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FEDERAL SPECIFICATION

CIRCUIT BREAKERS, MOLDED CASE; BRANCH CIRCUIT AND SERVICE

The General Services Administration has authorized the use of this federal specification by all federal agencies.

1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification covers the general requirements and test procedures for molded case circuit breakers which fall within the general parameters specified in table XVI which are specifically designed to provide service-entrance, feeder, meter-service, or branch circuit protection and rated at not more than 4,000 amperes and 600 volts ac, 60 hertz (Hz) (see 3.1 and 6.1).

1.2 Classification. Circuit breakers furnished under this specification shall be of the following types, as specified (see 3.1).

Types:

I	-	Uncompensating thermal magnetic
II	-	Ambient compensating thermal magnetic
III	-	Magnetic
IV	-	Fused

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 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 cited in the solicitation or contract (see 6.2).

Comments, suggestions, or questions on this document should be addressed to: DLA Land and Maritime ATTN: DLA Land and Maritime-VAT, Post Office Box 3990, Columbus, Ohio 43218-3990 or emailed to CircuitProtect@dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil.

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DEPARTMENT OF DEFENSE STANDARDS

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

(Copies of this documents are available online at https://assist.dla.mil/quicksearch/ or https://assist.dla.mil or from the DLA Document Services, Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094).

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract (see 6.2).

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60085 - Electrical Insulation - Thermal Evaluationa and Designation.

(Copies of this documents are available online at http://www.iec.ch/ or from the International Electrotechnical Commission, 3 Rue de Varembe, P.O. Box 131, CH - 1211, Geneva 20 - Switzerland)

INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS (IEEE)

IEEE Std 1 - General Principles for Temperature Limits in the Rating of Electric Equipment and for the Evaluation of Electrical Insulation.

(Copies of this document are available online at http://www.ieee.org or from the Institute of Electrical and Electronic Engineers, 2001 L Street, NW, Suite 700, Washington, DC 20036-4910)

INTERNATIONAL ORGANIZATION FOR STANDARDS (ISO)

ISO 10012 - Measurement, Management Systems – Requirements for Measurement Processes and Measuring Equipment.

(Copies of this documents are available online at http://www.iso.org/iso/home.html or from the American National Standards Institute (ANSI), 1899 L Street, NW, 11th Floor, Washington, DC 20036-3801).

NATIONAL CONFERENCE OF STANDARDS LABORATORIES (NCSL)

NCSL Z540-3 - Calibration of Measuring and Test Equipment, Requirements for.

(Copies of this document are available online at http://www.ansi.org/or from the National Conference of Standards Laboratories, 2995 Wilderness Place, Suite 107, Boulder, CO 80301-5404.)

UNDERWRITERS LABORATORIES INC. (UL) STANDARDS

UL 489 - Standard for Safety, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.

(Copies of this document are available online at http://www.ul.com or from the Underwriters Laboratories Inc., 2600 N. W. Lake Road, Camas, WA 98607-8542).

3. REQUIREMENTS

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

3.1.1 Circuit breaker ratings not listed in specification sheets. This specification shall be applicable to circuit breakers not covered by specification sheets which fall within the requirements of table XV and table XVI.

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3.2 Qualification. Circuit breakers furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified products list before award of the contract (see 4.5. and 6.3).

3.3 Material. Material shall be as specified herein. However, when a definite material is not specified, a suitable material shall be used that will enable the circuit breakers to conform to the performance requirements of this specification. Acceptance or approval of any constituent material shall not be construed as a guaranty of the acceptance of the finished product.

3.3.1 Current carrying parts. Current-carrying parts shall be of silver, a silver alloy, copper, a copper alloy, or other metal suitable for the application, however, iron and steel may be used in multimetallic thermal elements.

3.3.2 Restricted material. Flammable or explosive material, or material which can produce toxic or suffocating fumes when the circuit breakers are in service shall not be used in construction of the circuit breakers.

3.3.3 Corrosion. Iron and steel parts, except for thermal elements, magnet-pole faces, hardened and polished parts such as latching surfaces, etc., where such protection is impractical, shall be adequately protected against corrosion.

3.3.4 Dissimilar metals. When dissimilar metals are used in intimate contact with each other, protection against electrolysis and corrosion shall be provided. The use of dissimilar metals in contact, which tend toward active electrolytic corrosion (particularly brass, copper, or steel used in contact with aluminum or aluminum alloy) is not acceptable. However, metal plating or metal spraying of dissimilar base metals - to provide similar or suitable abutting surfaces is permitted. The use of dissimilar metals separated by a suitable insulating material is also permitted. The use of corrosion-resistant steel in contact with cadmium plating shall also be allowed.

3.4 Design and construction. Circuit breakers shall be of the design, construction, and physical dimensions specified (see 3.1), except circuit breakers not covered by specification sheets (see 3.1.1) shall be UL listed or meet the requirements of this specification prior to inclusion into a specification sheet.

3.4.1 Trip elements. An overcurrent trip element shall be provided in each pole. All overcurrent tripping devices, whether interchangeable or noninterchangeable, shall be sealed against tampering.

3.4.2 Trip-free feature. Circuit breakers shall be designed so that the circuit cannot be maintained closed when any pole is carrying overload currents that would normally automatically trip the circuit breaker to the open position.

3.4.3 Trip indication. Circuit breakers shall be designed to provide positive indication of the main contact position.

3.4.4 Interchangeable trips. An interchangeable trip unit shall not be capable of being installed in any frame having a current rating less than that of the trip unit.

3.4.5 Adjustable magnetic trip units. If a circuit breaker has a magnetic means for tripping, in addition to and entirely independent of a time-delay means for tripping which complies with all the calibration requirements of this specification, the magnetic trip may be adjustable, see 3.1. However, circuit breakers not specifically designed for adjustable magnetic trip shall not be adjustable thermally or magnetically without dismantling of the circuit breaker or trip unit or breaking of a seal.

3.4.6 Housings. A circuit breaker shall have an integral housing for all the mechanisms and live parts except the operating handle and the wiring terminals, and shall be manually operable without opening this housing.

3.4.7 Operating handles. An operating handle of conducting material extending into the housing shall be grounded.

3.4.8 Sealing. Any means for sealing shall be such that breaking or removing it will be plainly evident. Paper or cloth may be used as a seal indicator, but shall not be used as a means for holding parts together.

3.4.9 Plug-in design. A plug-in circuit breaker shall be retained on the stabs without depending on the trim or cover of the enclosure.

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3.4.10 Terminals. Unless otherwise specified (see 3.1), the line terminals of a circuit breaker rated at 40 amperes or less shall be capable of accommodating No. 8 AWG conductors.

3.4.11 Multi-pole circuit breakers. A multi-pole circuit breaker (having two or more poles controlled by a single, manually operated actuating member) shall be so designed that all poles will make and break simultaneously when operated manually or automatically in the intended manner; except that in a two- or three-wire circuit breaker rated at 120/240 volts or less and having two operating poles designed for use on the outside (ungrounded) wires of a three-wire, single-phase alternating current system having a solid neutral, the automatic tripping of either pole may be independent of the other, provided that the independent tripping is indicated.

3.4.12 Interlock. If fused circuit breaker current limiters or fuses are housed within the circuit-breaker frame, the circuit breaker shall be so interlocked that when the cover over the limiters or fuses, or the limiter pack, is removed, the circuit breaker will automatically trip.

3.4.13 Multi-limiter characteristics. If fused circuit breakers are designed to use two or more current limiters with different let-thru characteristics for different ranges of ratings within a frame size, it shall be difficult to install a limiter in any lower rated circuit breaker where it is not intended, if such installation could result in a hazard.

3.4.14 Trip indication on limiter opening. Fused circuit breakers shall be so designed that opening of the limiter or fuse will trip the circuit breaker mechanism.

3.4.15 Accessories. Accessories shall be in accordance with the applicable requirements of UL 489.

3.4.16 Spacings. The spacings between circuit breaker components shall be not less than those indicated in table I.. Soldering lugs or pressure wire connectors shall be prevented from turning so as not to reduce the spacings specified, except that if such minimum or greater spacings are maintained when lugs are turned 30 degrees toward each other or toward other uninsulated live or grounded parts, no means to prevent turning need be provided.

TABLE I. Minimum spacings.

Voltage between parts	Minimum spacing in inches									
	At terminals				Other than at terminals					
	Between terminals of opposite polarity		Between terminals and any grounded metal 1/		Between uninsulated live parts of opposite polarity		Between uninsulated live parts and any ground metal 1/			
	A		B		C		D 2/		E 3/	
	Thru air	Over surface	Thru air	Over surface	Thru air	Over surface	Thru air	Over surface	Thru air	Over surface
0-125	.25	.75	.50	.50	.25	.375	.50	.50	.25	.375
126-300	.75	1.25	.50	.50	.25	.375	.50	.50	.25	.375
301-600	1.00	2.00	.50	1.00	.375	.50	.50	1.00	.375	.50

1/ The spacing to the enclosure or circuit breaker mounting means may be reduced if an acceptable liner of insulating material, not less than .031 inch (0.79 mm) in thickness, is used to provide the required spacing through air.
2/ If indentation or deformation of the overall enclosure or circuit breaker mounting means may reduce spacings to less than those indicated in column E.
3/ If indentation or deformation of the overall enclosure or circuit breaker mounting means will not affect spacings.

3.4.17 Standard ampere ratings. Standard ampere ratings for circuit breakers are 10, 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100, 110, 125, 150, 175, 200, 225, 250, 300, 350, 400, 450, 500, 600, 700, 800, 1,000, 1,200, 1,600, 2,000, 2,500, 3,000, and 4,000 amperes.

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3.4.18 Ganging provisions. A single-pole circuit breaker rated at 120/240 volts ac, shall be designed to permit simultaneous operation with a similar adjacent circuit breaker, and shall have provision for the connection of the handle with that of a similar breaker.

3.5 Calibration. When circuit breakers are tested as specified in 4.7.2, the tripping times (see 6.7.1) shall not exceed the limits shown in table II for the applicable current and temperature specified (see 3.1 and table IX).

TABLE II. Calibration tripping times.

Current rating in amperes	Maximum tripping time in minutes at 200 percent rated current	Maximum tripping time in hours at 125 percent or 135 percent rated current
0 - 30	2	1
31 - 50	4	1
51 - 100	6	2
101 - 225	8	2
226 - 400	10	2
401 - 600	12	2
601 - 800	14	2
801 - 1,000	16	2
1,001 - 1,200	18	2
1,201 - 1,600	20	2
1,601 - 2,000	22	2
Over 2,000	24	2

3.5.1 Adjustable magnetic trip calibration. When subjected to the tests specified in 4.7.2.1, automatic tripping shall occur at the highest adjustment and shall be within the range of 80-110 percent of the marked tripping current. Tripping at the lowest setting shall be no greater than the tripping current at the highest setting (unless otherwise specified, see 3.1).

3.6 Overload. When circuit breakers are tested as specified in 4.7.3, there shall be no electrical failure, evidence of mechanical damage, and the fuse used to indicate arc-over shall not be ruptured.

3.7 Tungsten filament lamp load. When tested as specified in 4.7.4, circuit breakers shall not trip automatically nor freeze in the "ON" position.

3.8 100 percent calibration at 40°C ±3°C. When tested as specified in 4.7.5, circuit breakers shall not trip automatically.

3.9 Temperature and 100 percent calibration at 25°C ±3°C. When tested as specified in 4.7.6, circuit breakers shall not trip automatically and the temperature rise at the wiring terminals or lugs shall not exceed 50°C. In addition, the temperature rise of materials used in construction shall not exceed those specified in table III. The temperature rise at the terminals and casings of limiters in fused circuit breakers shall not exceed 85°C.

3.10 Endurance. When tested as specified in 4.7.7, there shall be no electrical or mechanical failure of the device and the fuse shall not be ruptured. In addition, circuit breakers shall meet the requirements of 3.5 during the calibration check following the endurance test.

3.11 Short circuit. When tested as specified in 4.7.8, there shall be no electrical or mechanical failure of the circuit breaker and the fuse specified in 4.7.3 shall not be ruptured. The case shall not be cracked or broken, cotton or cloth indicators shall not be ignited and the insulation of the conductors used to wire the device shall show no evidence of damage. After the final operation, the circuit breaker shall have conductivity in the closed position at rated voltage. During the 200 percent rated current test, the circuit breaker shall trip automatically within the maximum time specified in table II.

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3.12 Dielectric withstanding voltage. When circuit breakers are tested as specified in 4.7.9, the leakage current shall not exceed 1.0 milliampere and there shall be no evidence of flashover, mechanical damage, arcing, or breakdown.

3.13 Calibration 200 percent at 25°C ±3°C. When tested as specified in 4.7.10, the tripping time shall not exceed the maximum tripping time specified in table II.

TABLE III. Maximum temperature rise of construction materials in degrees Centigrade.

Materials	Temperature (°C)
Thermoplastic or rubber-insulated conductors	35
Plain or plated copper or copper-alloy separable contacts	40
Conductors having varnished-cloth insulation	60
Conductors having slow-burning insulation	65
Fiber employed as electrical insulation	65
Wood or other combustible material	65
Urea composition	75
Melamine	125
Phenolic composition employed as electrical insulation	125
The softening point minus 40°C on any sealing compound	---
Wire wound cells	
Class 90 insulation 1/	
Thermocouple method	50
Resistance method	70
Class 105 insulation 1/	
Thermocouple method	65
Resistance method	85
Class 130 insulation 1/	
Thermocouple method	85
Resistance method	105
Class "over 220" insulation 1/	No limit specified
Single-layer series coils with exposed surfaces uninsulated or enameled	
Class 105 insulation 1/	
Thermocouple method	90

1/ Defined in IEC 60085, with pertinent information found in IEEE Standard 1 of the Institute of Electrical and Electronic Engineers.

3.14 Short-circuit interruption. When tested as specified in 4.7.11, circuit breakers shall clear the test circuit. The insulation of conductors used to wire the device shall not be damaged, the wire shall not be ejected from the wire connector and the leads shall not be burned off, shunts, bi-metals, or heaters shall not be burned out. The case shall not be broken, however, hairline cracks are acceptable, but cracks where a portion of the case is deflected outward (or inward) are not acceptable. Any hole or opening in the case caused by the short circuit operator is not acceptable. A crack which would permit separation of two sections of the case is acceptable only if the two sections are caused to maintain their proper relative positions because of securing means such as mounting bolts, cover screws, etc. Contacts shall not be welded and the fuse indicated in 4.7.3 shall not be ruptured.

3.15 250 percent calibration at 25°C ±3°C. When tested as specified in 4.7.12, each pole of the circuit breaker

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shall trip within the time specified in table II for the 200 percent rated current test. Circuit breakers shall also meet the requirements of the dielectric withstanding voltage test (see 3.12).

3.16 Crossover (current limiters or fuses). When tested as specified in 4.7.13, the current limiter or fuse shall remain intact and permanently open the circuit. The cotton or cheesecloth shall not be ignited, there shall be no evidence of damage to the circuit breaker enclosure and the fuse shall not be ruptured.

3.17 Crossover (dummy fuses). When tested as specified in 4.7.14, there shall be no evidence of damage to the circuit breaker case, ejection of wire, or burn off of leads; all poles shall trip automatically; shunts, bi-metals, and heaters shall not be burned open; and circuit breakers shall be capable of being reclosed.

3.18 Maximum interrupting capacity. When tested as specified in 4.7.15, the circuit breaker case shall show no evidence of damage, the current limiter or fuse within the circuit breaker shall remain intact and permanently open, the cotton shall not be ignited and fuse as specified in 4.7.3 shall not be open.

3.19 Maximum energy (applicable only if tests in 4.7.15(b) were not required). When tested as specified in 4.7.16, current limiters shall remain intact and permanently open, the circuit breaker shall show no evidence of physical damage, there shall be no ejection of wire or burned off leads and the fuse as specified in 4.7.3 shall not be open.

3.20 250 percent calibration at 25°C ±3°C. When tested as specified in 4.7.17, the tripping time shall not exceed the limits shown in table II for the 200 percent rated current test. Circuit breakers must also meet the requirements of the dielectric withstanding voltage test (see 3.12).

3.21 Marking. Circuit breaker marking shall include the manufacturer's part or catalog number, name or symbol, the current rating, voltage rating, and interrupt rating in rms symmetrical amperes regardless of whether it is a standard or high interrupt rating (see tables VIII and XV). When multiple interrupt and voltage ratings apply (see table XVI), all the ratings shall be marked on the device. Additional circuit breaker and accessory marking shall be in accordance with UL 489. In addition, the Government PIN (see 3.1) may be marked on the device.

3.21.1 Underwriters Listed (UL Listed) mark. Circuit breakers which conform to UL 489 (see 4.5(b)) shall have the UL Listed mark on each circuit breaker.

3.22 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials should be used to the maximum extent possible, provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

3.23 Pure tin. The use of pure tin, as an underplate or final finish, is prohibited both internally and externally. Tin content of (product) and solder shall not exceed 97 percent, by mass. Tin shall be alloyed with a minimum of 3 percent lead, by mass (see 6.4).

3.24 Workmanship. Circuit breakers shall be manufactured and processed in such a manner as to be uniform in quality and shall be free from loose terminals, cracked, or displaced parts, sharp edges, burrs, 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 supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the supplier may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Test equipment and inspection facilities. Test equipment and inspection facilities shall be of sufficient accuracy, quality, and quantity to permit performance of the required inspection. The supplier shall establish calibration of inspection equipment to the satisfaction of the Government. Compliance with the requirements of NCSL Z540-3, ISO 10012 or equivalent system as approved by the qualifying activity.

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

a. Qualification inspection (see 4.5).

b. Conformance inspection (see 4.6).

4.3 Inspection of materials and components. In accordance with 4.1, the supplier is responsible for insuring that materials and components used were manufactured and inspected in accordance with the requirements of this specification and of referenced subsidiary specifications and standards to the extent specified, or if none, in accordance with this specification (see 3.3).

4.4 Inspection conditions. All inspections, examinations, and tests shall be performed in accordance with this specification and the applicable portion of UL 489.

4.5 Qualification inspection. Qualification shall be obtained by either of the following:

a. By testing the circuit breakers in accordance with 4.5.1. 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.

b. By having UL marking on circuit breakers. Manufacturers electing this option shall submit a letter of certification to the qualifying activity listing the UL file number, the Government part number, and the manufacturer's part number for each circuit breaker rating for which qualification is desired. The manufacturer shall also certify that he will notify the qualifying activity of any problem which threatens loss of the UL mark within 30 days after recognition of the problem.

NOTE: Extension of qualification. For circuit breaker ratings marked "Not for new design" (see 3.1), qualification is waived, however, acquisition shall be made from a source qualified for the remainder of values on that specification sheet.

4.5.1 Inspection routine. Circuit breakers shall be subjected to the tests specified in table IV in the order shown, for that circuit breaker design. Sample size shall be as specified in UL 489 for both the minimum and maximum current rating of each specification sheet. In the event of an internal design change, the minimum and maximum rating of each design shall be tested.

4.5.1.1 High available fault current ratings. Circuit breaker types which have been qualified for use in limited available fault current circuits via successfully passing group I testing may also be qualified for use on high available fault current circuits by passing the test specified in group II. Group II tests will be run on a new set of samples of the same type that has passed group I and shall be marked with one or more of the interrupting ratings specified in table XV to signify its capabilities. Sample size shall be as specified in UL 489.

4.5.1.2 Fused circuit breakers. Group III tests apply only to fused circuit breakers and may, at the option of the manufacturer, be performed on a new set or sets of samples as specified in UL 489.

4.5.2 Failures. One or more failures shall be cause for refusal to grant qualification approval.

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TABLE IV. Qualification inspection.

Examination or test	Circuit breaker design 1/					Requirement paragraph	Method paragraph
	Fully magnetic breakers 2/	Uncompensated thermal magnetic breakers 2/		Compensated thermal magnetic breakers	Fused uncompensated thermal magnetic breakers		
		25°C	40°C 4/	40°C 5/	40°C		
Group I 6/							
Visual and mechanical examination - - - - - - - -	X	X	X	X	X	3.1 thru 3.4.12, 3.21, and 3.22	4.7.1
Calibration						3.5	4.7.2
200% at 25°C - - - - - - -	X	X	X	X	X		
125% at 25°C - - - - - - -	X	X	---	---	---		
135% at 25°C - - - - - - -	---	---	X	X	X		
200% at 40°C - - - - - - -	---	---	---	X	---		
125% at 40°C (after carrying rated current)	---	---	---	X	---		
Calibration of adjustable magnet trip (when applicable)- - - - - - - - -	X	X	X	X	X	3.5.1	4.7.2.1
Overload - - - - - - - - - - -	X	X	X	X	X	3.6	4.7.3
Tungsten lamp load 7/- -	X	X	X	X	---	3.7	4.7.4
100% calibration at 40°C 8/ - - - - - - - - - -	---	---	X	X	X	3.8	4.7.5
Temperature and 100% calibration at 25°C - - -	X	X	X	X	X	3.9	4.7.6
Endurance - - - - - - - - - -	X	X	X	X	X	3.10	4.7.7
Short circuit - - - - - - - - - -	X	X	X	X	X	3.11	4.7.8
Dielectric withstanding voltage - - - - - - - - - - -	X	X	X	X	X	3.12	4.7.9.1
Group II 6/							
200% calibration at 25°C	X	X	X	X	---	3.13	4.7.10
Short circuit interruption -	X	X	X	X	---	3.14	4.7.11
250% calibration at 25°C	X	X	X	X	---	3.15	4.7.12
Dielectric withstanding voltage - - - - - - - - - - -	X	X	X	X	---	3.12	4.7.9.2
Group III 6/							
Special short circuit							
Crossover (current limiters or fuses) 9/ -	---	---	---	---	X	3.16	4.7.13
Crossover (dummy fuses) 10/- - - - - - -	---	---	---	---	X	3.17	4.7.14
Maximum IC 11/ - - - -	---	---	---	---	X	3.18	4.7.15
Maximum energy (when applicable) 11/	---	---	---	---	X	3.19	4.7.16
250% calibration at 25°C	---	---	---	---	X	3.15	4.7.12
Dielectric withstanding voltage - - - - - - - - - - -	---	---	---	---	X	3.12	4.7.9.2

See footnotes at top of next page.

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TABLE IV. Qualification inspection - Continued.

1/ X - Indicates test required.

2/ Circuit breakers whose automatic operation does not depend on the heating effect of current and is not affected by changes in ambient temperature.

3/ Circuit breakers whose automatic operation depends on the heating effect of current and is affected by changes in ambient temperature.

4/ If a circuit breaker includes any thermal compensation in its tripping mechanism, and if the manufacturer desires to have the circuit breaker marked "40°C", it shall be subjected to the tests for a compensated thermal breaker.

5/ Circuit breakers whose automatic operation depends on the heating effect of current, and which incorporate means for counteracting the effects of change in ambient temperature.

6/ Group I tests apply to all circuit breaker designs, secondary sample group II tests apply to circuit breaker designs with high interrupting capacity ratings (see 4.5.1.1), and group III tests apply to fused circuit breakers (see 4.5.1.2).

7/ Tests made only on circuit breakers rated at 50 amperes or less, rated 120 or 120-240 volts or less.

8/ This test may be performed after the temperature and 100 percent calibration tests at 25°C.

9/ "O" operation (see 6.7.2), conducted slightly above crossover to ensure operation of current limiters or fuses. Cotton and cheesecloth (see UL 489) indicators shall be sued when crossover current is less than short circuit current.

10/ With dummy fuses, "O" and "CO" (see 6.5) operation, no cheesecloth or cotton indicators used.

11/ No cheesecloth or cotton indicators used in circuit breaker area. Cotton used to cover openings in current limiter area.

4.5.3 Retention of qualification. To retain qualification, the contractor shall utilize the applicable procedure as follows:

a. Those suppliers that used the inspection requirements of 4.5.1, and when applicable, 4.5.1.1, or 4.5.1.2 to obtain qualification shall provide verification to the qualifying activity for the following items every 12 months:

   Verification that the conformance inspections have been performed on inspection lots supplied to the requirements of this specification. If 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 QPL.

In the event that no production has occurred in this period, the contractor shall still verify to the qualifying activity that the capacity to manufacture and test QPL circuit breakers still exists and that the contractor wants to remain on the QPL.

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b. Those suppliers that used the Underwriters Laboratories Listed (UL Listed) mark to obtain qualification shall submit certification that the qualified circuit breakers retain the UL Listed mark, at 12-month intervals, to the qualifying activity. The letter of certification shall include the UL file number, the Government PIN, and the manufacturer's PIN for each circuit breaker which is qualified. The manufacturer shall also certify that they will notify the qualifying activity of any problem which threatens loss of the UL Listed mark within 30 days after recognition of the problem. The initial reporting date shall be established by the qualifying activity. Failure to submit the certification within 30 days after the end of each 12-month period may result in loss of qualification for the product.

Failure to submit the above within 30 days after the end of each 12-month period may result in loss of qualification for the product. Suppliers shall notify the qualifying activity immediately of inspection data that indicates failure of the product to meet the requirements of UL 489.

4.6 Quality conformance inspection. Quality conformance inspection shall consist of groups A, B, and C inspections as specified herein, for circuit breakers which qualified in accordance with 4.5(a). For circuit breakers which qualified in accordance with 4.5(b), the UL Listed Mark shall be evidence of compliance.

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

4.6.1.1 Inspection lot. An inspection lot shall consist of all circuit breakers of the same specification sheet and current rating produced under essentially the same conditions, and offered for inspection at one time.

4.6.1.2 Group A inspection. Group A inspection shall consist of the tests specified in table V and is applicable to all circuit breaker designs.

TABLE V. Group A inspection.

Examination or test	Requirement paragraph	Method paragraph
Visual and mechanical examination:		
Dimensions - - - - - - - - - - - - - - - - - -	3.1, 3.4	
Marking -	3.21	4.7.1
Workmanship - - - - - - - - - - - - - - - - -	3.24	

4.6.1.2.1 Sampling plan. A sample of parts shall be randomly selected from each inspection lot in accordance with table VI. If one or more defects are found, the lot shall be rescreened and defects removed. After screening and removal of defects, a new sample of parts shall be randomly selected in accordance with table VI. If one or more defects are found in the second sample, the lot shall be rejected and shall not be supplied to this specification.

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TABLE VI. Groups A and B, zero defect sampling plan.

Lot size	Sample size		
	Group A		Group B
	Major	Minor	
1 to 3	100 percent	100 percent	100 percent
4 to 13	100 percent	3	100 percent
14 to 25	13	3	13
26 to 50	13	5	13
51 to 90	13	6	13
91 to 150	13	7	13
151 to 280	20	10	20
281 to 500	29	11	29
501 to 1,200	34	15	34
1,201 to 3,200	42	18	42
3,201 to 10,000	50	22	50

4.6.1.3 Group B inspection. Group B inspection shall consist of the tests specified in table VII, in the order shown and shall be made on sample units which have been subjected to and have passed the group A inspection. The applicability of a test listed for a particular design of circuit breaker shall be as specified in table IV.

4.6.1.3.1 Sampling plan. A sample of parts shall be randomly selected from each inspection lot in accordance with table VI, if one or more defects are found, the lot shall be rescreened and defects removed. After screening and removal of defects, a new sample of parts shall be randomly selected in accordance with table VI, if one or more defects are found in the second sample, the lot shall be rejected and shall not be supplied to this specification.

4.6.1.3.2 Disposition of sample units. Sample units which have been subjected to group B inspection and meet the requirements specified herein, may be delivered on the contract or order.

TABLE VII. Group B inspection.

Examination or test	Requirement paragraph	Method paragraph
Calibration		
125% at 25°C	3.5	4.7.2
135% at 25°C		
200% at 40°C		
125% at 40°C (after carrying rated current)		
Calibration of adjustable magnetic trip (when applicable)	3.5.1	4.7.2.1
Overload	3.6	4.7.3
Tungsten lamp load	3.7	4.7.4
100% calibration at 40°C	3.8	4.7.5
Temperature and 100% calibration at 25°C	3.9	4.7.6

4.6.2 Qualification verification inspection. Qualification verification inspection shall consist of the tests specified in table VIII. Except where the results of this inspection show noncompliance with the applicable requirement (see 4.6.2.1.4), delivery of products which have passed groups A and B shall not be delayed pending the results of this qualification verification inspection.

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TABLE VIII. Group C inspection.

Examination or test 1/	Requirement paragraph	Method paragraph
Group I 2/		
Overload -	3.12	4.7.3
Tungsten lamp load 3/ - - - - - - - - - - -	3.7	4.7.4
Temperature and 100% calibration at 25°C - - - - - - - - - - - - - - - - - - -	3.9	4.7.6
Endurance - - - - - - - - - - - - - - - - - - -	3.10	4.7.7
Short circuit - - - - - - - - - - - - - - - - - - -	3.11	4.7.8
Dielectric withstanding voltage - - - - -	3.12	4.7.9.1
Group II 2/		
200% calibration at 25°C - - - - - - - - -	3.13	4.7.10
Short circuit interruption - - - - - - - - - -	3.14	4.7.11
250% calibration at 25°C - - - - - - - - -	3.15	4.7.12
Dielectric withstanding voltage - - - - - -	3.12	4.7.9.2
Group III 2/		
Special short circuit		
Crossover (current limiters of fuses) 4/ - - - - - - - - - - - - - - - - - - -	3.16	4.7.13
Crossover (dummy fuses) - - - - - - - -	3.17	4.7.14
Maximum IC 5/ - - - - - - - - - - - - - - -	3.18	4.7.15
Maximum energy - - - - - - - - - - - - - - -	3.19	4.7.16
250% calibration at 25°C - - - - - - - - -	3.15	4.7.12
Dielectric withstanding voltage - - - - - -	3.12	4.7.9.2

1/ Group I tests shall be conducted on all sample units, group II tests shall be conducted on sample units with the high fault currents of table XV. Fused type sample units shall be tested to the requirements of groups I and III.

2/ Group I tests apply to all circuit breaker designs, secondary sample group II tests apply to circuit breaker designs with high interrupting capacity ratings (see 4.5.1.1) and group III tests apply to fused circuit breakers (see 4.5.1.2).

3/ Tests made only on breakers rated at 50 amperes or less, rated 125 or 125-250 volts or less.

4/ "O" operation conducted slightly above crossover to ensure operation of current limiters or fuses. Cotton and cheesecloth indicators shall be used when crossover current is less than short circuit current.

5/ No cheesecloth or cotton indicators used in circuit breaker area. Cotton used to cover openings in current limiter area. Test shall be conducted with one half of the current limiters in the "as received" condition and the other half shall be conditioned at (90°C for 24 hours) then subjected to 95 ±5 percent relative humidity at 20-25°C for 5 days). Conditioned sample shall be tested no later than one hour after removal from the conditioned environment.

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4.6.2.1 Group C inspection. Group C inspection shall consist of the tests specified in table VIII in the order shown and shall be made on sample units selected from lots which have passed the groups A and B inspections, unless the Government considers it more practical to select a sample from current production. A manufacturer's normal quality control and production tests may be used to fulfill group C inspection. The applicability of a test listed for a particular design of circuit breaker shall be as specified in table IV.

4.6.2.1.1 Sampling plan. Samples shall be selected at random. The sample size shall be as for qualification (see 4.5.1) for each specification sheet, 12 months after the date of notification of qualification and after each subsequent 12-month period.

4.6.2.1.2 Failures. If one or more sample units fail to pass group C inspection, the sample shall be considered to have failed.

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

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

4.7 Methods of examination and test. For the purpose of testing multi-pole circuit breakers having independent trip, the operation of each pole shall be tested as individual circuit breakers. Unless otherwise specified, no conditioning of the circuit breakers shall take place during or between tests. Unless otherwise specified, the test frequency shall be 60 Hz (see 3.1).

4.7.1 Visual and mechanical examination. Circuit breakers shall be examined to verify that the material, design, and construction, physical dimensions, marking, and workmanship are in accordance with applicable requirements (see 3.1, 3.4, 3.21, and 3.22).

4.7.2 Calibration (see 3.5). Circuit breakers shall be mounted in a vertical position without an enclosure, other than the molded case and wired in accordance with the requirements of UL 489. Devices shall be stabilized (see 6.6.3) at the applicable ambient temperature (see 6.6.4), and subjected to the percent of rated current specified in table IX for the particular design of circuit breaker under test. The 200 percent test shall be conducted separately on each pole of multi-pole circuit breakers and the 125 -135 percent test shall be conducted with each pole of multi-pole breakers simultaneously carrying the applicable current. Tests shall be conducted in the order shown reading the X's from left to right.

TABLE IX. Calibration tests sequence.

Circuit breaker design	Percent of rated current and ambient temperature ±3°				
	200 percent at 25°C	125 percent at 25°C	135 percent at 25°C	200 percent at 40°C	125 percent at 40°C
Fully magnetic breakers - - - - - - - - - - - - - - - -	X	X	---	---	---
Uncompensated thermal breakers calibrated at 25°C - - - - - - - - - - - - - - - - - - -	X	X	---	---	---
Uncompensated thermal and fused breakers calibrated at 40°C - - - - - - - - - - - - - - - - - - -	X	---	X	---	---
Compensated thermal breakers - - - - - - - - - -	X	---	X	X	X 1/

1/ This 125 percent test shall be conducted immediately after the breaker has carried its rated current until constant temperatures have been reached (see 4.7.6).

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4.7.2.1 Adjustable magnetic trip calibration (see 3.5.1). All circuit breakers with adjustable magnetic trip units shall be tested at the maximum and minimum setting. At the maximum setting, the test current at the beginning of the test is to be 70 percent of the current setting, and is then to be increased rapidly until the circuit breaker trips by means of the magnetic trip. At the minimum setting, the test current is to be increased slowly (but not so that the thermal trip operates) from zero until the circuit breaker trips by means of the magnetic trip. Each pole is to be tested separately three times at both maximum and minimum settings, and the average of the three tests on any pole in either case is to be considered to be the tripping current of that pole.

4.7.3 Overload (see 3.6). Circuit breakers shall be mounted in the enclosure specified (see 3.1), wired and connected to a supply circuit as specified in the applicable portions of UL 489. A 30 ampere non-time delay fuse shall be connected between the enclosure or mounting surface and one line to indicate arc over to the enclosure or grounded dead metal. Circuit breakers shall be subjected to 600 percent of their rated current but not less than 150 amperes, for the total number of close-open operations specified in table X. The power supply open circuit voltage shall be between 100 and 105 percent of the rated circuit breaker voltage. Upon application of power, the test circuit voltage shall remain within 15 percent of the rated voltage. Circuit breakers shall be tested with an inductive load. The power factor of the load shall be from 0.45 to 0.50 except, following the 35 cycles of manual operation, a two-pole independent trip (see 6.7.5), and single-pole circuit breakers rated at 120/240 V ac (to be tested in pairs as a two-pole independent trip) shall be tested by operating each pole separately for 15 cycles of automatic operation, and with both the line and load terminals of the other pole connected to the line wire of opposite polarity to that of the pole under test. The breaker shall be tested at a power factor of 0.75-0.80 for these automatic operations only.

TABLE X. Overload test operations.

Frame size in amperes	Total number to open-close operations	Number of operations		Number of cycles of operation per minute
		Manually	Automatically	
0 to 100	50	35	15	6
101 to 225	50	50	---	5
226 to 600	50	50	---	4
601 to 1,600 1/	50	50	---	1
1,601 to 2,500 1/	25	25	---	1
2,501 to 4,000 1/ 2/	28	28	---	1

1/ Operations may be conducted in groups of 5 with 15 minutes maximum between groups.
2/ For 3,000 ampere ratings and up. Three operations at 600 percent of rating followed by 25 operations at 200 percent of rating (may be conducted in groups of 5 with 15 minutes maximum between groups.)

4.7.4 Tungsten-filament lamp load (see 3.7). Circuit breakers rated 50 amperes and less and 120 or 120/240 volts or less shall be subjected to 100 percent of rated current and voltage at room temperature using tungsten filament lamps as a load. The current shall be measured when the filaments are hot. 200 watt lamps shall be used except for those which may be required for final current adjustment. Circuit breakers shall be operated at room temperature being closed for two seconds and then opened for two minutes allowing the lamps to cool. Each pole of a circuit breaker shall carry the rated load. The close-open cycle shall be repeated three times. The capacity of the supply circuit shall be ten times the rated circuit breaker current and within 2.5 percent of the rated voltage.

4.7.5 100 percent calibration of 40°C ±3°C (see 3.8). Circuit breakers shall be mounted on a vertical surface, with leads attached, in a 40°C ambient temperature. The ambient temperature is to be measured by means of thermocouples located 6 inches (152.4 mm) from the sides of the circuit breaker and adjacent to the center of the circuit breaker. 100 percent of the rated current shall be passed through each pole of the circuit breaker simultaneously until the temperature at the terminals stabilizes.

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4.7.6 Temperature and 100 percent calibration at 25°C ±3°C (see 3.9). Circuit breakers shall be mounted in a vertical position without an enclosure other than the molded case. They shall be wired and thermal couples placed on the terminals at a point to which the insulation is brought up as in actual service and at points of anticipated highest temperatures for each material used in the circuit breaker as specified in the applicable portions of UL 489. Circuit breakers shall be stabilized in an ambient temperature of 25°C ±3°C. All poles shall be continuously subjected to 100 percent of rated current at any convenient voltage until temperatures have restabilized. The temperature rise of each measurement shall be recorded. In addition the limiter, terminals, and casings temperature of fused circuit breakers shall be measured and recorded.

4.7.7 Endurance (see 3.10). Circuit breakers shall be mounted and wired as specified in the applicable portions of UL 489 in the enclosure specified (see 3.1). A fuse shall be connected as specified in 4.7.3. Circuit breakers shall be operated in such a manner that all poles make and break a current equal to their rated current at rated voltage and frequency and with a lagging power factor of 0.75 to 0.80 for operations requiring current. During this operation, the circuit breaker is to be closed then opened immediately. The number and rate of load and no-load operations shall be as specified in table XI. Two-pole independent trip circuit breakers shall be tested with both poles operating simultaneously. Following the endurance test, the calibration test specified in 4.7.2 shall be repeated, however note 1 of table IX does not apply for this test and the 200 percent test at 40°C applicable to compensated circuit breakers need not be conducted.

TABLE XI. Endurance test operations.

Frame size in amperes	Number of cycles of operation per minute 1/	Number of cycles of operation 2/		
		With current	Without current	Total
50	6	6,000	4,000	10,000
100	6	6,000	4,000	10,000
125	5	4,000 3/	4,000	8,000 3/
150	5	4,000 3/	4,000	8,000 3/
200	5	4,000	4,000	8,000
225	5	4,000	4,000	8,000
400	4	1,000	5,000	6,000
600	4	1,000	5,000	6,000
800	1	500	3,000	3,500
1,200	1	500	2,000	2,500
1,600	1	500	2,000	2,500
2,000	1	500	2,000	2,500
2,500	1	500	2,000	2,500
3,000	1 4/	400	1,100	1,500
4,000	1 4/	400	1,100	1,500

1/ Rate of operation may be increased to a maximum of 20 per minute.
2/ For circuit breakers rated more than 800 amperes, the endurance test may, at the option of the manufacturer, be conducted in groups of 100 load operations. No-load operations may be conducted between groups of load operations.
3/ Where tests are required on samples having ratings of 100 amperes or less, 240 volts or less, the number of operations shall be the same as for the 100 ampere frame.
4/ Rate of operation: 1 cycle per minute for first 10 operations; thereafter in groups of 5 (at 1 cycle per minute) for an interval between groups that is agreeable to all concerned.

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4.7.8 Short circuit (see 3.11). The power source, loading, instrumentation, calibration, wiring, and preparation for test shall be in accordance with the applicable portions of UL 489. Circuit breakers shall be tested in the enclosure specified (see 3.1). Circuit breakers shall be mounted as in actual service with the door or cover and any other openings, including unused knockout openings, closed. The knockout openings shall be closed on the outside of the enclosure by means of tape. Three thicknesses of cloth 1/ are to be taped to the inside sidewalls of the enclosure so as to cover the entire sidewall within .5 inch of front and rear vertical edges. A cotton pad 2/ at least .5 inch thick, and having a length and width four times the handle opening but not less than 3 inches in either dimension is to be centered and secured not more than .5 inch from the end of the circuit breaker handle. A small opening is permitted in a cotton pad to pass the plunger to operate a push-type circuit breaker. The circuit breaker shall be tested with alternating current at rated frequency. The power factor of the test circuit with required current of the test circuit with required current flowing shall be as tabulated in table X, except that a lower power factor may be employed. The capacity of the circuit together with the total limiting impedance shall be such as to permit the applicable current specified in table XIII. The open-circuit voltage shall be not less than 100 percent nor more than 105 percent of the rated voltage of the circuit breaker. The minimum point on the voltage wave is not to be less than 90 percent of the rated voltage of the circuit breaker. A fuse shall be connected as specified in 4.7.3 for operations conducted on the individual poles. For common operations, the fuse shall be connected to the side of the supply least likely to arc to grounded metal.

Circuit breakers shall be subjected to the number and type of short circuit operations indicated in table XIV. Successive operations shall be conducted by alternating between the "O" and "CO" operations (see 6.7.2). The time interval between the short-circuit operations of a circuit breaker shall be two minutes, except that the time interval may be extended to whatever is necessary to allow the circuit breaker to be reset, but not more than 1 hour. Each circuit breaker is to be subjected to all the operations of the short-circuit test with one set of line and load leads, i.e., without replacement of any lead during the test.

Following the short circuit test, circuit breakers shall be closed, subjected to 100 percent of the rated voltage and checked for continuity, then the 200 percent rated current test at 25°C shall be conducted as specified in 4.7.2.

TABLE XII. Power factor of test circuits.

Test circuit in amperes	Power factor
10,000 or less	0.45-0.50
10,001-20,000	0.25-0.30
Over 20,000	0.15-0.20

1/ The cloth employed is to be bleached cheesecloth, 36 inches wide, running 14 to 15 yards per pound, and having what is known to the trade as a "count of 32 by 28". In placing the cloth in position for the short-circuit test, the material is to be folded in such a manner that cut or torn edges will not be exposed directly to the arc or flash resulting from the opening of the circuit breaker.

2/ The cotton is to be surgical cotton such as is commonly used for medical purposes.

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TABLE XIII. Available current in test circuit.

Frame rating	RMS symmetrical				
	1 pole	2 pole		3 pole	
		Individual	Common	Individual	Common
100A maximum 250 V maximum	5,000	5,000	5,000	4,330 1/	5,000
100A maximum 251-600V	10,000	10,000	10,000	8,660 1/ 2/	10,000
101-800A any voltage	10,000	10,000	10,000	8,660 1/ 2/	10,000
801-1,200 any voltage	---	14,000	14,000	12,120 1/ 2/	14,000
1,201-1,600	---	14,000	20,000	14,000	20,000
1,601-2,000	---	14,000	25,000	14,000	25,000
2,001-2,500	---	20,000	30,000	20,000	30,000
2,501-3,000	---	25,000	30,000	25,000	35,000
3,001-4,000	---	30,000	45,000	30,000	45,000

1/ This value is the current available when using two legs of the 3-phase circuit indicated under "Common".
2/ For the 277/480 volt rating, the current indicated for 2-pole under "Individual" shall be used.

TABLE XIV. Short-circuit operations.

Poles	Frame rating	Circuit breaker-AC voltage rating	Operations by each pole			Common operations			Total number of operations
			O	CO	O (see 6.6.2)	O	CO	O	
1	All	120, 240, 277, 480, or 600	X	X	X	---	---	---	3
1	All	120/240 (tested in pairs)	---	---	---	X	X	X	3
2	All	240,480, or 600	X	X	---	X	---	---	5
2	All	120/240	---	---	---	X	X	X	3
2	0-1200A	277/480	X	X	---	X	---	---	5
2	All	10/30	X	X	---	X	---	---	5
3	0-1200A	240, 480, or 600	X	X	---	X	---	---	7
3	1201-Up	240, 480, or 600	X	X	---	X	X	---	8
3	All	120/240	---	---	---	X	X	X	3
3	0-1200A	277/480	X	X	---	X	---	---	7
3	1201-UP	277/480	X	X	---	X	X	---	8

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4.7.9 Dielectric withstanding voltage.

4.7.9.1 Method I (see 3.12). Circuit breakers shall be tested in accordance with method 301, MIL-STD-202. The following details shall apply:

a. Magnitude of test voltage: 1,000 volts (rms) plus twice the voltage which may be applied between the parts specified below when the circuit breaker is connected to a circuit of its maximum voltage rating.

b. Nature of potential: AC 60 Hz.

c. Points of application of test voltage:

(1) Between line and load terminals with the breaker open: With the breaker in the "tripped" or the "off" positions.

(2) Between terminals of opposite polarity with the breaker closed.

(3) Between live parts and the overall enclosure with the breaker both open and closed.

d. Measurement during test: Leakage current.

e. Examination after test: Circuit breakers shall be examined for evidence of flashover, mechanical damage, arcing, and breakdown.

4.7.9.2 Method II (see 3.12). Circuit breakers shall be tested as specified in 4.7.9.1, except the magnitude of the test voltage shall be two times the rated voltage of the circuit breaker but not less than 900 volts.

4.7.10 200 percent calibration at 25°C ±3°C (see 3.13). Circuit breakers shall be subjected to the 200 percent calibration test at 25°C ±3°C as specified in 4.7.2.

4.7.11 Short-circuit interruption (see 3.14). The power source, loading, instrumentation, calibration, wiring, and preparation for test shall be in accordance with the applicable portions of UL 489. Circuit breakers shall be tested in the enclosure specified (see 3.1). Openings may be provided in the enclosure if the combined area of all openings does not exceed 10 percent of the total external enclosure area and if no opening is directly opposite a vent in the circuit breaker case. The test enclosure shall be connected through a fuse as indicated in 4.7.3 to the line lead least likely to arc to the enclosure, or the neutral, if the circuit breakers are rated 120/240 or 277/480 volts ac. The connection is to be made to the load side of the limiting impedance by means of No. 10 AWG copper wire no more than 6 feet in length. The capacity of the supply circuit together with the total limiting impedance of the circuit shall be such as to permit the applicable current indicated in table XV. The open circuit voltage shall be not less than 100 percent nor more than 105 percent of the rated voltage of the circuit breaker under test, and the power factor of the test circuit with the required current flowing shall be in accordance with table XII. The operation shall consist of closing the short-circuit on the circuit breaker by means of suitable switching device, using random closing. After a 2-minute interval, or the time necessary to allow the circuit breaker to reset, but not more than 1 hour, the circuit breaker is to be closed on the short circuit. Circuit breakers tested under "bus bar conditions" require only one operation, that being closing of the test circuit on the circuit breaker. Following the test, circuit breakers shall be checked for damage to the circuit breaker case, ejection of wire from the wire connector or burn off of leads, failure of a pole to trip, burned out shunts, bi-metals or heaters, mechanical failures which do not permit relatching or reclosing of the circuit breaker and other similar failures.

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TABLE XV. Current interrupting rating: RMS symmetrical amperes applicable to circuit breakers rated for high available fault current circuits.

7,500 1/	25,000	65,000
10,000 1/	30,000	85,000
14,000	35,000	100,000
18,000	42,000	125,000
22,000	50,000	150,000
		200,000

1/ Applicable only to circuit breakers having continuous-current ratings of 100 amperes or less (frame size) and voltage ratings of 250 volts or less.

4.7.12 250 percent calibration at 25°C ±3°C (see 3.15). Each pole of the circuit breaker shall be subjected to the first test specified in 4.7.2, except the test current shall be 250 percent of rated current. Following the test, circuit breakers shall be subjected to the dielectric withstanding voltage test specified in 4.7.9.2.

4.7.13 Crossover (current limiters or fuses (see 3.16). Circuit breakers shall be prepared for test in accordance with 4.7.11 (except cotton and cloth indicators shall be used (see table IV and VIII), and subjected to an "O" operation at a current level slightly above the crossover point. Following the test, limiters or fuses shall be visually examined, cotton and cheesecloth shall be examined for evidence of burning and the circuit breaker enclosure shall be examined for evidence of damage.

4.7.14 Crossover (dummy fuses (see 3.17). With dummy fuses installed, the circuit breaker shall be prepared for test in accordance with 4.7.11. Circuit breakers shall be subjected to one "O" and one "CO" operation at a current equal to the crossover value. Following the test, circuit breakers shall be checked for damage to the circuit breaker case, ejection of wire from the wire connector or burn off of leads, failure of a pole to trip, burned out shunts, bi-metals or heaters, mechanical failures which do not permit relatching or reclosing of the circuit breaker or other similar failures.

4.7.15 Maximum interrupting capacity (see 3.18). Circuit breakers shall be prepared for test in accordance with 4.7.11, except cotton shall be placed directly over openings in the current limiter area and the power factor of the test circuit shall be not higher than .20. Test shall be conducted on one half of the current limiters in the "as received" condition and the other half shall be conditioned at 90°C for 24 hours then subjected to 95 ±5 percent relative humidity at 20°C - 25°C for 5 days. Conditioned samples shall be tested no later than 1 hour after removal from the conditioned environment. One "O" operation (or as specified, see 4.7.15 (a) and (b)) and one "CO" operation shall be performed in a circuit of rated interrupting capacity.

a. During the "O" operation, a full current off-set condition is to be present in one phase upon closing the test circuit. It is the intent to initiate limiter or fuse arcing within 30 electrical degrees prior to maximum voltage in that phase. If such arcing initiates prior to maximum voltage in that phase. If such arcing initiates prior to maximum voltage, a repeat test is to be made in which closing is delayed in order to obtain the desired condition.

b. If the closing angle in item (a) is zero degrees and if arcing, within the limiter or fuse, commenced after 90 degrees on the voltage wave, the sample is to be subjected to a test in which closing occurs at maximum voltage (no current off-set). Individual poles may be used for such testing in order to avoid destroying current limiters or fuses unnecessarily.

Then an "O" operation is to be made where closure is at a point on the voltage wave 45 degrees after a voltage zero.

Following the test, the circuit breaker case and leads and the limiters or fuses shall be examined.

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4.7.16 Maximum energy (applicable only if tests in 4.7.15(b) were not required) (see 3.19). Current limiters shall be installed in a circuit breaker and prepared for test as specified in 4.7.11. One half of the current limiters shall be in the "as received" condition and the other half shall be conditioned at 90°C for 24 hours then subjected to 95 ±5 percent relative humidity at 20°C-25°C for 5 days. Conditioned samples shall be tested no later than 1 hour after removal from the conditioned environment. The limiter shall be subjected to a value of symmetrical, rms current such that the current limiter permits a peak current of 70-100 percent of the peak symmetrical component of the alternating current of the test circuit. The closing angle is to be at voltage zero of the phase where the current is to be considered. These tests may be conducted on a three phase circuit with one phase meeting these conditions. The power factor shall be 0.20 maximum. Following the test, limiters and circuit breakers shall be examined.

4.7.17 250 percent calibration at 25°C ±3°C (see 3.20). Circuit breakers shall be subjected to the calibration test specified in 4.7.2 at a temperature of 25°C ±3°C and 250 percent of the rated current. Following the test, circuit breakers shall be subjected to the dielectric withstanding voltage test specified in 4.7.9.2.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the Military service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

INFORMATION FOR GUIDANCE ONLY. (This section contains information of a general or explanatory nature that is helpful, but is not mandatory.)

6.1 Intended use.

6.1.1 Thermal magnetic circuit breakers.

6.1.1.1 Thermal magnetic uncompensated circuit breakers. Thermal magnetic circuit breakers are especially well suited for overload protection of conductors when circuit breakers are exposed to similar ambient temperatures because the circuit breaker continuous current rating changes in about the same ratio as the average conductor rating changes with the ambient temperatures. The magnetic trip portion of the circuit breaker offers short circuit protection.

6.1.1.2 Thermal magnetic compensating breakers. Ambient compensating circuit breakers provide overload and short circuit protection but has temperature compensating elements which counteract the effect of ambient temperature changes thereby maintaining the calibrated current setting throughout a temperature range. Typical applications are a circuit breaker located outside and protecting wire in a temperature controlled building; circuit breaker is exposed to changing temperature conditions and is protecting underground cable; overload protection of conductors are not of prime importance or protection of a portable generator designed to operate throughout varied temperature extremes.

6.1.2 Magnetic circuit breakers. Magnetic circuit breakers are available in the same operating characteristics as ambient compensating. The intended use is the same as in 6.1.1.1 and 6.1.1.2.

6.1.3 Fused circuit breakers. Fused circuit breakers incorporate fuses or current limiters in series with the circuit breaker elements to increase the interrupting capacity of a circuit breaker.

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6.2 Acquisition requirements. Acquisition documents should specify the following:

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

b. Title, number, and date of the applicable specification sheet with the government circuit breaker number (see 3.1).

c. Packaging requirements (see 5.1).

d. Special marking, if required (see 5.1).

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 Qualified Products List whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from the DLA Land and Maritime, ATTN: DLA Land and Maritime-VQP, 3990 E. Broad Street, Columbus, OH 43218-3990, or by e-mail vqp.chief@dla.mil. An online listing of products qualified to this specification may be found in the Qualified Products Database (QPD) at https://assist.dla.mil.

6.4 Tin whisker growth. The use of alloys with tin content greater than 97 percent, by mass, may exhibit tin whisker growth problems after manufacture. Tin whiskers may occur anytime from a day to years after manufacture and can develop under typical operating conditions, on products that use such materials. Conformal coatings applied over top of a whisker-prone surface will not prevent the formation of tin whiskers. Alloys of 3 percent lead, by mass, have shown to inhibit the growth of tin whiskers. For additional information on this matter, refer to ASTM-B545 (Standard Specification for Electrodeposited Coatings of Tin).

6.5 Classification and ratings. Table XVI provides a list of circuit breaker ratings covered by this specification but is not necessarily limited to the values specified. It is the intent that the class numbers assigned in the table be used to specify the interrupting rating requirements in contracts, etc., but should not be assigned a federal stock number.

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TABLE XVI. Classification of ratings.

Class	Interrupting rating		Poles	Range of current trip 4/
	Symmetrical amperes 1/	Volts ac 60 Hz		
10a 2/	5,000	120/240	1 or 2	15-100
10b	5,000	240	2 or 3	15-100
11a	7,500	120	1	15-100
11b	7,500	240	2 or 3	15-100
12a 2/	10,000	120/240	1 or 2	15-100
12b	10,000	240	2 or 3	15-225
12c	10,000	277	1	15-100
13a	14,000	277	1	15-100
13b	14,000	277/480	1, 2, or 3	15-100
14a 2/	22,000	120/240	1 or 2	15-100
14b	22,000	240	2 or 3	70-400
15a 2/	65,000	120/240	1 or 2	15-100
15b	65,000	240	2 or 3	15-225
16a 3/	100,000	480	2 or 3	15-225
16b 3/	100,000	600	2 or 3	15-600
17a 3/	200,000	600	2 or 3	70-2,000
18a	18,000	240	2 or 3	15-100
	14,000	480		
	14,000	600		
19a	22,000	240	2 or 3	70-225
	18,000	480		
	14,000	600		
20a	25,000	240	2 or 3	70-225
	22,000	480		
	22,000	600		

See footnotes at end of table.

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TABLE XVI. Classification of ratings - Continued.

Class	Interrupting rating		Poles	Range of current trip 4/
	Symmetrical amperes 1/	Volts ac 60 Hz		
21a	42,000 30,000 22,000	240 480 600	2 or 3	70-800
22a	65,000 25,000 18,000	240 480 600	2 or 3	15-100
23a	65,000 35,000 25,000	240 480 600	2 or 3	70-1,200
24b	65,000 50,000 42,000	240 480 600	2 or 3	600-2,000
25a	125,000 80,000 65,000	240 480 600	2 or 3	600-4,000
26a 3/	200,000 200,000 200,000	240 480 600	2 or 3	15-800

1/ Interrupting ratings are not limited to the values or groups of values listed, however, the values listed are minimum values for the class specified.
2/ Single-unit or duplex construction must be specified.
3/ This class may incorporate a current limited device within the breaker case.
4/ Use minimum frame size for ampere rating.

6.6 Warning. Potentially hazardous situations are inherent in some of the test procedures specified in this specification. Precautions should therefore be taken to insure that test personnel are adequately protected and observe the necessary safety measures at all times.

6.7 Definitions.

6.7.1 Tripping time. Tripping time is the total interval of elapsed time from the instant of applying a given overcurrent to the circuit breaker to the completion of the interruption of the circuit.

6.7.2 "O" and "CO" operation. The "O" and "CO" operations are defined as "O" closing the short circuit on the closed circuit breaker and "CO" closing the circuit breaker on the short circuit.

6.7.3 Stabilize. The temperature of a device is considered to be stable when three successive temperature readings taken at not less than 10 minute nor more than 20 minute intervals indicate no temperature change.

6.7.4 Ambient temperature. Ambient temperature is considered to be the temperature of the air surrounding the device under test. Measurements shall be taken by thermocouple or thermometers placed not more than 12 inches from and in a plane horizontal to the center of the device under test.

6.7.5 Independent trip. A multi-pole circuit breaker so designed that one pole trips independently of the other.

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6.8 Part or Identifying Number (PIN). The circuit breakers shall be identified by a PIN constructed as follows:

WC375/01-001 (Specification number, slash sheet, and dash number).

6.9 Subject term (key word) listing.

Magnetic
Multi-pole
Single-pole
Trip-free

6.10 Environmentally preferable material. Environmentally preferable materials should be used to the maximum extent possible to meet the requirements of this specification. As of the dating of this document, the U.S. Environmental Protection Agency (EPA) is focusing efforts on reducing 31 priority chemicals. The list of chemicals and additional information is available on their website at http://www.epa.gov/osw/hazard/wastemin/priority.htm. Included in the list of 31 priority chemicals are cadmium, lead, and mercury. Use of the materials on the list should be minimized or eliminated unless needed to meet the requirements specified herein (see section 3).

6.11 Changes from previous issue. The margins of this specification are marked with vertical lines to indicate where changes (additions, modifications, corrections, deletions) from the previous issue were made. This was done as a convenience only, and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

Custodians:
Navy - YD
Air Force - 85
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Review activities:
Navy - MC, OS

Preparing activity:
DLA - CC

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