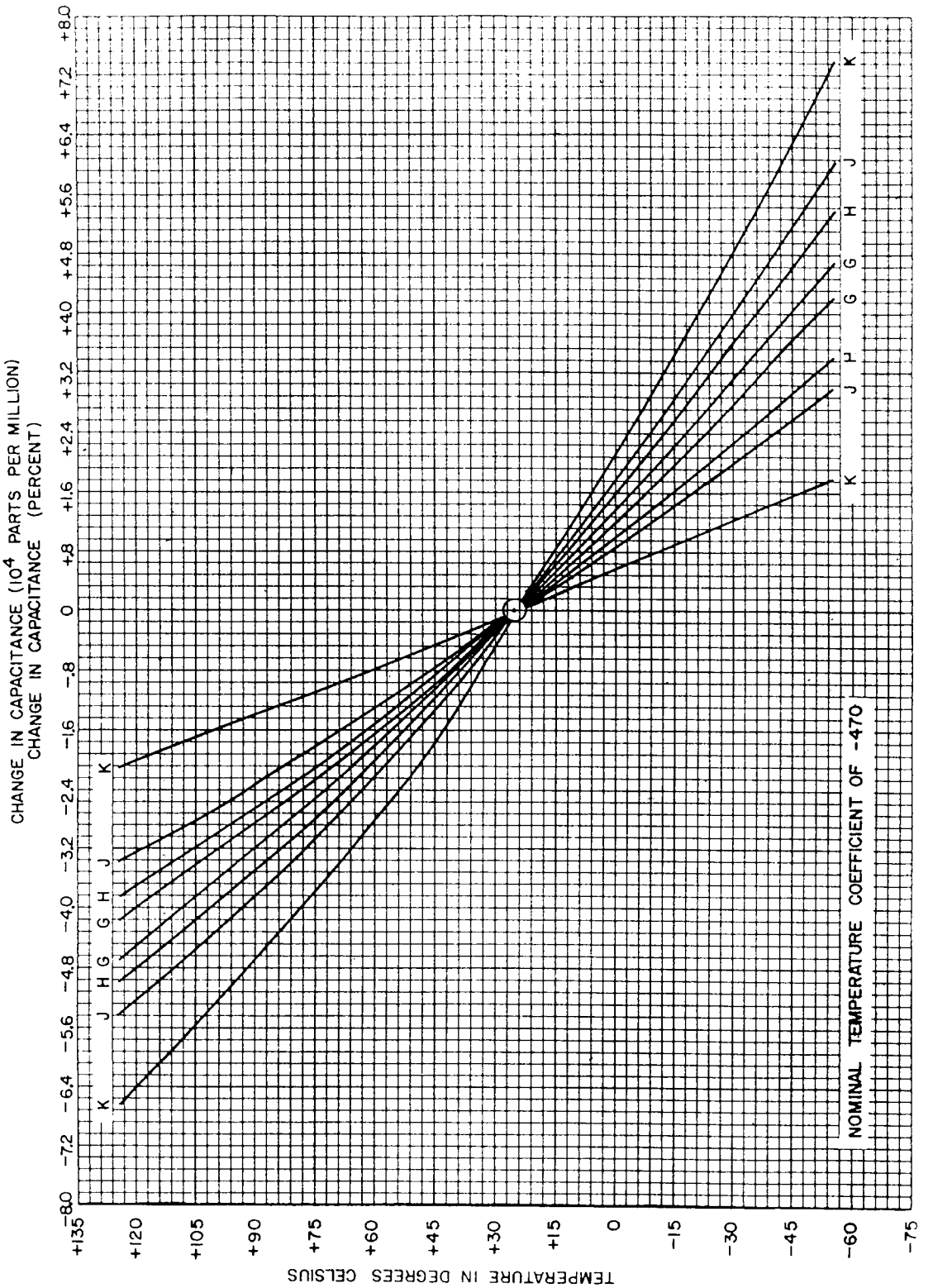


FIGURE 8. Tolerance envelopes for temperature coefficient T.

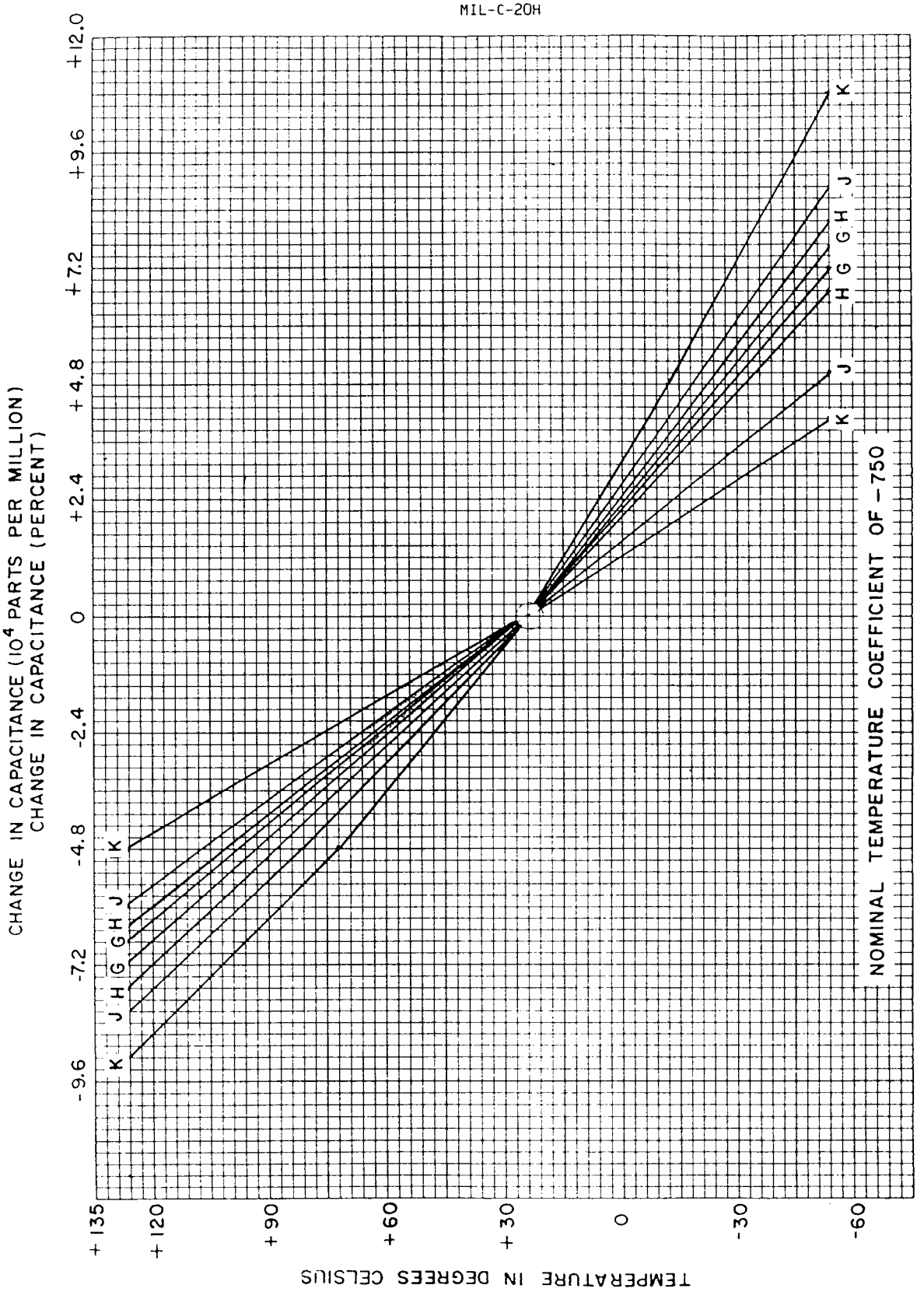


FIGURE 9. Tolerance envelope for temperature coefficient U.

1.2.1.5 Failure rate level. The failure rate level shall be as specified in table III.

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

Symbol	FR level
	Percent/1,000 hrs
M	1.0
P	0.1
R	0.01
S	0.001

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

MILITARY

MIL-C-39028 - Capacitors, Packaging of.
MIL-I-46058 - Insulating Compound, Electrical (For Coating Printed Circuit Assemblies).

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

STANDARDS

MILITARY

MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts.
MIL-STD-690 - Failure Rate Sampling Plans and Procedures.
MIL-STD-790 - Reliability Assurance Program for Electronic Parts Specifications.
MIL-STD-810 - Environmental Test Methods.
MIL-STD-1276 - Leads for Electronic Component Parts.
MIL-STD-1285 - Marking of Electrical and Electronic Parts.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Navy Publishing and Printing Service Office, Building 4D, NPM-DODSSP, 700 Robbins Avenue, Philadelphia, PA 19111-5094).

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the soliciation (see 6.2).

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

EIA-554 - Assessment of Outgoing Nonconforming levels in Parts Per Million (PPM).
EIA-557 - Statistical Process Control Systems.

(Application for copies should be addresed to the Electronic Industries Association (EIA), 2001 Pennsylvania Avenue, N.W., Washington, DC 20006.)

(Non-Government standards and other publications are normally available from the organization which prepares or distributes the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein, the text of this specification shall take precedence.

3. REQUIREMENTS

3.1 Specification sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheets. In the event of any conflict between requirements of this specification and the specification sheet, the latter shall govern (see 6.2).

3.2 Qualification. Capacitors furnished under this specification shall be products which are authorized by the qualifying activity for listing on the applicable qualified products list at the time of award of contract (see 4.4 and 6.3). Unless acquired from the manufacturer or his authorized distributor listed or approved for listing on the qualified products list, parts furnished under this specification shall not be considered as having met the requirements of this specification.

3.3 Reliability and quality (ER styles only).

3.3.1 Reliability. 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 MIL-STD-690 with details specified in 4.1.1, 4.4.4, and 4.4.6.

3.3.2 Quality.

3.3.2.1 Statistical process control (SPC). The manufacturer shall implement and use statistical process control techniques in the manufacturing process for ER parts covered by this specification. The SPC program shall be developed and maintained in accordance with all the requirements of EIA-557. The SPC program shall be documented and maintained as part of the overall reliability assurance program as specified in MIL-STD-790. The implementation date for statistical process control shall be 12 months from the date of this specification. Processes for application of SPC techniques should include but are not limited to:

a. Application of termination.

b. Assembly.

c. Chip firing.

d. Green chip assembly.

e. Dielectric material manufacture.

f. Packaging.

3.3.2.2 Quality levels. The quality of lots which have been subjected to and have passed the subgroup 1, 100% screening inspections, of group A inspection shall be established and maintained in accordance with 4.6.1.2.1.2.3 and EIA-554, method B. Individual PPM defect levels (i.e., PPM-2 and PPM-3) and an overall PPM defect level (i.e., PPM-5) shall be established based on the tests prescribed in the subgroup 2 tests of the group A inspections. The defect level for PPM-2 shall be less than 100 PPM. Data shall not be excluded from the appropriate PPM calculation unless specifically authorized by the qualifying activity. Guidance for exclusion of data is specified in EIA-554.

3.3.2.3 Noncompliance. The contractor shall notify the qualifying activity when the 100 PPM level is reached or exceeded for PPM-2. The contractor shall provide sufficient information to the qualifying activity documenting the causes of the problem and what corrective action is being taken. Failure to correct this problem shall be the basis for removal of the affected product from the QPL.

3.4 Material. The material shall be as specified herein; however, when a definite material is not specified, a material shall be used which will enable the capacitors to meet the performance requirements of this specification. Acceptance or approval of any constituent material shall not be construed as a guarantee of the acceptance of the finished product.

3.4.1 Insulating and impregnating compounds. Insulating and impregnating compounds, including varnishes, waxes, resins, and the like, shall be suitable for each particular application. Compounds shall preserve the electrical characteristics of the insulation to which they are applied.

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

3.5.1 Case. Capacitors shall be effectively sealed against the entry of moisture. When a molded case is specified (see 3.1), the capacitor element shall be enclosed via transfer molding or the use of a pre-formed case. When a conformal (dipped) case is specified (see 3.1), the capacitor element shall be enclosed within insulating resin, plastic, or ceramic.

3.5.2 Connections. Electrical connections shall not depend on wires, lugs, terminals, and the like, which are clamped between a metallic member and an insulating material other than the ceramic material. Such connections shall be soldered or shall be clamped between metallic members.

3.5.3 Solder dip (retinning leads). The manufacturer may solder dip/retin the leads of product supplied to this specification, provided the solder dip process has been approved by the qualifying activity.

3.5.3.1 Qualifying activity approval. Approval of the solder dip process will be based on one of the following options:

a. When the original lead finish qualified was hot solder dip lead finish 52 of MIL-STD-1276 (NOTE: The 200 microinch maximum thickness requirement is not applicable.), the manufacturer shall use the same solder dip process for retinning as is used in the original manufacture of the product.

b. When the lead originally qualified was not hot solder dip lead finish 52 of MIL-STD-1276 as prescribed in item a, approval for the process to be used for solder dip shall be based on the following test procedure:

(1) Thirty samples of any capacitance value for each style and lead finish are subjected to the manufacturer's solder dip process. Following the solder process, the capacitors shall be subjected to the electrical tests of group A inspection, with no defects allowed.

(2) Ten of the 30 samples shall then be subjected to the solderability test. No defects are allowed.

(3) The remaining 20 samples shall be subjected to the resistance to soldering heat test followed by the moisture resistance test, with no defects allowed.

3.5.3.2 Solder dip/retinning options. If the manufacturer solder dips or retins the leads as a part of normal production, or as a corrective action for solderability test failure, the following shall apply:

a. Following any solder dip or retinning process, the electrical tests as specified in group A, subgroup 2, shall be performed on a 25 piece sample for each hour of manufacturing. In the event of one or more defects, the production lot (or lots) produced during the hour from which the defects originated shall be subjected to 100 percent testing for dielectric withstanding voltage, insulation resistance (at 25°C), capacitance, and dissipation factor, and must meet the PDA requirements as specified in 4.6.1.2.1.1.

b. PPM-2 data following solder dip/retinning shall be reported each six months. The calculation method shall be in accordance with EIA-554, method B.

3.6 Thermal shock and voltage conditioning (ER parts only). When tested as specified in 4.7.2, capacitors shall withstand the extremes of high and low temperature without visible damage and meet the following requirements:

Dielectric withstanding voltage (at 25°C):	As specified in 3.10.
Insulation resistance (at 25°C):	Shall be not less than the value shown on figure 10.
Insulation resistance (at 125°C):	Shall be not less than the value shown on figure 10.
Capacitance (at 25°C):	Shall be within the tolerance specified (see 3.1).
Dissipation factor (at 25°C):	Shall not exceed the initial requirement (see 3.8).

3.7 Capacitance. When measured as specified in 4.7.3, the capacitance shall be within the specified tolerance (see 3.1).

3.8 Dissipation factor (when specified, see 3.1). When determined as specified in 4.7.4, the dissipation factor shall not exceed the percent specified on figure 11 (see 3.1).

NOTE: Due to the limitations of measuring equipment, capacitances of less than 30 pF appear to have a high dissipation factor, as shown on figure 11.

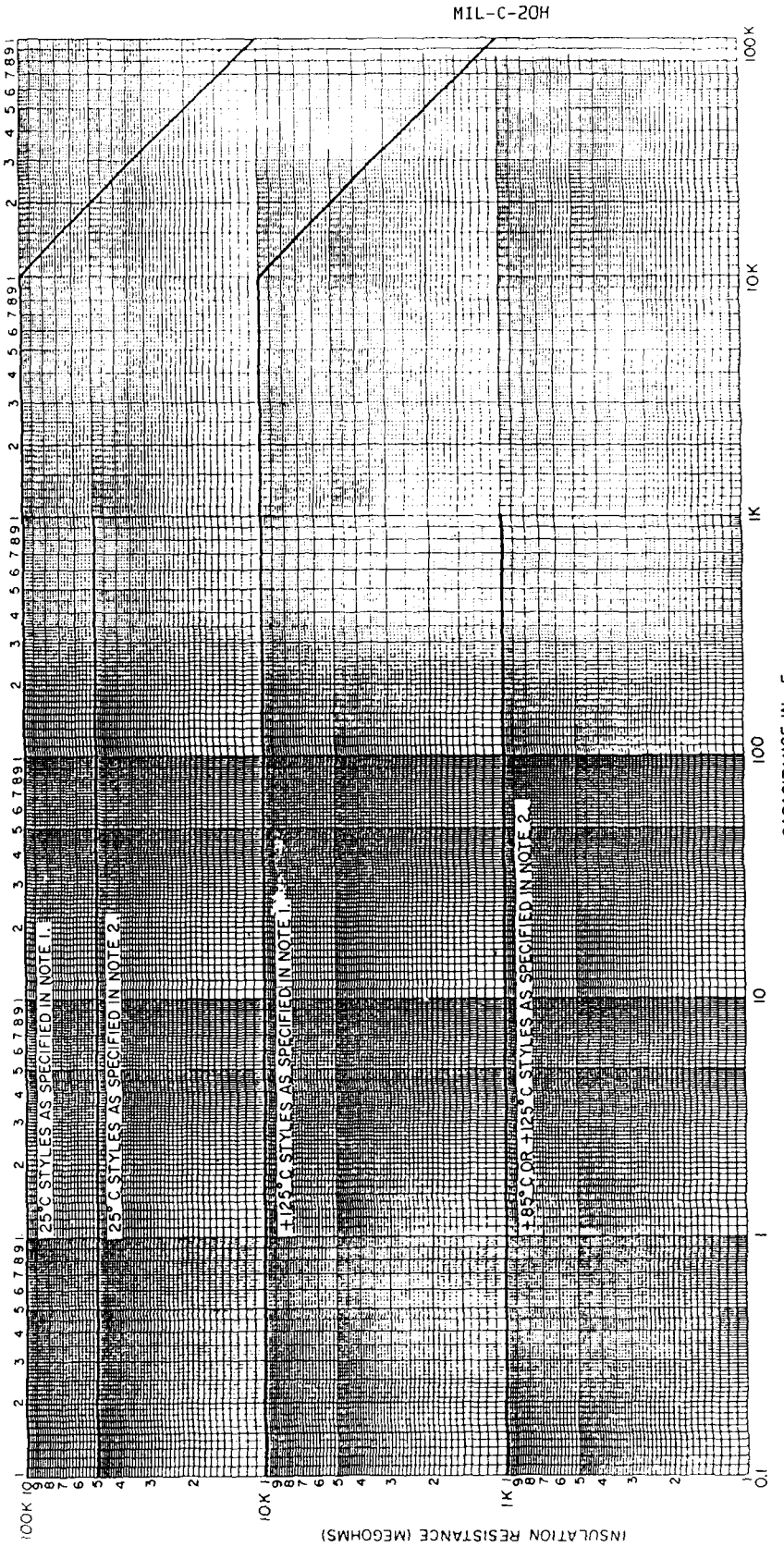
3.9 Quality factor (Q) (when specified, see 3.1). When determined as specified in 4.7.5, the Q shall be not less than the value shown on figure 12.

NOTE: Due to limitations of measuring equipment, capacitors of high capacitance and high Q may appear to have negative or infinite values of Q, and zero or negative dissipation factors. These capacitors shall be considered as having met the Q requirements, provided they meet the requirements for dielectric withstanding voltage and insulation resistance as specified in 3.10 and 3.12, respectively (see 6.4).

3.10 Dielectric withstanding voltage. When tested as specified in 4.7.6, capacitors shall withstand the dc potential without damage or breakdown.

3.11 Barometric pressure. When tested as specified in 4.7.7, capacitors shall withstand the dc potential without flashover.

3.12 Insulation resistance. When measured as specified in 4.7.8, the insulation resistance shall be not less than the value specified on figure 10.



NOTES:
1. Applicable to ER styles CCR05, 06, 07, 08, 09, 13, 14, 15, 16, 17, 19, 75, 76, 77, 78, and 79, and non-ER styles with same two-digit number.
2. Applicable to non-ER styles CC20, 22, 27, 30, 50, 51, 52, and 53 only.

FIGURE 10. Insulation resistance versus capacitance.

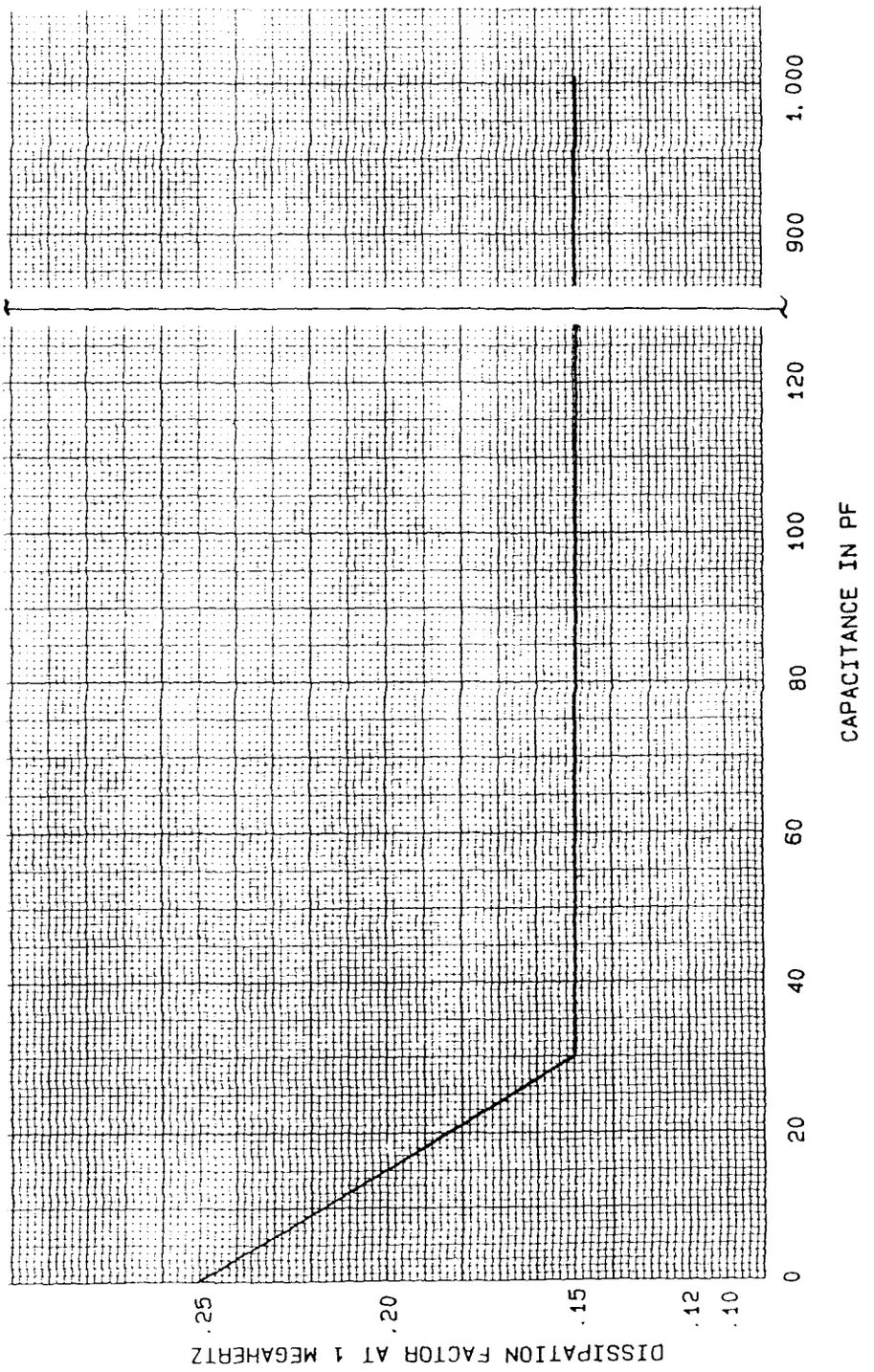


FIGURE 11. Maximum dissipation factor values.

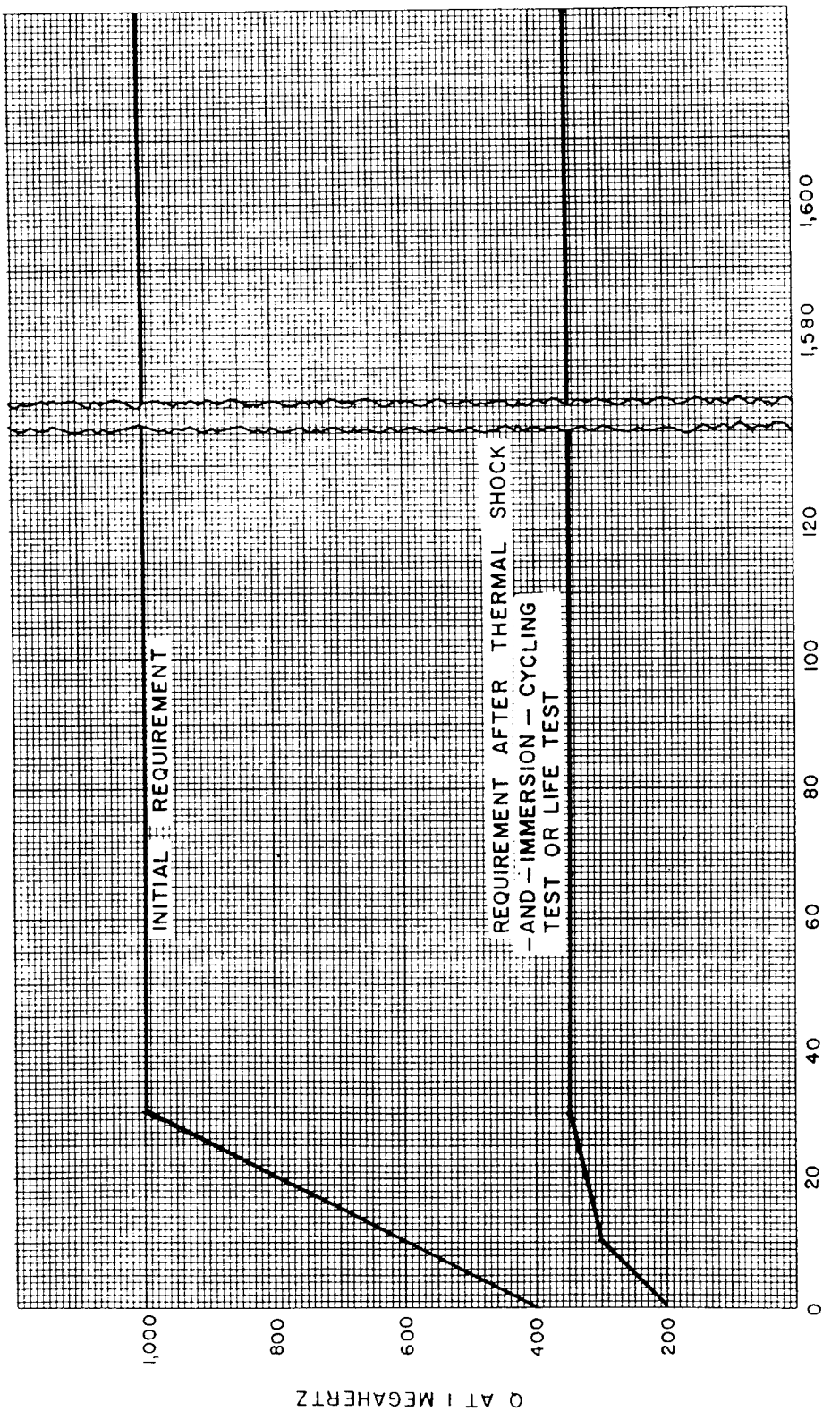


FIGURE 12. Minimum Q values.

3.13 Temperature coefficient and capacitance drift (see 4.7.9).

3.13.1 Temperature coefficient. Unless otherwise specified (see 3.1), each capacitance-temperature curve shall lie within the applicable tolerance envelope for the applicable temperature coefficient, as shown on figures 1 through 9 (see 6.5). Parts per million per degree Celsius can be calculated with the following equation:

$$PPM/^{\circ}C = \frac{C_2 - C_1}{T_2 - T_1} \times 10^6, \text{ where:}$$

C_2 = Capacitance at test temperature
C_1 = Capacitance at 25°C
T_2 = Test temperature
T_1 = 25°C

3.13.2 Capacitance drift. The capacitance drift shall be within ±(0.2 percent or 0.05 pF), whichever is greater.

3.14 Shock, specified pulse. When capacitors are tested as specified in 4.7.10, there shall be no momentary or intermittent contact of 0.5 millisecond (ms) or greater duration, open- or short-circuiting, or other evidence of mechanical damage.

3.15 Vibration, high frequency. When capacitors are tested as specified in 4.7.11, there shall be no momentary or intermittent contact of 0.5 ms or greater duration, open- or short-circuiting, or other evidence of mechanical damage; and capacitors shall meet the following requirements:

Capacitance:	Shall change not more than ± (2 percent or 0.5 pF) (0.25 pF for values less than 10 pF), whichever is greater, from the initial value obtained as measured as specified in 4.7.3.
Dissipation factor or Q (as applicable, see 3.1):	Shall not exceed the initial requirement.
Dielectric withstanding voltage:	Shall be as specified in 3.10.
Insulation resistance:	Shall be as specified in 3.12.

3.16 Thermal shock and immersion cycling. When tested as specified in 4.7.12, capacitors shall meet the following requirements:

Visual examination:	There shall be no evidence of corrosion or mechanical damage.
Capacitance:	Shall change not more than ±(3 percent or 0.5 pF) (0.25 pF for values less than 10 pF), whichever is greater, from the initial value obtained as measured as specified in 4.7.3.
Dissipation factor or Q (as applicable, see 3.1):	Shall not exceed the initial requirement; Q shall be not less than the value shown on figure 12.
Dielectric withstanding voltage:	Shall be as specified in 3.10.
Insulation resistance:	Shall be not less than 50 percent of the initial requirement.

3.17 Terminal strength (direct load). When capacitors are tested as specified in 4.7.13, the terminals shall not loosen or rupture, and there shall be no other damage to the terminals or capacitor body.

3.18 Moisture resistance. When tested as specified in 4.7.14, capacitors shall meet the following requirements:

Visual examination:	There shall be no evidence of corrosion or mechanical damage.
Capacitance:	Shall change not more than ± (3 percent or 0.5 pF) (0.25 pF for values less than 10 pF), whichever is greater, from the initial value obtained as measured as specified in 4.7.3.
Dielectric withstanding voltage:	Shall be as specified in 3.10.
Insulation resistance:	Shall be not less than 30 percent of the initial requirement.

3.19 Solderability (when specified, see 3.1). When capacitors are tested as specified in 4.7.15, the dipped surface of the leads shall be at least 95 percent covered with a new, smooth, solder coating. The remaining 5 percent may contain only small pinholes or rough spots; these shall not be concentrated in one area. In case of dispute, the percent of coverage with pinholes or rough spots shall be determined by actual measurement of these areas, as compared to the total area.

3.20 Resistance to soldering heat (when specified, see 3.1). When tested as specified in 4.7.16, capacitors shall meet the following requirements:

Insulation resistance at 25°C:	Unless otherwise specified (see 3.1), not less than the initial 25°C requirement.
Capacitance:	Shall change not more than ± 3 percent from the initial measured value.
Dissipation factor:	Shall not exceed the initial requirement.

3.21 Life (at elevated ambient temperature). When tested as specified in 4.7.17, capacitors shall meet the following requirements:

Visual examination:	There shall be no evidence of corrosion or mechanical damage.
Capacitance:	Shall change not more than ± (3 percent or 0.5 pF) (0.25 pF for values less than 10 pF), whichever is greater, from the initial value obtained as measured as specified in 4.7.3.
Dissipation factor or Q (as applicable, see 3.1):	Shall not exceed the initial requirement; Q shall be not less than the value shown on figure 12.
Insulation resistance:	Shall be not less than 50 percent of the initial requirement.

3.22 Radiographic inspection (for qualification and FR level 'S' when specified, see 3.1). When capacitors are tested as specified in 4.7.19, radiographic examination shall not disclose evidence of improperly made connections, substandard soldering or structural weakness, or attached solder particles or slivers.

3.23 Resistance to solvents (ink marking only). When capacitors are tested as specified in 4.7.20, there shall be no evidence of mechanical damage and the marking shall remain legible.

3.24 Fungus. The manufacturer shall certify that all external materials are fungus resistant or shall perform the test specified in 4.7.21. When capacitors are tested as specified in 4.7.21, examination shall not disclose evidence of fungus growth on the external surface.

3.25 Marking. Capacitors shall be marked as specified in 3.25.1 or 3.25.2, as applicable (see 3.1).

3.25.1 Method I. Marking of capacitors shall conform to method I of MIL-STD-1285. Unless otherwise specified (see 3.1), capacitor marking shall include the type designation, 'JAN' brand (ER only), trademark or manufacturer's name, source code, voltage, date code, and lot symbol in the order shown (see example).

Example of ER:

CCR78CG - PIN (see 1.2.1).
821KM
JAN TM - 'JAN' brand and trademark or manufacturer's name.
12345 - Source code (Commercial and Government Entity (CAGE)).
200V 9003A - Voltage, date code and lot symbol.

Example of non-ER:

CC78CG - PIN (see 1.2.1).
821K
TM - Trademark or manufacturer's name.
12345 - Source code (Commercial and Government Entity (CAGE)).
200V 9003A - Voltage, date code and lot symbol.

3.25.1.1 PIN marking. Unless otherwise specified (see 3.1), the PIN shall be divided between the characteristic and capacitance symbols. An ER part may be marked and furnished as a non-ER part, if produced on the same assembly line, and is subjected to and meets all the inspection requirements of the ER part.

3.25.1.2 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 that items so marked or identified are manufactured to, and meet all of the requirements of military specifications. Accordingly, items acquired to, and meeting all of the criteria specified herein and in applicable specifications shall bear the certification mark "JAN" except that items too small to bear the certification mark "JAN" shall bear the letter "J". The "JAN" or "J" shall be placed immediately before the PIN except that if such location would place a hardship on the manufacturer in connection with such marking, the "JAN" or "J" may be located on the first line above or below the PIN. Items furnished under contracts or orders which either permit or require deviation from the conditions or requirements specified herein or in applicable specifications shall not bear "JAN" or "J". In the event an item fails to meet the requirements of this specification and the applicable specification sheets or associated detail specifications, the manufacturer shall remove the "JAN" or the "J" from the sample tested and also from all items represented by the sample. The "JAN" or "J" certification mark shall not be used on products acquired to contractor drawings or specifications. The United States Government has obtained Certificate of Registration Number 504,860 for the certficiation mark "JAN".

3.25.2 Method II. Marking shall be in accordance with method II of MIL-STD-1285; details and exceptions shall be as follows, and as specified (see 3.1):

a. The characteristic, capacitance, and capacitance tolerance shall be indicated on the capacitor by bands of color or spots of color, as applicable (see 3.1). The characteristic band (or spot) shall be wider (or larger) than any other band or spot.

b. The colors used shall be as specified in table IV. When the body color is the same as any of the band or spot colors, then either the body color, or the band or spot color, shall be differentiated by shade or gloss, or by some other means.

TABLE IV. Color code.

Color	Characteristic 1/	Nominal capacitance (pF)		Capacitance tolerance	
		First and second significant figures	Multiplier 2/	For nominal capacitances greater than 10 pF	For nominal capacitances of 10 pF or smaller
				(±)	(±)
Black	C-	0	1		2.0 pF (G)
Brown	H-	1	10	1% (F)	
Red	L-	2	100	2% (G)	0.25 pF (C)
Orange	P-	3	1,000		
Yellow	R-	4			
Green	S-	5		5% (J)	0.5 pF (D)
Blue	T-	6			
Purple (violet)	U-	7			
Gray		8	0.01		
White		9	0.1	10% (K)	1.0 pF (F)
Gold	A-				

1/ The characteristic is a two-letter symbol identifying the nominal temperature coefficient and the tolerance envelope for the temperature coefficient, respectively. However, the characteristic band or spot identifies only the nominal temperature coefficient.

2/ The multiplier is the factor by which the significant figures are multiplied to yield the nominal capacitance (see 1.2.1.3). The lowest possible numerical multiplier shall be used to avoid alternate coding; for example, 0.5 pF should be green, black, gray - NOT black, green, white.

3.25.3 Marking legibility (laser marking only). When tested as specified in 4.7.18, the marking shall remain legible.

3.25.4 Substitution of failure rate levels (FRL's). A manufacturer may supply to all higher failure rate levels than to which he is qualified. Items of an exponential FRL as shown in table V and marked to lower FRL's with procuring agency approval, are substitutable for higher FRL's, and shall not be remarked unless specified in the contract or purchase order (see 6.2), the lot date codes on the parts are unchanged, and the workmanship criteria is met.

TABLE V. Failure rate level substitutability.

Parts qualified to failure rate level	Are substitutable for failure rate level
S	M, P, and R
R	M and P
P	M

3.25.5 Substitution of capacitance tolerance and voltage. Parts qualified and marked to tighter capacitance tolerance or higher rated voltage, with procuring agency approval, are substitutable for parts marked to looser capacitance tolerance or lower rated voltage, provided all other values, such as case size, characteristic, and leads are the same. The substitutable parts shall not be remarked unless specified in the contract or purchase order (see 6.2), the lot date code on the parts are unchanged, and the workmanship critera are met.

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

4. QUALITY ASSURANCE PROVISIONS

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

4.1.1 Responsibility for compliance. All items shall meet all requirements of section 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements; however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.1.2 Reliability assurance program (ER styles only). A reliability assurance program shall be established and maintained in accordance with MIL-STD-790.

4.1.3 Statistical process control (SPC)(ER styles only). An SPC program shall be established and maintained in accordance with EIA-557. Evidence of such compliance shall be verified by the qualifying activity as a prerequisite for qualification and retention of qualification.

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

a. Qualification inspection (see 4.4).

b. Verification of qualification (see 4.5).

c. Quality conformance inspection (see 4.6).

4.3 Inspection conditions and methods.

4.3.1 Conditions. Unless otherwise specified herein, all inspections shall be made in accordance with the "GENERAL REQUIREMENTS" of MIL-STD-202 except relative humidity shall not exceed 75 percent. Accuracy of all test voltage measurements shall be within ±2.0 percent of the specified voltage.

4.3.2 Methods.

4.3.2.1 Reference measurements. When requirements are based on comparative measurements made before and after conditioning, the reference measurement shall be considered the last measurement made at 25°C ±3°C prior to conditioning. Unless reference measurements have been made within 30 days prior to the beginning of conditioning, they shall be repeated.

4.3.3 Power supply. The power supply used for life testing shall have a regulation of ±2 percent or less of the specified test voltage.

4.4 Qualification inspection. Qualification inspection shall be performed at a laboratory acceptable to the Government (see 6.3), 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 of this specification. Each capacitor style shall be qualified separately.

4.4.2 Inspection routine. Sample units shall be subjected to the qualification inspection specified in table VI, in the order shown. ER styles shall be subjected to groups I through VI. Non-ER styles, active for new design, shall be subjected to groups II through VI. Non-ER styles, inactive for new design, shall be subjected to groups II, III, IV, and VI. For ER styles, all samples shall be subjected to group I with no failures permitted; for group II, one failure is permitted. Remaining samples shall be divided as shown in table VI for groups III through VI, respectively. For non-ER styles, active for new design, samples shall be subjected to group II, and then divided as shown in table VI for groups III through VI, respectively. For non-ER styles, inactive for new design, samples shall be subjected to group II, and then divided as shown in table VI for groups III, IV, and VI, respectively.

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

TABLE VI. Qualification inspection.

Inspection	Requirement paragraph	Test method paragraph	Number of sample units to be inspected	Number of defectives permitted 1/
Group I 2/				
Thermal shock and voltage conditioning (ER only)	3.6	4.7.2	49	0
Radiographic inspection (FR level 'S', when specified, see 3.1)	3.22	4.7.19	Not applicable	100% inspection (when applicable)
Group II 2/				
Visual and mechanical inspection: Material, design, and construction, marking 3/ and workmanship	3.1, 3.4, 3.5, 3.25, and 3.26	4.7.1	37 (non-ER) -- 4/	-- 1
Capacitance	3.7	4.7.3	49 (ER)	
Dissipation factor (when specified, see 3.1)	3.8	4.7.4		
Quality factor (Q) (when specified, see 3.1)	3.9	4.7.5		
Dielectric withstanding voltage	3.10	4.7.6		
Barometric pressure	3.11	4.7.7		
Insulation resistance	3.12	4.7.8		
Group III				
Temperature coefficient and capacitance drift	3.13	4.7.9.1	-- 12	-- 1
Shock, specified pulse	3.14	4.7.10		
Vibration, high frequency	3.15	4.7.11		
Thermal shock and immersion cycling	3.16	4.7.12		

See footnotes at end of table.

TABLE VI. Qualification inspection - Continued.

Inspection	Requirement paragraph	Test method paragraph	Number of sample units to be inspected	Number of defectives permitted 1/
Group IV				
Terminal strength (direct load)	3.17	4.7.13	6	1
Resistance to soldering heat(when specified see, 3,1)	3,20	4.7.16		
Moisture resistance	3.18	4.7.14		
Group V 5/				
Solderability	3.19	4.7.15	6	1
Marking legibility (laser marking only)	3.25.3	4.7.18		
Resistance to solvents (ink marking only)	3.23	4.7.20		
Fungus 6/	3.24	4.7.21		
Group VI				
Life (at elevated ambient temperature)	3.21	4.7.17.1	12 (non-ER) or 24 (ER)	1

1/ A sample unit having one or more defects shall be considered as a single failure.
2/ All examinations and tests are nondestructive.
3/ Marking defects are based on visual examination only and shall be charged only as illegible, incomplete, or incorrect marking. Provisions to reject unmarked parts will also be made.
4/ One additional sample unit is included in each sample to permit substitution for the failure allowed in group II (37 sample units for non-ER styles active for new design; 31 sample units for non-ER styles inactive for new design.
5/ Applicable to active for new design styles only.
6/ Certification of fungus resistance may be substituted for testing.

4.4.4 FR qualification (ER styles only). FR qualification shall be in accordance with the general and detailed requirements of MIL-STD-690 and the following details:

a. Procedure I - Qualification at the initial FR level. Level "M" (1.0 percent/1,000 hours) of FRSP-90 shall apply. Sample units which have been subjected to the qualification inspection specified in group VI, table VI shall be continued on test as specified in 4.7.17.2.

b. Procedure II - Extension of qualification to lower FR levels. To extend qualification to the 0.01 percent/1,000 hours "R" and 0.001 percent/1,000 hours "S" failure rate levels, data from two or more voltage groups within a style of similar construction may be combined.

c. Procedure III - Maintenance of FR level qualification. Maintenance period B of FRSP-10 shall apply. Regardless of the number of production lots produced during this period, the specified number of unit hours shall be accumulated to maintain qualification.

4.4.5 Quality level verification (ER styles only). The manufacturer is responsible for establishing a quality system to verify the PPM defect level of lots which are subjected to subgroup 2 tests of the group A inspections. The PPM defect level shall be based on a 6-month moving average. The manufacturer shall verify and report individual PPM categories (i.e., PPM-2 and PPM-3) and an overall PPM defect level (i.e., PPM-5). In the event that the manufacturer meets or exceeds 100 PPM for PPM-2, the qualifying activity shall take the actions specified in 3.3.2.3.

4.4.6 Retention of qualification (non-ER styles only). To retain qualification, the contractor 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 which have passed and the number which have failed. The results of tests of all reworked lots shall be identified and accounted for.

b. The results of the test performed for periodic inspection (group B), including the number and mode of failures. The test report shall include results of all periodic inspection tests performed and completed during the 6-month period. If the test results indicate 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 contractor 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 three consecutive reporting periods there has been no production, the manufacturer may be required, at the discretion of the qualifying activity, to submit a representative product of each style to testing in accordance with the qualification inspection requirements.

Retention of qualification of an ER style will also retain qualification of the similar non-ER style; e.g., CCR75 and CC75.

4.5 Verification of qualification (ER styles only). Every 6 months, the manufacturer shall compile a summary of the results of quality conformance inspections and, where applicable, extended failure rate test data, in the form of a verification of qualification report, and forward it to the qualifying activity as the basis of continued qualification approval. In addition to the periodic submission of failure rate test data, the manufacturer shall immediately notify the qualifying activity whenever the failure rate data indicates that the manufacturer has failed to maintain his qualified failure rate level. Continuation shall be based on evidence that, over the six-month period, the following have been met:

a. Verification by the qualifying activity that the manufacturer meets the requirements of MIL-STD-790.

b. The manufacturer has not modified the design of the item.

c. The specification requirements for the item have not been amended so far as to affect the character of the item.

d. Lot rejection for group A inspection does not exceed 10 percent or one lot, whichever is greater.

e. The data from group A quality conformance life test (failure rate level 1.0 percent/1,000 hours only) substantiates that the failure rate level is being maintained.

f. The records of all failure rate tests combined substantiate that the 1.0 percent/1,000 hours, or 0.1 percent/1,000 hours "P" failure rate level has been maintained or that the manufacturer continues to meet the 0.01 percent/1,000 hours, or 0.001 percent/1,000 hours failure rate level for which qualified, although the total component hours of testing do not as yet meet the requirements of 4.4.4c.

g. The manufacturer shall provide documentation to the qualifying activity pertaining to PPM calculations including numbers of part types tested, individual PPM defect categories (i.e., PPM-2 and PPM-3), and the overall PPM defect rate (PPM-5). This information shall be submitted on a specification sheet basis.

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

If group B test requires a comparison of "post-test" readings with initial readings (delta measurements), the verification of qualification summary shall include the maximum and minimum delta changes for each inspection lot. For life testing, delta C readings shall be reported at each interval in which readings are taken.

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 contractor 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 three consecutive reporting periods there has been no production, the manufacturer may be required, at the discretion of the qualifying activity, to submit a representative product of each style to testing in accordance with the qualification inspection requirements.

4.5.1 Records. Test records shall be in accordance with the format in MIL-STD-690.

4.6 Quality conformance inspection.

4.6.1 Inspection of product for delivery. Inspection of product for delivery shall consist of group A inspection (FR levels 1.0, 0.1, 0.01, and 0.001 percent/1,000 hours).

4.6.1.1 Inspection and production lot.

4.6.1.1.1 Inspection lot. An inspection lot shall consist of all capacitors of one or more styles produced under essentially the same conditions and offered for inspection at the same time. ER parts shall be kept separate from the non-ER parts. The sample selected from the lot shall be representative of the styles in the lot. The styles may be grouped as follows:

Group	Style
1	CCR05, CCR06, CCR07, CCR08, and CCR09.
2	CCR13, CCR14, CCR15, CCR16, CCR17, and CCR19.
3	CCR75, CCR76, CCR77, CCR78, and CCR79.
4	All styles inactive for new design may be combined.

4.6.1.1.2 Production lot. A production lot shall consist of all capacitors of the same style, voltage rating, nominal capacitance value, and voltage-temperature characteristic. The manufacture of all parts in the lot shall have been started, processed, assembled, and tested as a group. Lot identity shall be maintained throughout the manufacturing cycle.

4.6.1.2 Group A inspection. Group A inspection shall consist of the inspections specified in tables VII or IX. Subgroups 1 through 3 shall be done in the order shown. Subgroups 4 and 5 in table VII may be done at any time after subgroup 1.

4.6.1.2.1 ER styles.

4.6.1.2.1.1 Subgroup 1 tests. The subgroup 1 tests shall be performed on each capacitor offered for inspection. Capacitors failing the tests of subgroup 1 shall be removed from the lot. Production lots exceeding 5 percent PDA shall be segregated from new lots and lots which have passed inspection. Production lots exceeding 15 percent PDA shall be rejected and shall not be resubmitted for reinspection. Production lots with greater than 5 percent to 15 percent PDA may be offered for acceptance only if the manufacturer 100 percent retests to the requirements of subgroup 1. Resubmitted lots shall be kept separate and shall be clearly identified as resubmitted lots. If, during the 100 percent reinspection to subgroup 1, the lot exceeds 3 percent defective, the lot shall be rejected and shall not be resubmitted.

TABLE VII. Group A inspection (ER).

Inspection	Requirement paragraph	Test method paragraph	Sampling procedure
Subgroup 1			
Thermal shock and voltage conditioning	3.6	4.7.2	100% inspection
Subgroup 2 (PPM)			see table VIII
Capacitance (PPM-2)	3.7	4.7.3	
Dissipation factor (when specified, see 3.1) (PPM-2)	3.8	4.7.4	
Dielectric withstanding voltage (PPM-2)	3.10	4.7.6	
Insulation resistance (PPM-2)	3.12	4.7.8	
Mechanical examination: (Physical dimensions only)(PPM-3)	3.5	4.7.1	
Subgroup 3			13 samples 0 failures
Visual examination: Material	3.4	4.7.1	
Marking 1/	3.25		
Workmanship	3.26		
Subgroup 4			
Solderability	3.19	4.7.15	13 samples 0 failures
Subgroup 5			
Radiographic inspection (FR level "S", when specified, see 3.1)	3.22	4.7.19	100% inspection

1/ Marking defects are based on visual examination only.

TABLE VIII. Sampling plans for PPM categories.

Lot size	Sample size
1-125	100 percent
126-3200	125 samples
3201-10,000	192 "
10,001-150,000	294 "
150,001-500,000	345 "
500,001-up	435 "

TABLE IX. Group A inspection (Non-ER).

Inspection	Requirement paragraph	Test method paragraph	Sampling procedure
Subgroup 1			
Capacitance	3.7	4.7.3	125 samples 0 failures
Dissipation factor (when specified, see 3.1)	3.8	4.7.4	
Quality factor (Q) (when specified, see 3.1)	3.9	4.7.5	
Dielectric withstanding voltage	3.10	4.7.6	
Insulation resistance	3.12	4.7.8	
Subgroup 2			
Visual and mechanical inspection:	3.1, 3.4	4.7.1	13 samples 0 failures
Design and construction	3.5		
Marking 1/	3.25		
Workmanship	3.26		
Subgroup 3			
Solderability (when specified, see 3.1)	3.19	4.7.15	13 samples 0 failures

1/ Marking defects are based on visual examination only.

4.6.1.2.1.1.1 Manufacturer's production inspection. If the manufacturer performs tests similar to that specified in subgroup 1 of 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. Test conducted by the manufacturer during production shall be clearly identical to or more stringent than that specified for subgroup 1.

b. Manufacturer subjects 100 percent of the product supplied under this specification to his production tests.

c. The parameters measured and the failure criteria shall be the same or more stringent than those specified herein.

d. The lot rejection criteria are the same as or more stringent than that specified herein.

e. The manufacturer shall make available all information concerning the test procedures and instrumentation used in his production tests. This data shall be provided as part of the evaluation required for MIL-STD-790. The manufacturer shall also make available to the Government all records of all test data detail resulting from production tests.

f. Once approved, the manufacturer shall not change the test procedures or criteria without prior notification of and concurrence by the qualifying activity.

4.6.1.2.1.2 Subgroup 2 tests (PPM categories).

4.6.1.2.1.2.1 Sampling plans. Subgroup 2 tests shall be performed on an inspection lot basis. Samples subjected to subgroup 2 shall be selected in accordance with table VIII, based on the size of the production lot. In the event of one or more failures the lot shall be rejected. Equipment and operators used to perform the subgroup 2 tests shall not be the same as those used in the subgroup 1 100 percent tests.

4.6.1.2.1.2.2 Rejected lots. The rejected lot shall be segregated from new lots and those lots which have passed inspection. The rejected lot shall be 100 percent inspected for those quality characteristics found defective in the sample and any defectives found shall be removed from the lot. A new sample of parts shall then be randomly selected in accordance with table VIII. If one or more defects are found in this second sample, the lot shall be rejected and shall not be supplied to this specification.

4.6.1.2.1.2.3 PPM calculations. PPM calculations shall be based on the results of the first sample check as prescribed in 4.6.1.2.1.2.1. Calculations and data exclusion shall be in accordance with EIA-554. (Note: PPM calculations shall not use data on the second sample submission).

4.6.1.2.1.3 Subgroup 3 tests. Subgroup 3 shall be performed on an inspection lot basis. The sampling procedure shall be as specified in table VII.

4.6.1,2.1.3.1 Rejected lots. The rejected lot shall be segregated from new lots and those lots that have passed inspection. Lots rejected because of failures in subgroup 3 may be offered for acceptance only if the manufacturer inspects all units in the lot for those quality characteristics found defective in the sample and, after removing all defective units found, reinspects the lot using the sampling procedure specified in table VII. If one or more defects are found in the second sample, the lot shall be rejected and shall not be supplied to this specification. Resubmitted lots shall be kept separate from new lots, and shall be identified as resubmitted lots.

4.6.1.2.1.4 Subgroup 4 (solderability).

4.6.1.2.1.4.1 Sampling plan. Thirteen samples shall be selected randomly from every inspection lot and subjected to the subgroup 4 solderability test. The manufacturer may use electrical rejects from the Subgroup 1 screening tests for all or part of the samples to be used for solderability testing. If there are one or more defects, the lot shall be considered to have failed.

4.6.1.2.1.4.2 Rejected lots. In the event of one or more defects, the inspection lot shall be rejected. The manufacturer may use one of the following options to rework the lot:

a. Each production lot that was used to form the failed inspection lot shall be individually submitted to the solderability test as required in 4.6.1.2.1.4.1. Production lots that pass the solderability test are available for shipment. Production lots failing the solderability test can be reworked only if submitted to the solder dip procedure in item "b".

b. The manufacturer shall submit the failed lot to a 100 percent solder dip. Two hundred sample units (or 100 percent of the lot, whichever is less) from this lot shall then be subjected to all group A, subgroup 1 post-electrical tests, with no defects allowed.

(1) If the 200 sample units (or 100 percent of the lot, whichever is less) pass the group A, subgroup 1 post-electrical tests, 13 additional units shall then be subjected to the solderability test, with no defects allowed. If there are one or more defects, the lot shall be considered rejected and shall not be furnished against the requirements of this specification.

(2) If the 200 sample units (or 100 percent of the lot, whichever is less) fail group A, subgroup 1 post-electrical tests, these tests shall be performed on 100 percent of the lot. The lot must meet the 5 PDA requirement as specified in 4.6.1.2.1.1. If the 5 percent PDA requirement is not met, the lot shall be considered rejected and shall not be furnished against the requirements of this specification. If the 5 percent PDA requirement is met, 13 sample units shall be subjected to the solderability testing criteria of 4.6.1.2.1.4.2b(1).

4.6.1.2.1.4.3 Disposition of samples. The solderability test is considered a destructive test and samples submitted to the solderability test shall not be supplied on the contract.

4.6.1.2.1.5 Subgroup 5 (radiographic inspection) (FR level "S", when specified, see 3.1). The subgroup 5 test shall be performed on each capacitor offered for inspection. Capacitors not meeting the inspection criteria shall be removed from the production lot and shall not be supplied to this specification.

4.6.1.2.2 Non-ER styles.

4.6.1.2.2.1 Sampling plan. The sampling plan for subgroups 1 and 2 shall be as specified in table IX.

4.6.1.2.2.2 Rejected lots. If an inspection lot for subgroups 1 or 2 is rejected, the contractor 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 separated from new lots, and shall be clearly identified as reinspected lots.

4.6.1.2.2.3 Subgroup 3 (solderability).

4.6.1.2.2.3.1 Sampling plan. Thirteen samples shall be selected randomly from every inspection lot and subjected to the subgroup 3 solderability test. The manufacturer may use electrical rejects from the subgroup 1 screening tests for all or part of the samples to be used for solderability testing. If there are one or more defects, the lot shall be considered to have failed.

4.6.1.2.2.3.2 Rejected lots. In the event of one or more defects, the inspection lot shall be rejected. The manufacturer may use one of the following options to rework the lot:

a. Each production lot that was used to form the failed inspection lot shall be individually submitted to the solderability test as required in 4.6.1.2.2.3.1. Production lots that pass the solderability test are available for shipment. Production lots failing the solderability test can be reworked only if submitted to the solder dip procedure in item "b".

b. The manufacturer shall submit the failed lot to a 100 percent solder dip using an approved solder dip process in accordance with 3.5.3. Following the solder dip, the electrical measurements required in the group A, subgroup 1 tests shall be repeated on another 125 samples with no defects allowed. Thirteen additional samples shall then be selected and subjected to the solderability test with no defects allowed. If the lot fails this solderability test, the lot shall be considered rejected and shall not be furnished against the requirements of this specification.

4.6.1.2.2.3.3 Disposition of samples. The solderability test is considered a destructive test and samples submitted to the solderability test shall not be supplied on the contract.

4.6.2 Periodic (group B) inspection. Periodic inspection shall consist of group B. Except where the results of these inspections show noncompliance with the applicable requirements (see 4.6.2.1.3), delivery of products which have passed group A shall not be delayed pending the results of this inspection.

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

TABLE X. Group B inspection.

Test	Requirement paragraph	Test method paragraph	Number of sample units to be inspected	Number of defectives permitted 1/
Every month				
Barometric pressure	3.11	4.7.7	-- 12	-- 0
Temperature coefficient and capacitance drift	3.13	4.7.9.2		
Every 2 months 2/				
Subgroup 1 3/				
Shock, specified pulse	3.14	4.7.10	-- 12	- 1
Vibration, high frequency	3.15	4.7.11		
Thermal shock and immersion cycling	3.16	4.7.12		- 1
Subgroup 2				
Terminal strength (direct load)	3.17	4.7.13	-- 12	- 1
Resistance to soldering heat (when specified, see 3.1)	3.20	4.7.16		
Moisture resistance	3.18	4.7.14		
Subgroup 3 4/				
Marking legibility (laser marking only)	3.25.3	4.7.18	-- 6	- 1
Resistance to solvents (ink marking only)	3.23	4.7.20		
Every 4 months				
Life (at elevated ambient temperature)	3.21	4.7.17.2	12	5/

1/ A sample unit having one or more defects shall be considered as a single failure.
2/ Subgroups 1 and 2 shall be checked during alternate bimonthly periods.
3/ Subgroup 1 tests may be performed on sample units that have been subjected to and have passed the monthly inspection, when these sampling periods coincide.
4/ Applicable to new design styles (ER and non-ER) only.
5/ For non-ER, one defective is permitted. For ER, the number of allowable defectives may vary with the failure rate level of the part being tested.

4.6.2.1.1 Sampling plan.

4.6.2.1.1.1 Every month. Every month (every 3 months for styles CC50 through CC53), sample units from each temperature coefficient and tightest temperature coefficient tolerance in each temperature coefficient shall be selected and subjected to the applicable tests in table X.

4.6.2.1.1.2 Every 2 months. Every 2 months (every 6 months for styles CC50 through CC53), sample units of the same type designation shall be selected and subjected to the tests of subgroups 1, 2, and 3 of table X. When each sample is selected, the Government shall review all selections made within the preceding 2 years in order to assure that all styles have been drawn into the testing program.

4.6.2.1.1.3 Every 4 months. Every 4 months (every 12 months for styles CC50 through CC53), sample units of the highest capacitance value of each style produced shall be selected and subjected to the test specified in table X. These capacitors may be in any capacitance tolerance.

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

4.6.2.1.3 Noncompliance. If a sample fails to pass group B inspection, the manufacturer shall notify the qualifying activity and the cognizant inspection activity of such failure and take corrective action on the materials and processes, or both, as warranted, and on all units of product which can be corrected and which were manufactured under essentially the same processes and materials, and which are considered subject to the same failure. Acceptance and shipment of product shall be discontinued until corrective action, acceptable to the qualifying activity, has been taken. After the corrective action has been taken, group B inspection shall be repeated on additional sample units (all inspections, or the inspection which the original sample failed, at the option of the qualifying activity). Group A inspection may be reinstituted; however, final acceptance and shipment shall be withheld until the group B inspection has shown that the corrective action was successful. In the event of failure after reinspection, information concerning the failure shall be furnished to the cognizant inspection activity and the qualifying activity.

4.7 Methods of inspection.

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

4.7.2 Thermal shock and voltage conditioning (ER parts only) (see 3.6). Capacitors shall be subjected to the tests of 4.7.2.1 and 4.7.2.2.

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

a. Test condition: A, except that in step 3, sample units shall be tested at the applicable high test temperature (see 3.1).

b. Measurements before and after cycling: Not applicable.

4.7.2.2 Voltage conditioning. One of the voltage conditioning tests in 4.7.2.2.1 or 4.7.2.2.2 shall be performed. The lot traveler shall indicate which test is used. When the optional voltage conditioning test of 4.7.2.2.2 (ER only) is used, the traveler shall include the specific accelerated voltage used and the test time.

4.7.2.2.1 Standard voltage conditioning. Voltage conditioning shall follow the thermal shock test. The voltage conditioning shall consist of applying twice the rated voltage to the unit at 125°C, +4°C, -0°C for 96 hours minimum. After completion of the exposure period, the unit shall be allowed to stabilize at room temperature (25°C), and the dielectric withstanding voltage and insulation resistance shall be measured as specified in 4.7.6 and 4.7.8.1, respectively. After measurement of dielectric withstanding voltage and insulation resistance at 25°C, the unit shall be stabilized at 125°C, +4°C, -0°C and insulation resistance shall be measured as specified in 4.7.8.2. After allowing the unit to stabilize at room temperature, the capacitance and dissipation factor shall be measured as specified in 4.7.3 and 4.7.4, respectively.

4.7.2.2.2 Optional voltage conditioning (ER only). The manufacturer, with approval from the qualifying activity, may perform an optional voltage conditioning test instead of the standard voltage conditioning test of 4.7.2.2.1. Optional voltage conditioning shall be limited to capacitors with a dc rated voltage of 200 volts or less. All conditions of 4.7.2.2.1 apply, with the exception of the voltage applied and the test time. The minimum time duration, T(test), shall be calculated as follows:

$$T(test) = \frac{800}{(E\ test/E\ rated)^3}$$

Where: 2 x E rated ≤ E test ≤ 4 x E rated

T(test) = Minimum test time in hours
E test = Applied voltage
E rated = Rated voltage of the capacitor

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

a. Test frequency: 1 megahertz (MHz) ±100 kilohertz (kHz), when the nominal capacitance is 1,000 pF and smaller, and 1 KHz ±100 Hz when the nominal capacitance is greater than 1,000 pF. At the option of the manufacturer, capacitance measurements may be made at any frequency from 1 kHz to 1 MHz and referred to measurements at 1 MHz and 1 kHz, as applicable.

b. Limit of accuracy: The accuracy of measurement shall be 1/3 of the nominal capacitance tolerance or 2 percent, whichever is smaller; however, the accuracy need not be better than 0.1 pF.

c. Test jig for measuring capacitance values of less than 10 pF: Shall be a guarded three terminal type, or equivalent.

4.7.4 Dissipation factor (when specified, see 3.1) (see 3.8). The dissipation factor shall be measured with a capacitance bridge or other suitable method at the frequency specified in 4.7.3a. The voltage shall be 1.0 ±0.2 volts rms. The inherent accuracy of the measurement shall be ±2 percent of the reading plus 0.1 percent dissipation factor (absolute). Suitable measurement techniques shall be used to minimize errors due to the connections between the measuring apparatus and the capacitor.

4.7.5 Quality factor (Q) (when specified, see 3.1) (see 3.9). Capacitors shall be tested in accordance with method 306 of MIL-STD-202. The test frequency shall be as specified in 4.7.3a.

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

a. Magnitude and nature of test voltage: 300 percent of the dc rated voltage specified (see 3.1).

b. Duration of application of test voltage: 5 ±1 seconds.

c. Points of application of test voltage: Between the capacitor-element terminals.

d. Limiting value of surge current: Shall not exceed 50 milliamperes (mA).

e. Examination after test: Capacitors shall be examined for evidence of damage and breakdown.

4.7.6.1 Body insulation (when specified, see 3.1). Capacitors shall be tested in accordance with one of the following, as specified (see 3.1).

a. Test I: Capacitors shall be placed in the trough of a V-block which shall extend beyond the ends of the body of the capacitor. A dc potential of 1,300 volts shall then be applied between the two leads connected together and the V-block for a period of 5 ±1 seconds. The surge current shall not exceed 50 mA.

b. Test II: Capacitors shall be wrapped with a conductive tape or foil so that the conductive tape or foil shall not be less than 0.0625 inch (1.588 mm) and not more than 0.125 inch (3.18 mm) away from the lead wires. A dc potential of 1,300 volts shall be applied between the two leads connected together and the tape or foil for a period of 5 ±1 seconds. The test circuit shall be so arranged that the surge current does not exceed 50 mA.

After the test, capacitors shall be examined for evidence of damage or breakdown.

4.7.7 Barometric pressure (see 3.11). Capacitors shall be tested in accordance with method 105 of MIL-STD-202. The following details shall apply:

a. Method of mounting: Capacitors shall be mounted by suitably clamping their leads.

b. Test condition: B.

c. Test during subjection to reduced pressure: 100 percent of the dc rated voltage (see 3.1) shall be applied between the capacitor-element terminals for a period of 5 ±1 seconds. The surge current shall not exceed 50 mA.

4.7.8 Insulation resistance (see 3.12).

4.7.8.1 At 25°C. Capacitors shall be tested in accordance with method 302 of MIL-STD-202. The following details shall apply:

a. Test potential: Rated voltage (see 3.1).

b. Points of measurement: Between capacitor-element terminals.

c. Electrification time: 2 minutes ±5 seconds, except during quality conformance inspection when the electrification time may be the time required by the capacitor to reach full charge, provided it does not exceed 2 minutes. Voltage shall be applied through a resistor which will limit the charging current from 30 to 50 mA.

4.7.8.2 At high ambient temperature. Capacitors shall be subjected to the applicable high ambient temperature (see 3.1) for a period of time sufficient to reach thermal stability, and the insulation resistance shall then be measured as specified in 4.7.8.1.

4.7.9 Temperature coefficient and capacitance drift (see 3.13).

4.7.9.1 For qualification inspection.

4.7.9.1.1 Temperature coefficient. Capacitance measurements shall be made as specified in 4.7.3 and at the temperatures specified in table XI.

4.7.9.1.2 Capacitance drift. Capacitance drift shall be computed by dividing the greatest single difference between any two of the three capacitance values recorded at 25°C by the value determined at the reference temperature (see table XI).

TABLE XI. Temperature coefficient and capacitance drift cycle.

Sequence	Temperature °C	Sequence	Temperature °C
a	+25 +0 -2	g	+65 +2 -0
b	-55 +0 -2	h	+85 +2 -0
c	-40 +0 -2	i	2/ +105 +2 -0
d	-10 +0 -2	j	2/ +125 +2 -0
e	1/ +25 +0 -2	k	+25 +0 -2
f	+45 +2 -0		

1/ Reference temperature.
2/ Applicable to 125°C capacitors.

The measurement at each temperature shall be recorded when two successive readings taken at 5 minute intervals at that temperature indicate no change in capacitance. The accuracy of measurement of capacitance increments shall be within ±0.005 pF. For capacitors with values of 20 pF or less, the temperature coefficient tolerance shall be as specified (see 3.1).

4.7.9.2 For quality conformance inspection.

4.7.9.2.1 Temperature coefficient. Capacitance measurements shall be made as specified in 4.7.9.1.1, except that measurements shall be made only at +25°C, +0°C, -2°C; -55°C, +0°C, -2°C; +25°C, +0°C, -2°C (reference temperature), +85°C, +2°C, -0°C; +125°C, +2°C, -0°C; (if applicable, see 3.1), and +25°C, +0°C, -2°C, respectively, and the values so determined shall be checked against the known shape of the curve for the dielectric material used, as determined in more complete tests.

4.7.9.2.2 Capacitance drift. Capacitance drift shall be computed as specified in 4.7.9.1.2.

4.7.10 Shock, specified pulse (see 3.14). Capacitors shall be tested in accordance with method 213 of MIL-STD-202. The following details shall apply:

a. Mounting: Capacitors shall be rigidly mounted by the body.

b. Test condition: I (100 G's).

c. Measurements during shock: During the last shock in each direction, an electrical measurement shall be made to determine intermittent contacts of 0.5 ms or greater duration, or open- or short-circuiting.

d. Examination after shock: Capacitors shall be visually examined for evidence of breakdown, arcing, and mechanical damage.

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

a. Mounting of specimens: Capacitors shall be mounted as specified in 4.7.10a. The mounting fixture shall be so constructed as to preclude any resonances within the test range. An examination of the mounting fixture shall be made on a vibrator. If any resonant frequencies are observed, adequate steps must be taken to damp the structure.

b. Electrical load conditions: During the test, a dc potential equal to 125 percent of the dc rated voltage (see 3.1) shall be applied between the

b. Electrical load conditions: During the test, a dc potential equal to 125 percent of the dc rated voltage (see 3.1) shall be applied between the terminals of the capacitor-element under test.

c. Test condition: D (20 G's).

d. Duration and direction of motion: 4 hours in each of two mutually perpendicular planes (total of 8 hours), one parallel to and the other perpendicular to the major axis.

e. Measurements during vibration: As specified in 4.7.10c.

f. Examination and measurements after vibration: Capacitors shall be visually examined for evidence of mechanical damage, and the capacitance, dissipation factor or Q (as specified, see 3.1), dielectric withstanding voltage, and insulation resistance shall be measured as specified in 4.7.3, 4.7.4 or 4.7.5, 4.7.6 (and 4.7.6.1, if applicable), and 4.7.8.1, respectively.

4.7.12 Thermal shock and immersion cycling (see 3.16).

4.7.12.1 Thermal shock. Capacitors shall be tested in accordance with method 107, test condition A, of MIL-STD-202, except that the maximum temperature shall be +85°C, +3°C, -0°C, or +125°C, +3°C, -0°C, as applicable (see 3.1), and no measurements shall be made before and after cycling.

4.7.12.2 Immersion cycling. Capacitors shall be tested in accordance with method 104 of MIL-STD-202. The following details shall apply:

a. Test condition: B.

b. Examination and measurements after final cycle: Capacitors shall be visually examined for evidence of corrosion and mechanical damage; the capacitance, dissipation factor or Q (as specified, see 3.1), dielectric withstanding voltage, and insulation resistance shall be measured as specified in 4.7.3, 4.7.4 or 4.7.5, 4.7.6 (and 4.7.6.1, if applicable), and 4.7.8.1, respectively.

4.7.13 Terminal strength (direct load) (see 3.17). Capacitors shall be tested in accordance with method 211 of MIL-STD-202. The following details shall apply:

a. Test condition: A. Applied force: 5 pounds (2.3 kg), unless otherwise specified (see 3.1).

b. Test condition: C, applicable to radial-lead units only. Applied force: 1.0, +0.1, -0 pound (0.5, +0.05, -0 kg).

c. Test condition: D, applicable to axial-lead units only.

d. Examination after test: Capacitors shall be visually examined for evidence of loosening or rupturing of terminals.

4.7.14 Moisture resistance (see 3.18). 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 (unless otherwise specified, see 3.1): During the first 10 cycles only, a dc potential of 100 volts or rated voltage, whichever is less, shall be applied across the capacitor terminals. Once each day, a check shall be performed to determine whether any capacitors have shorted.

c. Examination and final measurement: On completion of step 6 of the final cycle, capacitors shall be conditioned at 25°C ±5°C and a relative humidity of 60 percent maximum for a period of 18 hours minimum to 24 hours maximum, and shall be visually examined for evidence of mechanical damage and obliteration of marking; capacitance, dielectric withstanding voltage, and insulation resistance shall then be measured as specified in 4.7.3, 4.7.6 (and 4.7.6.1, if applicable), and 4.7.8.1, respectively.

d. Number of cycles: 20 continuous cycles.

4.7.15 Solderability (see 3.19). Capacitors shall be tested in accordance with method 208 of MIL-STD-202. Two terminations shall be tested.

4.7.16 Resistance to soldering heat (when specified, see 3.1) (see 3.20). Capacitors shall be tested in accordance with method 210 of MIL-STD-202. The following details and exceptions shall apply.

a. Depth of immersion in the molten solder: To a minimum of .050 inch, +.020, -0 inch (1.27 mm, +0.51, -0 mm) from the capacitor body (the example shown on figure 13 is applicalbe to all terminal types).

b. Test condition: G, except that the immersion duration shall be 20 ±1 seconds.

c. Cooling time prior to measurement after test: 10 ±1 minutes, unless otherwise specified (see 3.1).

d. Measurements after test: Capacitance, dissipation factor or Q (as specified, see 3.1), and insulation resistance shall be measured as specified in 4.7.3, 4.7.4 or 4.7.5, and 4.7.8.1, respectively.

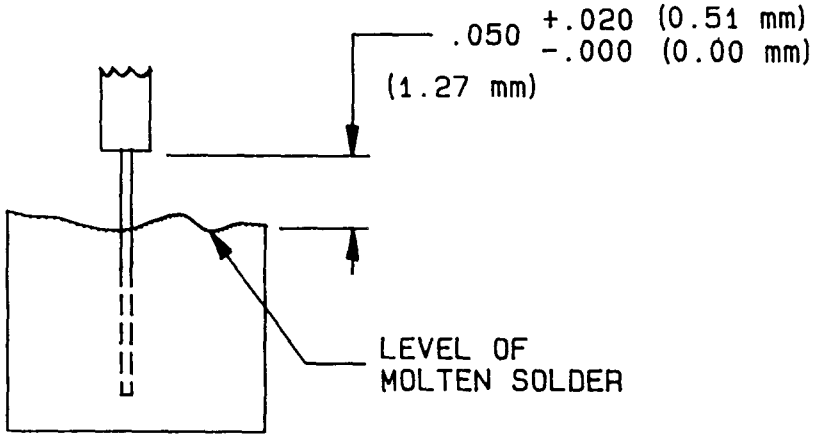


FIGURE 13. Example of axial wire-lead depth of immersion in molten solder.

4.7.17 Life (at elevated ambient temperature) (see 3.21).

4.7.17.1 For qualification inspection. Capacitors shall be tested in accordance with method 108 of MIL-STD-202. The following details and exceptions shall apply:

a. Distance of temperature measurements from specimens, in inches: Not applicable.

b. Test temperature and tolerance: At the applicable elevated test temperature, ±3°C (see 3.1).

c. Operating conditions: One of the following conditions as specified (see 3.1).

Condition 1: Capacitors shall be subjected to the dc potential equal to a minimum of 150 percent of the dc rated voltage on which an alternating-current rms potential (60 ±2 Hz) equal to a minimum of 50 percent of dc rated voltage is superimposed.

Condition 2: Capacitors shall be subjected to the dc potential equal to a minimum of 200 percent of the dc rated voltage. Current shall be 30 to 50 mA.

d. Test condition: D, ±12 hours (non-ER) or F, ±24 hours (ER).

e. Examination and measurements after exposure: Capacitors shall be returned to the inspection conditions specified in 4.3, and shall be visually examined for evidence of corrosion and mechanical damage; the capacitance, dissipation factor or Q (as specified, see 3.1), and insulation resistance shall be measured as specified in 4.7.3, 4.7.4 or 4.7.5, and 4.7.8.1, respectively.

4.7.17.2 For quality conformance inspection. Capacitors shall be tested as specified in 4.7.17.1 except the length of test shall be 2000 +96, -0 hours for ER styles and 1000 +48, -0 hours for non-ER styles.

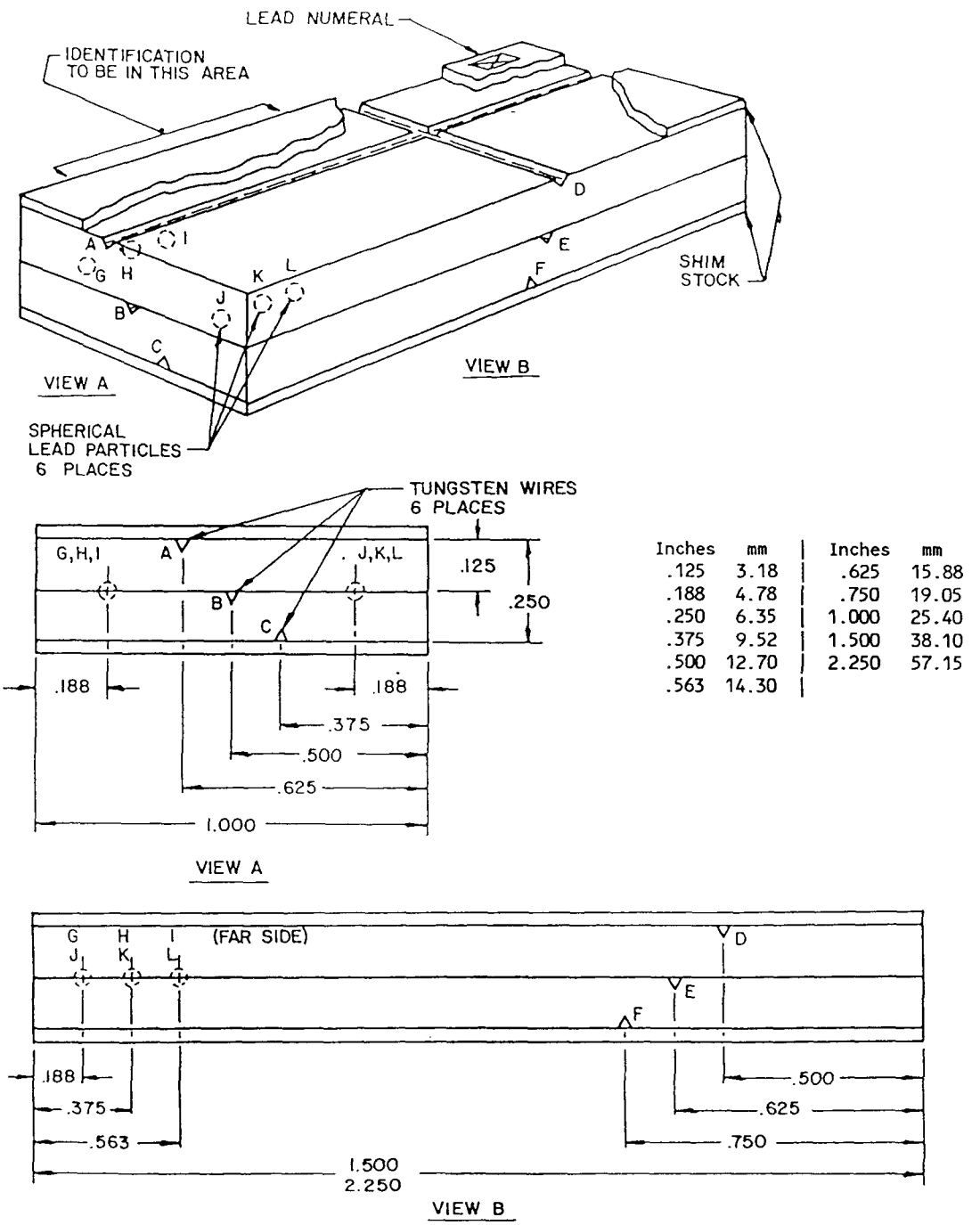
4.7.18 Marking legibility (laser marking only). Capacitors shall be coated with .005 inch (0.127mm) minimum of silicone resin insulating compound, type SR of MIL-I-46058. After curing, coated capacitors shall be examined for legibility under normal production room lighting by an inspector with normal or corrected 20/20 vision.

4.7.19 Radiographic inspection (for qualification and quality conformance inspection for FR level"S", when specified, see 3.1 and 3.22). Capacitors shall be tested in accordance with method 209 of MIL-STD-202. The following details and exception shall apply:

a. Radiographic quality: The radiograph shall render a clear, sharp image of the penetrameter.

b. Image quality indicator: A radiograph of the penetrameter shall be included on each radiograph film. The penetrameter may be made from a sample capacitor, of the same style as the capacitor being radiographed, with an AWG number 48 copper wire mounted across the capacitor body or it may be fabricated in accordance with, or be equivalent to, the example on figure 14.

c. Positions of specimen: Unless otherwise specified (see 6.2), one view shall be taken of each capacitor perpendicular to the plane of the lead surface (see figure 15).



Inches	mm	Inches	mm
.125	3.18	.625	15.88
.188	4.78	.750	19.05
.250	6.35	1.000	25.40
.375	9.52	1.500	38.10
.500	12.70	2.250	57.15
.563	14.30		

FIGURE 14. Image quality indicator (optional).

Tungsten wire diameters						Lead particles diameters						Steel shim stock
A	B	C	D	E	F	G	H	I	J	K	L	
.002 (0.05)	.001 (0.03)	.0005 (0.013)	.0005 (0.013)	.001 (0.03)	.002 (0.05)	.015 (0.38)	.010 (0.25)	.008 (0.20)	.006 (0.15)	.004 (0.10)	.002 (0.05)	None
"	"	"	"	"	"	"	"	"	"	"	"	.002 (0.05)
"	"	"	"	"	"	"	"	"	"	"	"	.005 (0.13)
"	"	"	"	"	"	"	"	"	"	"	"	.007 (0.18)
.003 (0.08)	.002 (0.05)	.001 (0.03)	.001 (0.03)	.002 (0.05)	.003 (0.08)	"	"	"	"	"	"	.010 (0.25)
.003 (0.08)	.002 (0.05)	.001 (0.03)	.001 (0.03)	.002 (0.05)	.003 (0.08)	"	"	"	"	"	"	.015 (0.38)
.005 (0.13)	.003 (0.08)	.002 (0.05)	.002 (0.05)	.003 (0.08)	.005 (0.13)	"	"	"	"	"	"	.025 (0.64)
.005 (0.13)	.003 (0.08)	.002 (0.05)	.002 (0.05)	.003 (0.08)	.005 (0.13)	"	"	"	"	"	"	.035 (0.89)

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Millimeters are in parentheses.
4. Wires shall be tungsten, shim stock shall be carbon steel, particles shall be lead. Center section shall be .125 (3.18 mm) layers of clear acrylic plastic bonded with clear plastic cement of low X-ray density. Fasteners may be used within .250 (6.35 mm) from each corner, but shall not interfere with end use of the penetrameter. Bottom surface shall be flush.
5. All dimensions shown are ±.005 (0.13 mm), except wires and shim stock, which shall be within standard mil tolerances, and lead particles which shall be ±.0002 (0.005 mm). Groove details are not critical, but wire must be embedded flush or below surface of plastic and centered at location shown. Particle-hole sizes are not critical, but should not exceed .031 (0.79 mm) in diameter and depth, and must be centered as shown ±.005 (0.13 mm).
6. Additional layers of shim stock may be used as necessary.
7. Identification marking shall be permanent and legible. Location and size of characters are not critical, but shall not interfere with or obscure the radiographic image details.

FIGURE 14. Image quality indicator (optional) - Continued.

d. Evaluation of images:

(1) Special kind of viewing equipment: Magnifying glass.

(2) Magnification: 10X.

(3) Defects to be sought in specimen: As specified in 3.22.

e. Additional required examination:

(1) There shall be a minimum of 80 percent solder fillet between capacitor-element and each lead.

(2) There shall be a minimum of .005 inch (0.13 mm) encapsulating material encasing the capacitor-element, except as shown on figure 16.

(3) There shall be a minimum of .005 inch (0.13 mm) between edge of case and tip of solder spike.

(4) Extraneous particles or voids in encapsulating material shall not be greater than .005 inch (0.13 mm) in any dimension.

NOTE: Test results (covering the number of capacitors tested with number and kind of failures noted) and radiograph shall be retained for a minimum period of 5 years. On request of the user, this data shall be supplied with each shipment.

4.7.20 Resistance to solvents (ink marking only) (see 3.23). Capacitors shall be tested in accordance with method 215 of MIL-STD-202. Brushing may be applied to the marked portion of the capacitor body only.

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

5. PACKAGING

5.1 Packaging requirements. The requirements for packaging shall be in accordance with MIL-C-39028.

6. NOTES

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

6.1 Intended use. These capacitors are primarily designed for use where compensation is needed to counteract reactive changes, caused by temperature variations, in other circuit components. However, they can be used in any precision-type circuit where their characteristics are suitable. Ceramic capacitors are substantially smaller than paper or mica units of the same capacitance and voltage rating. They can be used where mica or paper capacitors have too wide a capacitance tolerance. The lead placement makes ceramic capacitors suitable for printed-circuit use.

6.2 Acquisition data. Acquisition documents must specify the following:

a. Title, number, and date of this specification.

b. Title, number and date of the applicable specification sheet, and the complete PIN (see 1.2.1 and 3.1).

c. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1).

d. Required number of radiographic views and planes, if other than that specified (see 4.7.19c).

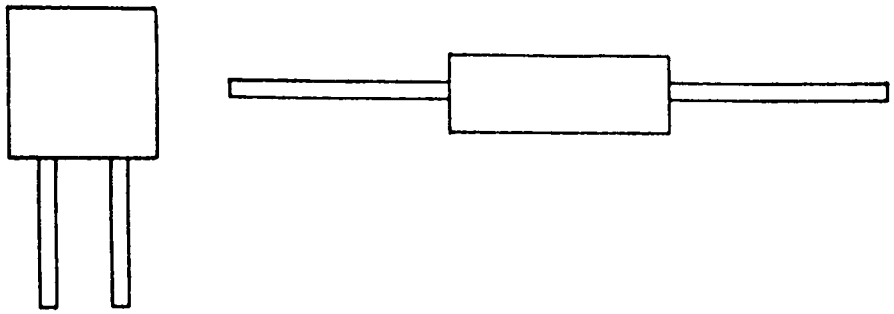


FIGURE 15. Viewing planes for radiographic inspection.

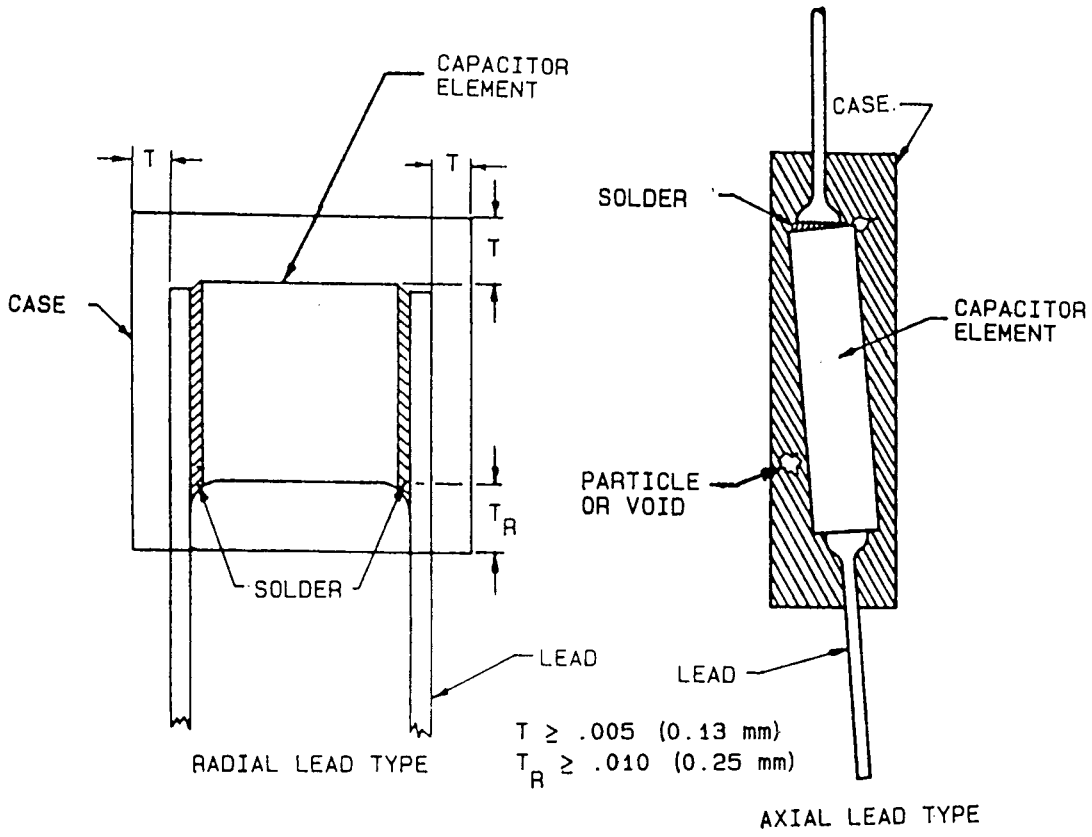
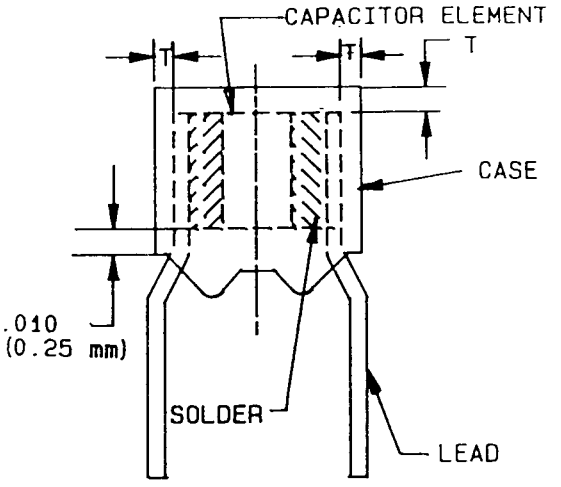
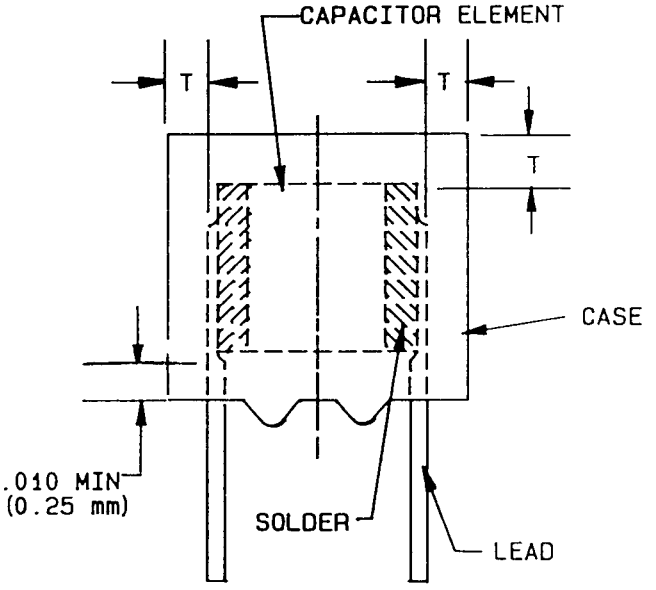


FIGURE 16. Radiographic inspection criteria.



T ≥ .005 (0.13 mm)

CCR05



T ≥ .005 (0.13 mm)

CCR06

RADIAL LEAD TYPE WITH STANDOFFS

FIGURE 16. Radiographic inspection criteria - Continued.

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are at the time of award of contract, qualified for inclusion in the applicable qualified products list, whether or not such products have actually been so listed by that date. The attention of the contractors is called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or purchase orders for the products covered by this specification. The activity responsible for the qualified products list is Air Force Logistics Command, 2750 LOG/ES, Gentile Air Force Station, OH 45444-5400; however, information pertaining to qualification of products may be obtained from the Defense Electronics Supply Center (DESC-E), Dayton, OH 45444-5254. Application for qualification tests shall be made in accordance with SD-6, "Provisions Governing Qualification", which may be obtained by applying to the Navy Publishing and Printing Service Office, Building 4D, NPM-DODSSP, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

6.4 Quality factor (Q). Q is defined as the value of the tangent of the angle between the voltage and current vectors for the capacitor at the specified frequency, and is expressed as follows:

$$Q = \frac{1}{R\dot{\omega}C}$$

Where:

R = equivalent series resistance (in ohms)
$\dot{\omega}$ = 2π times the frequency (in hertz).
C = capacitance (in farads).

6.5 Characteristic. To facilitate use of the curves on figures 1 through 9, maximum and minimum readings at -55°C, -40°C, -10°C, +45°C, +65°C, +85°C, and +125°C for each characteristic are given in table XII.

6.6 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.

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

6.8 Key work listing.

Part Per Million
Statistical process control (SPC)

TABLE XII. Points read from tolerance envelopes on figures 1 through 9 .

Characteristic	Permissible capacitance change from capacitance at 25°C (parts per million)													
	At -55°C		At -40°C		At -10°C		At +45°C		At +65°C		At +85°C		At +125°C	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
AH	-2,100	-12,500	-1,800	-10,300	-1,000	-5,600	3,000	700	6,300	1,500	9,600	2,400	16,200	4,100
AJ	3,300	-17,300	2,600	-14,000	1,300	-7,700	4,200	-500	8,800	-900	13,200	-1,200	21,400	-1,500
AK	16,300	-27,500	13,000	-22,400	6,700	-12,200	6,500	-3,300	13,800	-6,300	21,000	-9,000	34,100	-13,500
CF	2,800	-900	2,000	-800	900	-500	300	300	600	-600	900	-900	1,500	-1,500
CG	4,300	-2,200	3,400	-1,900	1,700	-1,100	600	-700	1,100	-1,400	1,700	-1,800	3,000	-3,000
CH	7,300	-4,400	5,800	-3,700	2,900	-2,000	1,300	-1,500	2,400	-2,500	3,600	-3,600	6,000	-6,000
CJ	13,300	-9,300	10,500	-7,600	5,400	-4,200	2,300	-2,700	4,700	-5,100	7,200	-7,200	12,000	-12,000
CK	26,100	-19,700	20,800	-16,100	10,700	-8,600	5,000	-5,500	10,000	-10,400	15,000	-15,000	25,000	-25,000
HF	5,800	1,800	4,600	1,400	2,300	700	-300	-1,100	-600	-2,000	-800	-2,800	-1,000	-4,100
HG	7,300	300	5,900	200	2,900	100	0	-1,400	0	-2,600	0	-3,600	0	-5,200
HH	10,300	-2,100	8,200	-1,800	4,200	-1,000	500	-2,100	1,200	-3,800	1,800	-5,400	3,200	-8,300
HJ	16,200	-6,900	13,000	-5,600	6,700	-3,000	1,700	-3,300	3,500	-6,300	5,300	-9,000	8,900	-13,300
HK	29,300	-17,500	23,400	-14,200	12,100	-7,600	4,400	-6,000	8,800	-11,800	13,200	-16,800	21,200	-25,500
LF	10,400	7,700	8,000	6,000	4,400	3,400	-1,500	-1,800	-3,100	-4,300	-4,400	-6,200	-6,700	-9,700
LG	12,200	5,300	9,800	4,200	5,000	2,200	-1,100	-2,500	-2,100	-4,700	-3,000	-6,600	-5,200	-11,200
LH	15,200	2,400	12,100	1,900	6,200	900	-500	-3,100	-900	-5,900	-1,200	-8,400	-2,200	-14,200
LJ	21,200	-2,900	16,900	-2,400	8,700	-1,300	700	-4,500	1,600	-8,400	2,400	-12,000	3,800	-20,200
LK	34,300	-13,300	27,300	-10,900	14,200	-5,900	3,300	-7,100	6,700	-13,800	-10,000	-19,800	16,800	-33,200
PF	16,000	13,600	12,800	10,800	6,700	5,600	-2,800	-3,400	-5,500	-6,700	-8,100	-9,900	-12,600	-15,700
PG	19,300	12,400	15,500	10,200	8,000	5,100	-2,400	-3,800	-4,800	-7,400	-7,200	-10,900	-11,000	-17,600
PH	23,300	9,500	18,000	7,900	9,300	3,900	-1,800	-4,600	-3,600	-8,600	-5,500	-12,600	-8,800	-20,200
PJ	28,000	3,400	22,500	2,700	11,500	1,300	-600	-5,700	-1,200	-11,200	-1,800	-16,300	-3,000	-25,600
PK	41,000	-7,500	33,000	-6,400	17,100	-3,500	1,800	-8,600	3,800	-16,500	6,000	-24,100	10,700	-39,300

TABLE XII. Points read from tolerance envelopes on figures 1 through 9 - Continued.

Characteristic	Permissible capacitance change from capacitance at 25°C (parts per million)													
	At -55°C		At -40°C		At -10°C		At +45°C		At +65°C		At +85°C		At +125°C	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
RF	22,200	19,800	18,000	16,000	9,100	8,200	-4,800	-5,400	-9,000	-10,200	-13,000	-14,800	-20,200	-23,200
RG	24,000	18,700	19,100	14,900	9,800	7,700	-4,500	-5,700	-8,400	-10,800	-12,100	-15,700	-18,700	-24,500
RH	29,100	15,500	23,000	12,000	12,200	6,100	-3,100	-6,200	-6,200	-11,900	-9,500	-16,800	-15,700	-25,700
RJ	35,300	10,700	28,000	8,200	14,600	3,900	-1,900	-7,400	-3,900	-14,000	-6,800	-20,500	-10,500	-32,200
RK	48,000	-2,000	38,000	-1,700	19,700	-1,000	600	-10,000	1,300	-19,500	1,800	-28,400	2,700	-44,400
SG	34,400	29,600	28,000	24,100	14,700	12,600	-6,400	-7,600	-12,300	-14,700	-18,100	-21,700	-28,800	-34,600
SH	40,800	26,000	31,900	20,300	16,600	10,000	-5,300	-8,300	-11,300	-16,500	-16,000	-23,600	-25,600	-37,600
SJ	46,200	21,500	36,400	17,200	18,900	9,000	-4,500	-9,800	-9,000	-18,800	-12,600	-26,900	-19,600	-43,600
SK	59,100	8,300	47,600	6,800	24,200	3,100	-1,500	-12,800	-3,000	-24,000	-4,800	-34,800	-6,600	-57,500
TG	46,800	42,000	37,200	33,300	19,600	17,500	-9,200	-10,500	-18,000	-20,400	-25,700	-29,300	-40,800	-46,800
TH	54,000	34,000	43,000	27,500	22,200	15,000	-8,500	-11,500	-16,500	-22,300	-24,500	-31.800	-38,100	-49,700
TJ	60,000	30,000	48,000	24,000	25,000	13,000	-7,000	-13,000	-14,000	-24,500	-21,000	-35,300	-33,500	-54,600
TK	73,500	18,000	58,500	14,500	30,000	8,000	-4,500	-16,000	-8,800	-30,000	-12,800	-43,200	-21,200	-66,400
UG	77,400	72,600	61,900	58,000	33,100	31,000	-16,000	-17,200	-30,600	-33,000	-44,500	-48,100	-67,800	-73,800
UH	79,800	70,200	63,900	56,100	35,200	29,400	-15,400	-18,000	-29,400	-34,500	-42,700	-49,900	-64,800	-76,800
UJ	88,000	52,500	70,500	42,200	36,800	22,900	-12,800	-19,000	-25,000	-36,000	-37,700	-52,200	-61,400	-80,400
UK	110,000	40,500	87,000	33,000	45,000	18,000	-10,000	-22,500	-19,900	-42,000	-30,000	-59,800	-50,000	-91,800

APPENDIX

PROCEDURE FOR QUALIFICATION INSPECTION

10. SCOPE

10.1 Scope. This appendix details the procedure for submission of samples, with related data, for qualification inspection of capacitors covered by this specification. The procedures for extending qualification of the required sample to other capacitors covered by this specification is also outlined herein. This appendix is a mandatory part of this specification. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS. This section is not applicable to this appendix.

30. SUBMISSION

30.1 Sample.

30.1.1 Single-style submission. A sample of the size required in table VI, of the highest capacitance value in each voltage rating in each operating temperature range and voltage-temperature limit in each style for which qualification is sought shall be submitted.

30.1.2 Combined style submission. Samples as shown in table XIII in each qualification group for which qualification is sought shall be submitted.

30.2 Test data. When examinations and tests are to be performed at a Government laboratory, prior to submission, all sample units shall be subjected to all of the examinations and tests indicated as nondestructive in table VI. Each submission shall be accompanied by the test data obtained from these inspections. The performance of the destructive tests by the manufacturer on a duplicate set of sample units is encouraged, though not required. All test data shall be submitted in duplicate.

30.3 Certification of material. When submitting samples for qualification, the contractor shall submit certification, in duplicate, that the materials used in his components are in accordance with the applicable specification requirements.

30.4 Description of items. The contractor shall submit a detailed description of the capacitors being submitted for inspection, including body, coating, electrode material, terminal leads, etc.

40. EXTENT OF QUALIFICATION

40.1 Single-style submission. Capacitance-range qualification will be restricted to values equal to and less than the capacitance value submitted. Capacitance-tolerance qualification will be restricted to tolerances equal to and wider than the tolerance submitted. DC rated voltage, operating temperature range, and voltage-temperature limit qualification will be restricted to that submitted.

40.2 Combined style submission. Combined style submission shall be restricted as shown in table XIII. Qualification of ER styles with standoffs will be extended to similar ER and non-ER styles without standoffs as follows:

Qualification to ER standoff	Will extend qualification to	
	ER nonstandoff	Non-ER nonstandoff
CCR05 CCR06	CCR05 CCR06	CC05 CC06

TABLE XIII. Combined style submission.

Qualification group	ER PIN	Number of samples	Non-ER PIN	Number of samples	Will qualify 1/
	2/				
I	CCR05CG331GM	25	CC05CG331GM	16	CCR05, 06, 07, 08, 09
	CCR05CG332GM	25	CC05CG332GM	16	CC05, 06, 07, 08, 09 in CG, CH characteristic; B, C, D, F, G, J, K cap. tolerance;
	CCR08CG472GM	25	CC08CG472GM	19	200, 100, and 50 volts;
	CCR08CG683GM	25	CC08CG683GM	19	FRL M.
II	CCR15CG331GM	25	CC15CG331GM	16	CCR15, 16, 17, 19
	CCR15CG332GM	25	CC15CG332GM	16	CC15, 16, 17, 19 in CG, CH characteristic; B, C, D, F, G, J, K cap. tolerance;
	CCR17CG332GM	25	CC17CG332GM	19	200, 100, and 50 volts;
	CCR17CG473GM	25	CC17CG473GM	19	FRL M.
III	CCR13CG750GM	25	CC13CG750GM	16	CCR13, 14
	CCR13CG221GM	25	CC13CG221GM	16	CC13, 14 in CG, CH characteristic; B, C,
	CCR14CG221GM	25	CC14CG221GM	19	D, F, G, J, cap
	CCR14CG561GM	25	CC14CG561GM	19	tolerance; 200, 100, and 50 volts; FRL M.
IV	CCR75CG750GM	25	CC75CG750GM	16	CCR75, 76, 77, 78, 79
	CCR75CG681GM	25	CC75CG681GM	16	CC75, 76, 77, 78, 79 in CG, CH characteristic; B, C, D, F, G, J, K cap.
	CCR79CG103GM	25	CC79CG103GM	19	tolerance; 200, 100,
	CCR79CG823GM	25	CC79CG823GM	19	and 50 volts; FRL M.

1/ ER style qualification will grant equivalent non-ER style qualification. Non-ER style qualification will grant non-ER style coverage only.

2/ For qualification of style CCR05 with standoffs, see 40.2.

CONCLUDING MATERIAL

Custodians:
Army - ER
Navy - EC
Air Force - 85
NASA - NA

Review activities:
Army - MI
Navy - OS
Air Force - 99
DLA - ES

User activities:
Navy - AS, MC, SH
Air Force - 19

Preparing activity:
Air Force - 85

Agent:
DLA - ES

(Project 5910-1694)