INCH-POUND

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DETAIL SPECIFICATION

CIRCUIT BREAKERS, ACB, LOW VOLTAGE, ELECTRIC POWER, AIR, REMOVABLE CONSTRUCTION, GENERAL SPECIFICATION FOR

Comments, suggestions, or questions on this document should be addressed to: Commander, Naval Sea Systems Command, ATTN: SEA 05Q, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or emailed to CommandStandards@navy mil, with the subject line "Document Comment". Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at http://assist.daps.dla mil.

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This specification is approved for use by the Naval Sea Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers ACB, low voltage, electric power, air circuit breakers with removable construction, their stationary component (cradle), and attachments for shipboard use.

1.2 Classification. Circuit breakers are of the following types, as specified (see the applicable specification sheet and 6.2).

AC circuit breakers		DC circuit breakers
ACB-900RC	ACB-5KV-2000RC	ACB-901R
ACB-902R	ACB-2002HRC	ACB-2601R
ACB-904LRC	ACB-2004HRC	ACB-2603R
ACB-1600HR	ACB-2010HRC	ACB-2801R
ACB-1600HRC	ACB-2012	ACB-4001R
ACB-1600R	ACB-2020	ACB-5003R
ACB-1606HRC	ACB-3200HR	
ACB-2000HR	ACB-4000HR	
ACB-2000LRC	ACB-4010HR	
ACB-2000RC	ACB-6400HR	

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 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, 4, or 5 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.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-S-901	-	Shock Tests, H.I. (High-Impact) Shipboard Machinery, Equipment, and Systems, Requirements for
MIL-E-917	-	Electric Power Equipment, Basic Requirements
MIL-P-15024/5	-	Plate, Identification
MIL-DTL-16036	-	Switchgear, Power, Low Voltage, Naval Shipboard
MIL-DTL-83734	-	Sockets, Plug-In Electronic Components, Dual-In-Line (DIPS) and Single-In-Line Packages (SIPS), General Specification for

(See supplement 1 for list of specification sheets)

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-130	-	Identification Marking of U.S. Military Property
MIL-STD-167-1	-	Mechanical Vibrations of Shipboard Equipment (Type I – Environmental and Type II – Internally Excited)
MIL-STD-461	-	Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment
MIL-STD-1285	-	Marking for Electrical and Electronic Parts
MIL-STD-1399-300	-	Interface Standard for Shipboard Systems Section 300A Electric Power, Alternating Current (Metric)

(Copies of these documents are available online at http://assist.daps.dla mil/quicksearch/ or http://assist.daps.dla.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, 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.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI/IEEE C37.09	-	Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis (DoD adopted)
ANSI C37.50	-	Switchgear - Low-Voltage AC Power Circuit Breakers Used in Enclosures, Test Procedures

(Copies of these documents are available from the American National Standards Institute, 25 W. 43rd St., 4th Floor, New York, NY 10036 or online at http://webstore.ansi.org/.)

ASTM INTERNATIONAL

ASTM B117	-	Standard Practice for Operating Salt Spray (Fog) Apparatus (DoD adopted)
ASTM B700	-	Standard Specification for Electrodeposited Coatings of Silver for Engineering Use
ASTM D3359	-	Standard Test Methods for Measuring Adhesion by Tape Test

(Copies of this document are available from ASTM International, 100 Barr Harbor Dr., PO Box C700, West Conshohocken, PA 19428-2959 or online at www.astm.org.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related specification sheets), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specification exemption has been obtained.

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 the requirements of this specification and the specification sheet, the latter shall govern.

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 contract award (see 4.2 and 6.5).

3.3 General design, construction, and performance requirements.

3.3.1 Drawout-mounted construction. Circuit breakers shall be of drawout-mounted construction, consisting of a removable element (see 6.3.19) and a stationary element (see 6.3.21). The removable element shall be referred to as "circuit breaker" for the remainder of this specification. The stationary element shall be referred to as the "cradle" for the remainder of this specification. Circuit breakers and cradles shall provide accessibility for maintenance purposes, adjustment of devices, and replacement of overcurrent protection devices.

3.3.2 Creepage and clearance distances. Unless otherwise specified in the specification sheets (see 3.1), creepage and clearance distances shall be in accordance with MIL-E-917. Unless otherwise specified (see 6.2), set C spacing and enclosed type of enclosure apply.

3.3.3 Insulation. Insulation shall meet the material, dielectric strength, insulation resistance, and temperature rise requirements specified herein.

3.3.4 Endurance/manual cycling. Circuit breakers shall have the ability to be cycled continuously for the number and rate of mechanical and electrical endurance operations as shown in the applicable specification sheets without failure, evidence of undue wear, or development of operating irregularities in any part. See 3.4.17.2 for attachment endurance requirements. Circuit breakers shall have the ability to be manually cycled at various times during qualification testing as required by this specification (see Table V).

3.3.5 Calibration. Circuit breakers shall perform in accordance with the applicable trip curves and overcurrent tables (long-time, short-time, instantaneous) in the specification sheets.

3.3.6 Inclination. Circuit breakers, attachments, and cradles shall operate in accordance with the requirements specified herein when inclined in any direction to a 30-degree maximum position from the normal vertical/horizontal orientation.

3.3.7 Temperature rise. Unless otherwise specified in the specification sheets, circuit breakers, attachments, and insulation shall meet the temperature rise requirements specified in Table I.

3.3.8 Short-time current duty cycle performance (withstand rating). Circuit breakers shall perform short-time current duty cycle in accordance with the current rating and time duration shown in the applicable specification sheet.

3.3.9 Interrupting current duty cycle performance. Circuit breakers shall be able to interrupt an O-CO-CO short-circuit sequence in accordance with the interruption current rating shown in the applicable specification sheet.

3.3.10 Shock. Circuit breakers, attachments, and cradles shall withstand electrically and mechanically the high impact shock tests of MIL-S-901 for Grade A, Class I, Type C equipment.

3.3.11 Vibration. Circuit breakers, attachments, and cradles shall withstand electrically and mechanically the Type I vibration tests specified in MIL-STD-167-1.

3.3.12 Electromagnetic interference (EMI). Circuit breakers with electronic trip units and communications capability (if applicable) shall meet and demonstrate compliance with the applicable emissions and susceptibility requirements and limits of MIL-STD-461 for surface ship, below deck, metallic hull installations. Requirements for EMI test plans shall be as specified in the qualification package.

3.3.13 Voltage spike. Circuit breakers with electronic trip units and communications capability (if applicable) shall withstand voltage spikes of 2500 volts peak in accordance with MIL-STD-1399-300. Voltage spikes shall not cause failure of trip units (including false tripping) and attachments.

3.4 Additional design, construction, and performance requirements.

3.4.1 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.

3.4.2 Safety. To ensure maximum personnel safety and to minimize equipment casualties, the safety requirements of MIL-E-917 shall be adhered to during the design and manufacture of circuit breakers, cradles, and attachments.

3.4.2.1 Polyvinyl chloride (PVC). PVC material shall not be used unless it is a part of or integral to the leads of a component or as a constituent or integrated element of a component.

3.4.3 Ambient temperature. Circuit breakers, cradles, and attachments shall operate in a switchboard enclosure ambient air temperature outside the switchboard of 0 to 50 degrees Celsius (°C).

3.4.4 Special tools. Special tools used as manual means to prevent circuit breakers from moving in the test, disconnect, and withdrawn positions shall be supplied with each circuit breaker as applicable. Special tools shall not be required for the removal of the circuit breakers from the front of its specified enclosure except for drawout wrench. When special tools are required for maintenance, the tools shall be supplied as specified (see 6.2).

3.4.5 Mounting and dimensions. Maximum outline and mounting dimensions for the circuit breaker types shall be as shown in the applicable specification sheet. When MIL-DTL-16036 standardized switchgear unit is specified as the enclosure for the circuit breakers (see 6.2), the circuit breakers shall be mounted and operated in the switchgear unit. Studs or tapped holes, retainer nuts or threaded inserts shall be provided in the rear of the stationary element as shown in applicable specifications sheet for blind bolting to the switchboard. Bolts shall be provided and shall resist a high impact mechanical shock test, in accordance with the requirements of MIL-DTL-16036.

3.4.6 Current carrying connections. Current-carrying connections shall be silver-plated in areas of current-carrying contact with lugs, terminals, bus ties, and screw bolts. Silver plating shall be in accordance with ASTM B700, with the exception that the silver plate shall be 0.0002-inch thick or greater. The contact surfaces of all bus bars shall be silvered up to 1 inch past the joint area.

3.4.7 Electrical arc enclosures. Electrical arc enclosures shall confine the arc to the switchboard enclosure under all specified operating conditions.

3.4.8 Thermoplastic parts. Unless otherwise specified (see 6.2), selected parts may be made from thermoplastic material.

3.4.9 Painting. Circuit breaker metal parts not having a corrosion resistant treatment, or not fabricated of corrosion resisting material of the types specified in MIL-E-917, shall be prepared and painted in accordance with MIL-E-917, with the exception that only one coat of gray enamel shall be applied. Touching up is permitted for marks or scratches due to assembly, testing, or other factory handling.

3.4.9.1 Powder coating. Powder coating may be used as an alternative to painting. The type of powder coating, method of application, curing, and repair shall be as specified (see 6.2).

3.4.9.1.1 Selection. The powder coating shall be based on thermoset powder. The selected powder coating shall not contain any unacceptable, prohibited, or toxic materials unless otherwise approved by the procuring agency. Unacceptable and prohibited materials include asbestos, cadmium, fungus-susceptible materials, lithium and lithium compounds, magnesium and magnesium compounds, mercury and mercury compounds or amalgams, radioactive materials, zinc and zinc compounds or zinc chromate primer or coatings, flammable materials, and polyvinylchloride. Toxic materials include any material known to produce harmful toxic effects under conditions, including fire, encountered in shipboard service.

3.4.9.1.2 Appearance. The part surface shall be cleaned, prepared and powder coated in a manner that provides a smooth, continuous, and completely cured surface.

3.4.9.1.3 Color. The final powder coated surface shall be light gray in color.

3.4.9.1.4 Thickness. The thickness of powder coated surfaces shall be the nominal thickness initially qualified to meet adhesion and salt spray resistance requirements of 3.4.9.1.5.1 and 3.4.9.1.5.2, respectively.

3.4.9.1.5 Acceptance. The powder coating shall be of the color specified in 3.4.9.1.3, certified to meet the selection criteria of 3.4.9.1.1, and initially qualified to the adhesion and salt spray resistance requirements of 3.4.9.1.5.1 and 3.4.9.1.5.2, respectively.

3.4.9.1.5.1 Adhesion. Powder coated panels shall be initially subjected to an adhesion tape test in accordance with ASTM D3359 Test Method B. The cured film of applied powder coating shall have a minimum classification of 5B. Alternate test methods and acceptance criteria shall be as specified (see 6.2).

3.4.9.1.5.2 Salt spray resistance. Powder coated panels shall be initially subjected to a 500-hour salt spray test in accordance with ASTM B117. The cured film of applied powder coating shall not show undercutting greater than ¼ inch from the score lines. There shall also be no blistering, wrinkling, or loss of adhesion of the coating or any general surface corrosion or pitting.

3.4.9.1.6 Repair. Repair of powder coated surfaces is acceptable. Repair of powder coating using the same thermoset powder shall be accomplished by heating the part to a temperature that will cause the replacement powder to melt. Scratches, marks, or other similar minor imperfections in powder coatings may be repaired by using touch-up paint conforming to the same selection (3.4.9.1.1), appearance (3.4.9.1.2), and color (3.4.9.1.3) for powder coatings.

3.4.10 Insulation.

3.4.10.1 Material. Electrical insulation shall be a minimum of Class B, in accordance with MIL-E-917, except that coils and wires may be a minimum of Class A, in accordance with MIL-E-917.

3.4.10.2 Temperature rise. Temperature rise shall not exceed the applicable requirements of Table I.

TABLE I. Temperature rise limits./1

Temperature rise test	Parts	Maximum temperature rise above enclosure external ambient (°C)	Maximum temperature with 50 °C enclosure external ambient (°C)
Pre-interruption at rated current	**Insulation**		
	Class A	65	105
	Class B	80	130
	Class F	105	155
	Class H	130	180
	Terminals	70	120
	Contacts	80	130
	Conducting mechanical joints	80	130
Pre-interruption at 150% rated current and 5-minute duration	**Insulation**		
	Class A		
	Class B		
	Class F		
	Class H		
	Terminals	85	135
	Contacts		
	Conducting mechanical joints	85	135
Post-interruption at rated current	**Insulation**		
	Class A	97.5	147.5
	Class B	120	170
	Class F	157.5	207.5
	Class H	195	235
	Terminals	105	155
	Contacts	120	170
	Conducting mechanical joints	120	170

NOTES:
/1 See specification sheets for any exceptions to Table I temperature criteria.

3.4.10.3 Dielectric strength.

3.4.10.3.1 Application points on circuit breaker poles and ground. Unless otherwise specified in the specification sheets, insulation in as-new condition shall be able to withstand without breakdown a 60 Hz voltage of 1900 volts for a period of 1 minute when applied in accordance with 4.5.10 and Tables XV and XVI. As circuit breakers are cycled and tested for qualification, dielectric strength requirements at 60 percent of values listed above may apply. See 4.5.10 for these test requirements.

3.4.10.3.2 Application points on control wiring (excluding charging motor), circuit breaker poles, and ground. Insulation in as-new condition shall be able to withstand without breakdown a 60 Hz voltage of twice the rated voltage plus 1000 volts for a period of 1 minute when applied in accordance with 4.5.10 and Table XVII. As circuit breakers and attachments are cycled and tested for qualification, dielectric strength requirements at 60 percent of values listed above may apply. See 4.5.10 for these test requirements.

3.4.10.3.3 Application points on charging motor control wiring, circuit breaker poles, and ground. Insulation in as-new condition shall be able to withstand without breakdown a 60 Hz voltage of 900 volts for a period of 1 minute when applied in accordance with 4.5.10. As circuit breakers and attachments are cycled and tested for qualification, dielectric strength requirements at 60 percent of values listed above may apply. See 4.5.10 for these test requirements.

3.4.10.4 Insulation resistance. With insulation in as-new condition, insulation resistance shall be greater than 10 megohms between all measuring points of 4.5.11. As circuit breakers are cycled and tested for qualification, insulation resistance values of greater than 1 megohm may apply. See 4.5.11 for these test requirements.

3.4.11 Withdrawal interlock mechanism. Circuit breakers shall be provided with an interlock device which prevents the circuit breaker from being withdrawn or inserted in the closed position.

3.4.12 Circuit breaker positions in or on cradle for rack-in/rack-out. Circuit breaker/cradle configurations provided with connect, test, disconnect, and withdrawn positions or any combination thereof shall meet the applicable requirements of this section. Unless otherwise specified herein, these requirements shall be met with the circuit breaker/cradle configuration permanently in the normal vertical/horizontal orientations and inclined in any direction to a 30-degree maximum position from the normal vertical/horizontal orientations. The available positions and any exceptions to the requirements above shall be specified or addressed in the qualification package.

3.4.12.1 Connect position. In the connect position, the circuit breaker shall operate manually and electrically and the circuit breaker main contacts and control circuitry shall be energized.

3.4.12.2 Test position. In the test position, the circuit breaker shall operate manually and electrically without energizing the circuit breaker main contacts. Control circuitry shall remain energized.

3.4.12.3 Disconnect position. In the disconnect position, the circuit breaker main contacts and control circuitry shall not be energized. The circuit breaker shall operate manually.

3.4.12.4 Withdrawn position. In the withdrawn position, the circuit breaker is fully extended on the cradle rails/tray. The circuit breaker main contacts and control circuitry shall not be energized. The circuit breaker shall operate manually. The cradle shall be subjected to the cradle strength test of 4.5.5.1.3.3 with the circuit breaker in the normal vertical/horizontal orientation.

3.4.12.5 Anti-rolling/retention in the test, disconnect, and withdrawn positions. The circuit breaker shall **not** come off the cradle rails/tray when subjected to tests specified herein. The circuit breaker shall come off the cradle rails/tray and no part of the circuit breaker shall come off the cradle rails/tray in such a manner as to require manual repositioning of the circuit breaker. Manual or automatic means may be used to prevent the circuit breaker from moving.

3.4.13 Operating mechanisms. (see 6.3.9)

3.4.13.1 Simultaneous operation. All poles of the circuit breaker shall be operated from a common shaft.

3.4.13.2 Closing.

3.4.13.2.1 Manual closing. All circuit breakers shall be provided with handles for manual operation as specified (see 6.2). The handles shall be adaptable for dead-front, flush-mounted circuit breaker applications. The force necessary to manually operate the circuit breakers shall not exceed that which can be quickly and readily exerted by a human operator. When the handle is used to charge a closing spring, the position of the charging spring shall be readily discernible.

3.4.13.2.2 Electric closing. Circuit breakers shall be electrically operated by means of electric closing devices. See 3.4.17.3 for requirements.

3.4.13.3 Trip-free. Circuit breakers shall be mechanically and electrically trip-free in any position and under all conditions of operation. The presence of a trip condition shall always and under any and all conditions, override actions to close the circuit breaker and result in tripping the circuit breaker.

3.4.13.4 Anti-pump. In any position and under all conditions of operation, a repeated manual or electrical closing (pumping action) of the circuit breaker during a short-circuit, overload condition, or other trip signal shall not be permitted.

3.4.14 Electrical connections on rear of cradle for cable and bus bar. Cradles shall be provided with connections on the backside to accommodate all cable and bus bar. Stud or lug terminals shall not turn in a manner that will reduce electrical clearances.

3.4.15 Wiring. Remote control devices mounted on the circuit breaker shall be completely wired and connected to the secondary disconnecting devices. Wires shall be bundled and secured to the maximum extent possible, to prevent damage from vibration. Each wire more than 8 inches long and all wires combined in a bundle shall be marked on each end in compliance with MIL-DTL-16036.

3.4.16 Overcurrent protection.

3.4.16.1 Overcurrent coils and overcurrent sensors. Overcurrent coils or overcurrent sensors (see 6.3.12 and 6.3.13) shall be provided for the circuit breakers as specified (see 6.2), with ratings and pickup settings as shown in the applicable specification sheet.

3.4.16.2 Overcurrent protection tripping devices (calibration). Circuit breakers shall be provided with overcurrent protection as specified (see 6.2). The overcurrent protection tripping devices shall be direct acting electromechanical, electronic, or a combination thereof and operate in an ambient temperature range of 0 to 50 °C.

3.4.16.2.1 Electromechanical trip devices. Adjustable settings, other than for long-time delay devices, shall be sealed against tampering with the setting.

3.4.16.2.1.1 Long-time delay trip element.

3.4.16.2.1.1.1 Long-time delay pickup settings. Available long-time delay pickup settings for each trip coil or sensor rating shall be in accordance with the applicable specification sheet. The settings shall be adjustable and clearly marked. Unless otherwise specified in the applicable specification sheets or noted in the qualification package, a pickup setting shall be provided that equals 1.5 times the continuous current setting established by the coil or sensor rating. The maximum error for any setting shall not exceed ±10 percent.

3.4.16.2.1.1.2 Long-time delay band settings. Available long-time delay band settings shall be in accordance with the applicable specification sheet. The operating characteristics of each band setting shall be in accordance with the applicable specification sheet. The characteristics shall apply for single-pole operation, for any two poles in series and for three poles in series.

3.4.16.2.1.2 Short-time delay trip element. The short-time delay trip element shall be direct-acting.

3.4.16.2.1.2.1 Short-time delay pickup settings. Available short-time delay pickup current settings shall be in accordance with the applicable specification sheet. The settings need not be readily adjustable but shall be set at the place of manufacture as specified (see 6.2). The setting shall be indicated on the identification plate of the short-time delay trip element. The maximum error for any setting shall not exceed ±10 percent.

3.4.16.2.1.2.2 Short-time delay band settings. Available short-time delay band settings shall be in accordance with the applicable specification sheet. The settings need not be readily adjustable but shall be set at the place of manufacture as specified (see 6.2). The setting shall be indicated on the identification plate of the short-time delay trip element. The characteristics apply for single-pole operation, for any two poles in series, for three poles in series, and for single-phase and three-phase operation. Values of operating time and resettable delay shall not fall outside the predetermined short-time delay band.

3.4.16.2.1.3 Instantaneous trip element. The instantaneous trip element shall trip the circuit breaker with no intentional time delay. Instantaneous pickup settings need not be readily adjustable, as specified (see 6.2), but shall be set at the place of manufacture to any of the settings specified in the applicable specification sheet. The pickup current value setting shall be accurate to within ±10 percent for settings up to 10 times the trip coil rating and ±20 percent for settings above 10 times the coil rating. The instantaneous trip feature may have a setting to turn it off. The characteristics of instantaneous trip apply for single-phase and three-phase operation.

3.4.16.2.2 Solid-state overcurrent trip device. Solid-state overcurrent trip devices shall have provisions for determining that the device is functioning and that no parts have failed. The device shall have a provision through a test socket for secondary injection testing to check the overload calibrations.

3.4.16.2.2.1 Long-time delay trip element.

3.4.16.2.2.1.1 Long-time delay pickup settings. Available long-time delay pickup settings for each trip coil or sensor rating shall be in accordance with the applicable specification sheet. The settings shall be adjustable and clearly marked on the trip unit. Unless otherwise specified in the applicable specification sheets or noted in the qualification package, a pickup setting shall be provided that equals 1.5 times the continuous current setting established by the coil or sensor rating. The maximum error for any setting shall not exceed ±10 percent.

3.4.16.2.2.1.2 Long-time delay band settings. Available long-time delay band settings shall be in accordance with the applicable specification sheet. The operating characteristics of each band setting shall be in accordance with the applicable specification sheet. The settings shall be adjustable and clearly marked on the trip unit. The operating characteristics shall apply for single-pole operation, for any two poles in series, for three poles in series, and for three-phase operation.

3.4.16.2.2.2 Short-time delay trip element.

3.4.16.2.2.2.1 Short-time delay pickup settings. Available short-time delay pickup current settings shall be in accordance with the applicable specification sheet. The settings shall be adjustable and clearly marked on the trip unit. Unless otherwise specified in the applicable specification sheet, the maximum error for any setting shall not exceed ±10 percent.

3.4.16.2.2.2.2 Short-time delay band settings. Available short-time delay band settings shall be in accordance with the applicable specification sheet. The settings shall be adjustable and clearly marked on the trip unit. The characteristics apply for single-pole operation, for any two poles in series, for three poles in series, and for single-phase and three-phase operation. Values of operating time and resettable delay shall not fall outside the predetermined short-time delay band.

3.4.16.2.2.3 Instantaneous trip element. The instantaneous trip element shall trip the circuit breaker with no intentional time delay other than filtering that may be required to eliminate nuisance tripping. Instantaneous pickup settings shall be adjustable and clearly marked on the trip unit. The pickup current value setting shall be accurate to within ±10 percent for settings up to 10 times the trip coil rating and ±20 percent for settings above 10 times the coil rating. The instantaneous trip feature may have a setting to turn it off. The characteristics of instantaneous trip apply for single-phase and three-phase operation.

3.4.17 Attachments. Attachments shall include the electric closing device, undervoltage release device (see 6.3.30), undervoltage lockout device, shunt trip, auxiliary switch, secondary disconnect device, hold-closed mechanism, operations counter, mechanical position indicator, indicator light, trip on power up (TOPU) device, position indicator for rack-in/rack-out, and cell switch.

3.4.17.1 Temperature rise. Temperature rise of electric closing devices, undervoltage release devices, shunt trips, auxiliary switches, and secondary disconnect devices shall not exceed the requirements of molding and insulating materials specified in MIL-E-917 in as-new condition. As circuit breakers and attachments are cycled and tested for qualification, temperature rise limits may vary. See 4.5.9.3 and Table V for these test requirements.

3.4.17.2 Endurance. Electric operating mechanisms, undervoltage release devices, and shunt trips shall have the ability to be cycled continuously for the number of electrical endurance operations specified herein. Rate of operations shall be as specified for the circuit breaker electrical endurance test in the applicable specification sheet.

3.4.17.3 Electric closing devices. Electric closing devices shall have the following characteristics:

a. Closing devices may be a motor, solenoid, or stored energy system, which consists of a closing spring (see 6.3.5) or springs charged by an electric motor with an electrical or mechanical closing release (see 6.3.4).

b. The nominal control voltage and their ranges, when measured at the terminals of the operating motors or solenoids with full operating current, shall be as specified in Table II. The closing springs shall be recharged immediately after the circuit breaker closes.

c. The closing time, with rated voltage applied, shall not exceed 0.5 second.

d. The device to charge a stored energy system shall be able to sustain an undervoltage condition for 15 seconds without sustaining damage or a need for realignment.

e. All wiring and control devices necessary for electric operation, including rectifiers used to supply closing energy, shall be installed on the circuit breaker. A transformer, when necessary for reducing a circuit breaker's control voltage, may be mounted on the rear of the cradle or supplied loose for mounting in the circuit breaker's enclosure, as specified (see 6.2).

TABLE II. Voltages for electric closing mechanisms.

Direct current		Alternating current	
Nominal voltage	**Operating voltage range (volts)**	**Nominal voltage**	**Operating voltage range (volts)**
120	90–130	120	90–135
250	175–355	450	360–500

3.4.17.4 Undervoltage release device. When specified (see 6.2), an undervoltage release device shall be provided and shall have the following characteristics:

a. The device shall be simple and compact without intentional time delay, other than filtering that may be required to eliminate nuisance in tripping for electronic undervoltage release devices, and shall be connected to either the line or load terminals.

b. The device shall have a continuous duty rating and shall operate directly on the trip mechanism of the circuit breaker.

c. The nominal voltages and operating voltage ranges shall be as specified in Table III. The specified pickup voltages shall apply to a cold coil (approximately 25 °C).

d. The device shall automatically reset; after it has dropped out and tripped the circuit breaker on reduced voltage, it shall reset automatically on restoration of voltage to the pickup level. The reset may be electrical or mechanical by circuit breaker action.

e. When the device is mounted in the open, at the front of the circuit breaker, the device and connecting wires shall be fully insulated without exposed terminals and connections. The word "DANGER" shall be marked in red on the device.

TABLE III. Voltages for undervoltage release devices.

Nominal voltage	Operating voltage range	Pickup volts (maximum)	Dropout voltage range
250 DC	175–355	175	100–25
450 AC	360–500	360	290–45
120 AC	90–135	90	Above 15

3.4.17.5 Undervoltage lockout device. When specified (see 6.2), the undervoltage lockout device shall be capable of continuous energization. When energized, the lockout device shall not affect the circuit breaker operation. The lockout device shall not trip a closed circuit breaker. It shall prohibit closing of an open circuit breaker when de-energized.

3.4.17.6 Shunt trip device. When specified (see 6.2), a shunt trip device shall be provided. The device shall be simple and compact and shall have remote control. Devices shall be available for tripping from either an AC or DC voltage source, and in some instances, both may be required on the same circuit breaker, when specified (see 6.2). The nominal voltages and their operating ranges shall be as specified in Table IV (see 6.2).

TABLE IV. Voltages for shunt trip devices.

Direct current		Alternating current	
Nominal voltage	**Operating voltage range**	**Nominal voltage**	**Operating voltage range**
20S /1	25–180	115	80–130
120	70–140	450	360–500
250	175–355		

NOTE:

/1 For use on circuit breakers to be tripped from variable voltage exciters. Unless otherwise specified (see 6.2), the tripping current shall not exceed 30 A at the maximum voltage.

3.4.17.7 Auxiliary switches. Auxiliary switches shall have the following characteristics:

a. Unless otherwise specified (see 6.2), circuit breakers shall be provided with an auxiliary switch having the minimum set of contacts shown in the applicable specification sheet.

b. When the circuit breaker main contacts are closed, auxiliary switch “a” contacts shall be closed and auxiliary switch “b” contacts shall be open. When the circuit breaker main contacts are open, auxiliary switch “a” contacts shall be open and auxiliary switch “b” contacts shall be closed.

c. An “a” contact shall be convertible to a “b” contact and a “b” contact shall be convertible to an “a” contact.

d. The auxiliary switch shall be so arranged that the switch cover or complete switch can be removed within the width of the circuit breaker base.

e. Auxiliary switches shall have a minimum continuous current rating of 15 amps and a rated voltage of 500 volts for AC circuit breakers and 250 volts for DC circuit breakers.

3.4.17.8 Secondary disconnecting devices. Unless otherwise specified (see 6.2), each manually operated circuit breaker shall be furnished with a secondary disconnecting device consisting of a minimum of seven contacts. Each electrically operated circuit breaker shall be furnished with a secondary disconnecting device consisting of a minimum of 21 contacts. Each contact shall consist of a stationary and movable component and each component shall be provided with a screw-type terminal for fastening of the control wiring. All parts of the circuit breaker which require connection to external wiring shall be connected to the secondary disconnecting devices of the circuit breaker. The voltage and current rating of each secondary disconnect contact and its associated wiring for those applications internal to the circuit breaker shall be adequate to their intended use. Secondary disconnect contacts that access the circuit breaker auxiliary switches shall have a continuous current rating equal to the auxiliary switch.

3.4.17.9 Hold-closed mechanism. A hold-closed mechanism (see 6.3.7) shall render the trip device and trip-free mechanism ineffective, thus permitting the circuit breaker to be closed from the open position or be held closed when in the closed position against an overload as long as the hold-closed device is held in position by the operator.

3.4.17.10 Operations counter. When specified (see 6.2), circuit breakers shall be equipped with a mechanical device which indicates the number of close – open operations. The device may be operated on either the close or open portion of the cycle. The read-out shall be readably visible from the front of the circuit breaker, but is not required to be mounted on the escutcheon plate. Failure of the operations counter shall not affect circuit breaker operation.

3.4.17.11 Mechanical position indicators. Circuit breakers shall be provided with mechanical position indicators that show whether the main contacts of the circuit breaker are opened or closed. The indicators shall be plainly visible at a minimum angle of 45 degrees from either side of the indicator, when the circuit breaker is installed in its specified enclosure.

3.4.17.12 Indicator light. Unless otherwise specified (see 6.2), circuit breaker face plates shall have provisions for the mounting of two indicator lights. One light shall indicate when the circuit breaker is closed and the other light shall indicate when the circuit breaker is open. Each light shall be of a different color. Lens style and lens coloring shall be as specified (see 6.2).

3.4.17.13 Trip on power up (TOPU) device. When specified (see 6.2), a TOPU device shall be provided to trip the circuit breaker without intentional delay if the circuit breaker is left closed in the absence of control power and the control power is subsequently restored. The TOPU device shall not trip the circuit breaker during momentary control power absences of 20 milliseconds or less.

3.4.17.14 Rack-in/rack-out position indicator. When provided, position indicators that show what position the circuit breaker is in during rack-in and rack-out shall meet the requirements specified herein. The available positions shall be specified in the qualification package. The indicator shall include the words “Connect”, “Test”, and “Disconnect” and shall plainly show when the circuit breaker is in those positions. The indicator shall be located as closely as possible to the access for the rack-in/rack-out mechanism.

3.4.17.15 By-pass switch and cell switch. When specified (see 6.2), a by-pass switch (see 6.3.1) shall be provided. The by-pass switch is comprised of a normally closed limit switch (cell switch) mounted on the cradle and connected to the stationary secondary contacts in parallel with a normally closed auxiliary switch. The cell switch shall open when the circuit breaker is in the connect or test position and close when the circuit breaker is in the disconnect or withdrawn position. The cell switch rating shall be the same as the auxiliary switch rating of 3.4.17.7.d.

3.4.18 Semiconductor devices.

3.4.18.1 Electrostatic discharge susceptible items. Electrostatic discharge control for the protection of electrical and electronic parts, components, assemblies, and equipment shall be in accordance with MIL-STD-1686. Items which are subject to damage by electrostatic discharge, such as metal oxide semi-conductors (MOS) whether installed in equipment or held as parts for original installation or as spares, shall be protected against such damage. The package shall be provided with a warning label for handling with care on electrostatic discharge.

3.4.18.2 Conformal coating. Conformal coating shall be provided for printed wiring in accordance with IPCCC-830, unless otherwise specified (see 6.2).

3.4.18.3 Sockets. When specified (see 6.2), sockets specified by MIL-DTL-83734 shall be used for all dual-inline package integrated circuit components.

3.4.19 Designation and marking. Identification plates and other designating marking for circuit breakers shall be in accordance with MIL-STD-130 and Type A, B, or C of MIL-P-15024/5. Plates shall be installed on and furnished as part of the circuit breaker. Plates shall be attached to the part of the circuit breaker which will not ordinarily be renewed during normal service life, and be located in a readily accessible position where they can be read at all times without danger to personnel.

3.4.19.1 Markings for attachments and small components. Markings for attachments and small components shall be in accordance with MIL-STD-1285.

3.4.19.2 Identification plates. The data marked on identification plates shall include the following:

Data	On circuit breaker	On components /1
Nomenclature of the item	X	X
Manufacturer's name and catalog number	X	X
Manufacturer's type	X	X
Year of manufacture	X	
Manufacturer's serial number	X	
Navy circuit breaker type designation	X	
Rated voltage and frequency	X	X
Number of poles	X	
Current rating (s)	X	X
Calibration		X
National stock number	X	X
Blank space for Government inspector's stamp	X	X

NOTE:
/1 Components include attachments and other circuit breaker parts, such as auxiliary switches, overcurrent protection devices, shunt trip devices, undervoltage release devices, relays, electric closing devices and solenoids, and rectifiers.

3.4.19.3 Warning plate. Circuit breakers shall be provided with a plate to warn that if the power source is connected to the circuit breaker bottom studs, most of the current-carrying parts are alive, even though the circuit breaker is in the open position. The word "WARNING" shall be in prominent red letters. The warning plate shall be located where it can be easily read by an operator.

3.4.19.4 Information plate. An information plate, containing instructions for positioning of the circuit breaker in the test position, shall be provided where applicable (see 3.4.12.2).

3.5 Certification data (CD) sheets. Certification data sheets shall include applicable data listed on the identification plate and classification table shown in Detail "A" of Figure 1.

4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

a. Qualification inspection (see 4.2).

b. Conformance inspection (see 4.3).

c. Comparison inspection (see 4.4).

4.2 Qualification inspection of circuit breakers, attachments, and cradles. Note the following:

a. One circuit breaker sample shall be subjected to the examination and tests in the order specified in Table V. Any exceptions or changes to the test order shall be addressed in the qualification package.

b. Test sample shall include a cradle and one attachment of each type and rating.

c. The circuit breaker shall have the maximum rated coil or sensor rating installed as specified in the applicable specification sheet.

d. Refer to the applicable specification sheet for additional test information and requirements.

e. No adjustments shall be made to circuit breakers, cradles, and attachments during or between qualification tests. One or more failures shall be cause for refusal to grant qualification approval.

TABLE V. Qualification and comparison test schedule and sequence /1.

Test number	Inspection	Requirement	Verification
1	General examination	4.5.1	4.5.1
2	Creepage and clearance distances	3.3.2	4.5.2
3	Attachment operating characteristics and control power removal (circuit breaker in connect position and in normal vertical/horizontal orientation)	3.4.17	4.5.3
3A	Undervoltage lockout device operation (energized)	3.4.17.5	4.5.3.1.1
3B	Electric closing device operation	3.4.17.3	4.5.3.2
3B(1)	Operating voltage range/closing time	3.4.17.3.b 3.4.17.3.c	4.5.3.2.1
3B(2)	Charging mechanism stall test	3.4.17.3.d	4.5.3.2.2
3C	Undervoltage release device operation	3.4.17.4	4.5.3.3
3C(1)	Operating voltage range	3.4.17.4.c	4.5.3.3.1
3C(2)	Dropout voltage range	3.4.17.4.c	4.5.3.3.2
3D	Shunt trip device operation (voltage range/tripping current)	3.4.17.6	4.5.3.4
3E	Operation of indicator light, operations counter, mechanical position indicator operation, and auxiliary switch	3.4.17	4.5.3.5
3E(1)	Indicator light	3.4.17.12	4.5.3.5.a
3E(2)	Operations counter	3.4.17.10	4.5.3.5.b
3E(3)	Mechanical position indicator	3.4.17.11	4.5.3.5.c
3E(4)	Auxiliary switch	3.4.17.7	4.5.3.5.d
3F	Operation of cell switch and rack-in/rack-out position indicator	3.4.17	4.5.3.6
3F(1)	Cell switch	3.4.17.15	4.5.3.6.a
3F(2)	Rack-in/rack-out position indicator	3.4.17.14	4.5.3.6.b
3G	Undervoltage lockout device operation (de-energized)	3.4.17.5	4.5.3.1.2
3H	Trip on power up (TOPU) device operating characteristics and control power removal/reapplication (electronic trip units only)	3.4.17.13	4.5.3.7
3H(1)	TOPU device turned off and circuit breaker closed	3.4.17.13	4.5.3.7.1
3H(2)	TOPU device turned on and circuit breaker closed	3.4.17.13	4.5.3.7.2
3H(2)(a)	15-second TOPU test	3.4.17.13	4.5.3.7.2.1
3H(2)(b)	20-millisecond TOPU test	3.4.17.13	4.5.3.7.2.2
3H(3)	TOPU device turned off and circuit breaker open	3.4.17.13	4.5.3.7.3

TABLE V. Qualification and comparison test schedule and sequence /1 - Continued.

Test number	Inspection	Requirement	Verification
3I	Hold-closed mechanism operation	3.4.17.9	4.5.3.8
4	Trip-free operation and anti-pump operation	3.4.13.3 3.4.13.4	4.5.4
4A	Mechanical	3.4.13.3 3.4.13.4	4.5.4.1
4B	Electrical	3.4.13.3 3.4.13.4	4.5.4.2
5	Positions in or on cradle for rack-in/rack-out (normal vertical/horizontal orientation)	3.4.12	4.5.5
5A	Rack-out (circuit breaker initially in the connect position and closed)	3.4.12	4.5.5.1
5A(1)	Test position:	3.4.12.2	4.5.5.1.1
5A(1)(a)	Main contact de-energization and rack-in/rack-out position indicator operation	3.4.12.2 3.4.17.14	4.5.5.1.1.1
5A(1)(b)	Cell switch operation	3.4.17.15	4.5.5.1.1.2
5A(1)(c)	Electrical cycling and mechanical position indicator operation	3.4.12.2 3.4.17.11	4.5.5.1.1.3
5A(1)(d)	Manual cycling and mechanical position indicator operation	3.4.12.2 3.4.17.11	4.5.5.1.1.4
5A(1)(e)	Anti-rolling verification	3.4.12.5	4.5.5.1.1.5
5A(2)	Disconnect position:	3.4.12.3	4.5.5.1.2
5A(2)(a)	Withdrawal interlock mechanism and rack-in/rack-out position indicator operation	3.4.11 3.4.17.14	4.5.5.1.2.1
5A(2)(b)	Cell switch operation	3.4.17.15	4.5.5.1.2.2
5A(2)(c)	Manual cycling and mechanical position indicator operation	3.4.12.3 3.4.17.11	4.5.5.1.2.3
5A(2)(d)	Anti-rolling verification	3.4.12.5	4.5.5.1.2.4
5A(3)	Withdrawn position:	3.4.12.4	4.5.5.1.3

TABLE V. Qualification and comparison test schedule and sequence /1 - Continued.

Test number	Inspection	Requirement	Verification
5A(3)(a)	Manual cycling and mechanical position indicator operation	3.4.12.4 3.4.17.11	4.5.5.1.3.1
5A(3)(b)	Anti-rolling verification	3.4.12.5	4.5.5.1.3.2
5A(3)(c)	Cradle strength	3.4.12.4	4.5.5.1.3.3
5B	Rack-in (circuit breaker initially in the withdrawn position and closed)	3.4.12	4.5.5.2
5B(1)	Disconnect position:	3.4.12.3	4.5.5.2.1
5B(1)(a)	Rack-in/rack-out position indicator operation	3.4.17.14	4.5.5.2.1
5B(1)(b)	Cell switch operation	3.4.17.15	4.5.5.2.1
	Manual cycling and mechanical position indicator operation	3.4.12.3 3.4.17.11	4.5.5.2.1
5B(1)(c)	Anti-rolling verification	3.4.12.5	4.5.5.2.1
5B(2)	Test position:	3.4.12.2	4.5.5.2.2
5B(2)(a)	Main contact de-energization, rack-in/rack-out indicator operation, and withdrawal interlock mechanism operation	3.4.12.2 3.4.17.14 3.4.11	4.5.5.2.2
5B(2)(b)	Cell switch operation	3.4.17.15	4.5.5.2.2
5B(2)(c)	Electrical cycling and mechanical position indicator operation	3.4.12.2 3.4.17.11	4.5.5.2.2
5B(2)(d)	Manual cycling and mechanical position indicator operation	3.4.12.2 3.4.17.11	4.5.5.2.2
5B(2)(e)	Anti-rolling verification	3.4.12.5	4.5.5.2.2
5B(3)	Connect position:	3.4.12.1	4.5.5.2.3
5B(3)(a)	Main contact energization and rack-in/rack-out indicator operation	3.4.12.1 3.4.17.14	4.5.5.2.3.1
5B(3)(b)	Cell switch operation	3.4.17.15	4.5.5.2.3.2

TABLE V. Qualification and comparison test schedule and sequence /1 - Continued.

Test number	Inspection	Requirement	Verification
6	Endurance – circuit breaker (mechanical and electrical)	3.3.4	4.5.6
	Tests performed during circuit breaker electrical endurance:		
6A	Electric closing device endurance	3.3.4 3.4.17.2	4.5.6.2
6B	Electric closing device temperature rise	3.3.7 3.4.17.1	4.5.9.3.1
6C	Undervoltage release device endurance	3.3.4 3.4.17.2	4.5.6.2
6D	Shunt trip device endurance	3.3.4 3.4.17.2	4.5.6.2
6E	Shunt trip device temperature rise	3.3.7 3.4.17.1	4.5.9.3.1
6F	Auxiliary switch temperature rise	3.3.7 3.4.17.1	4.5.9.3.2
6G	Operations counter check	3.4.17.10	4.5.6.2
7	Calibration	3.3.5 3.4.16.2	4.5.7
7A	Long-time delay	3.4.16.2.1.1 3.4.16.2.2.1	4.5.7.1
7A(1)	Long-time delay pickup test	3.4.16.2.1.1.1 3.4.16.2.2.1.1	4.5.7.1
7A(2)	Long-time delay timing test	3.4.16.2.1.1.2 3.4.16.2.2.1.2	4.5.7.1
7B	Short-time delay	3.4.16.2.1.2	4.5.7.2
7B(1)	Short-time delay pickup test	3.4.16.2.1.2.1 3.4.16.2.2.2.1	4.5.7.2
7B(2)	Short-time delay timing test	3.4.16.2.1.2.2 3.4.16.2.2.2.2	4.5.7.2
7B(3)	Short-time delay resettable delay test	3.4.16.2.1.2.1 3.4.16.2.2.2.1	4.5.7.2

TABLE V. Qualification and comparison test schedule and sequence /1 - Continued.

Test number	Inspection	Requirement	Verification
7C	Instantaneous	3.4.16.2.1.3 3.4.16.2.2.3	4.5.7.3
7C(1)	Instantaneous pickup test	3.4.16.2.1.3 3.4.16.2.2.3	4.5.7.3
7C(2)	Instantaneous timing test	3.4.16.2.1.3 3.4.16.2.2.3	4.5.7.3
8	Inclined operation	3.3.6	4.5.8
8A	Connect position	3.4.12.1	4.5.8.1
8A(1)	Abbreviated calibration (electromechanical trip units only)	3.3.5 3.4.16.2	4.5.8.1.1
8A(2)	Attachment operational checks	3.4.17	4.5.8.1.2
8A(2)(a)	Undervoltage lockout device nominal voltage (energized)	3.4.17.5	4.5.8.1.2.1.1
8A(2)(b)	Electric closing device nominal operating voltage/closing time	3.4.17.3	4.5.8.1.2.2
8A(2)(c)	Undervoltage release nominal operating voltage/dropout voltage range	3.4.17.4	4.5.8.1.2.3
8A(2)(d)	Shunt trip nominal operating voltage/tripping current	3.4.17.6	4.5.8.1.2.4
8A(2)(e)	Operation of indicator light, operations counter, mechanical position indicator operation, and auxiliary switch	3.4.17.12 3.4.17.10 3.4.17.11 3.4.17.7	4.5.8.1.2.5
8A(2)(f)	Operation of cell switch and rack-in/rack-out position indicator	3.4.17.15 3.4.17.14	4.5.8.1.2.6
8A(2)(g)	Undervoltage lockout device operation (de-energized)	3.4.17.5	4.5.8.1.2.1.2
8A(2)(h)	Trip on power up (TOPU) device operating characteristics and control power removal/reapplication (electronic trip units only)	3.4.17.13	4.5.8.1.2.7
8B	Test position	3.4.12.1	4.5.8.2
8B(1)	Main contact de-energization and rack-in/rack-out position indicator operation	3.4.12.2 3.4.17.14	4.5.8.2.1
8B(2)	Cell switch operation	3.4.17.15	4.5.8.2.2

TABLE V. Qualification and comparison test schedule and sequence /1 - Continued.

Test number	Inspection	Requirement	Verification
8B(3)	Electric cycling and mechanical position indicator operation	3.4.12.2 3.4.17.11	4.5.8.2.3
8B(4)	Manual cycling and mechanical position indicator operation	3.4.12.2 3.4.17.11	4.5.8.2.4
8B(5)	Anti-rolling verification	3.4.12.5	4.5.8.2.5
8C	Disconnect position:	3.4.12.3	4.5.8.3
8C(1)	Rack-in/rack-out position indicator operation	3.4.17.14	4.5.8.3.1
8C(2)	Cell switch operation	3.4.17.15	4.5.8.3.2
8C(3)	Manual cycling and mechanical position indicator operation	3.4.12.3 3.4.17.11	4.5.8.3.3
8C(4)	Anti-rolling verification	3.4.12.5	4.5.8.3.4
8D	Withdrawn position:	3.4.12.4	4.5.8.4
8D(1)	Manual cycling and mechanical position indicator operation	3.4.12.4 3.4.17.11	4.5.8.4.1
8D(2)	Anti-rolling verification	3.4.12.5	4.5.8.4.2
9	Circuit breaker temperature rise (pre-interruption at rated current)	3.3.7	4.5.9.1
	Tests performed during circuit breaker temperature rise:		
9A	Auxiliary switch rating	3.4.17.7	4.5.3.9
9B	Auxiliary switch temperature rise	3.4.17.1	4.5.9.3.2
9C	Secondary disconnecting device rating	3.4.17.8	4.5.3.9
9D	Secondary disconnecting device temperature rise	3.4.17.1	4.5.9.3.2
9E	Undervoltage release device temperature rise	3.3.7 3.4.17.1	4.5.9.3.2
10	Circuit breaker temperature rise (pre-interruption at 150% rated current)	3.3.7	4.5.9.2
11	Dielectric strength (full voltage)	3.4.10.3	4.5.10
12	Insulation resistance (10-megohm threshold)	3.4.10.4	4.5.11
13	Short-time current duty cycle performance (withstand rating)	3.3.8	4.5.12
14	Interrupting current duty cycle performance	3.3.9	4.5.13

TABLE V. Qualification and comparison test schedule and sequence /1 - Continued.

Test number	Inspection	Requirement	Verification
15	Dielectric strength (reduced voltage)	3.4.10.3	4.5.10
16	Insulation resistance (1-megohm threshold)	3.4.10.4	4.5.11
17	Circuit breaker temperature rise (post-interruption at rated current)	3.3.7	4.5.9.1
	Tests performed during circuit breaker temperature rise:		
17A	Auxiliary switch rating	3.4.17.7	4.5.3.9
17B	Auxiliary switch temperature rise	3.4.17.1	4.5.9.3.2
17C	Secondary disconnecting device rating	3.4.17.8	4.5.3.9
17D	Secondary disconnecting device temperature rise	3.4.17.1	4.5.9.3.2
18	Shock	3.3.10	4.5.14
19	Attachment operation checks and rack-out checks (same as test numbers 8A(2) through 8D(2) except performed in the normal vertical/horizontal orientation)	See tests above as noted	4.5.14.3
20	Rack-in checks (same as test number 5B through 5B(3)(b))	See tests above as noted	4.5.14.3
21	Abbreviated calibration	3.3.5 3.4.16.2	4.5.7.4 4.5.14.3
22	Vibration	3.3.11	4.5.15
23	Attachment operation checks and rack-out checks (same as test numbers 8A(2) through 8D(2) except performed in the normal vertical/horizontal orientation)	See tests above as noted	4.5.15.2
24	Rack-in checks (same as test number 5B through 5B(3)(b))	See tests above as noted	4.5.15.2
25	Abbreviated calibration	3.3.5 3.4.16.2	4.5.7.4 4.5.15.2
26	Dielectric strength (reduced voltage)	3.4.10.3	4.5.10
27	Insulation resistance (1-megohm threshold)	3.4.10.4	4.5.11
28	EMI (circuit breakers with electronic trip units only)	3.3.12	4.5.16
29	Voltage spike (circuit breakers with electronic trip units only)	3.3.13	4.5.17
30	Abbreviated calibration (circuit breakers with electronic trip units only)	3.3.5 3.4.16.2	4.5.18 4.5.7.4

TABLE V. Qualification and comparison test schedule and sequence /1 - Continued.

Test number	Inspection	Requirement	Verification
31	Attachment operational checks (same as test numbers 8A(2) through 8A(2)(h) except performed in the normal vertical/horizontal orientation – circuit breakers with electronic trip units only)	See tests above as noted	4.5.18
32	Dielectric strength (reduced voltage – circuit breakers with electronic trip units only)	3.4.10.3	4.5.18 4.5.10
33	Insulation resistance (1-megohm threshold – circuit breakers with electronic trip units only)	3.4.10.4	4.5.18 4.5.11

NOTE:

/1 Refer to the applicable circuit breaker individual specification sheet for additional test information and requirements.

4.3 Conformance inspection.

4.3.1 Inspection. Each manufactured unit shall be subjected to the inspection specified in Table VI, unless inspection sampling is otherwise specified (see 6.2).

4.3.2 Rejected units. If a unit is rejected, the contractor shall rework the unit to correct the defects and resubmit the unit for inspection, as specified (see 6.2). Such units shall be separate from new units and shall be clearly identified as a resubmitted unit for inspection. The contractor shall also determine if the identified defect is likely to exist in other in-process and completed units, and inspect and disposition these units if appropriate.

TABLE VI. Conformance inspection.

Item	Inspection	Requirement paragraph	Test method paragraph
Circuit breakers	Dielectric strength	3.4.10.3	4.5.10
	Abbreviated calibration	3.3.5 3.4.16.2	4.5.7.4
Attachments	Attachment operating characteristics	3.4.17	4.5.3 through 4.5.3.9

4.4 Comparison inspection of circuit breakers, attachments, and cradles. At intervals of not more than 3 years during which circuit breakers of a type have been acquired under this specification, the manufacturer shall provide sample production circuit breakers and production cradles with all attachments and conduct complete qualification tests in the order specified in Table V. Any exceptions or changes to the test order shall be addressed in the qualification package. Circuit breakers of a type which have not been supplied within the three-year period shall be tested as a part of the subsequent order for production line units. Failure of a sample to meet the requirements of this specification shall be cause for removal from the qualified products list.

4.5 Qualification inspection and comparison inspection tests. All tests shall be conducted with the circuit breaker installed in the cradle and all applicable attachments installed in the circuit breaker. See applicable specification sheets for additional test requirements.

4.5.1 General examination. Circuit breakers and attachments shall be subjected to a thorough examination to determine that the material, workmanship, safety to operating personnel, design, and construction are in conformance with this specification and applicable drawings. Examination shall include, but need not be limited to, the following:

a. Electrical connections and wiring are as specified.

b. Orientation of DC poles is as specified.

c. Insulation is as specified.

d. Circuit breaker frame is as specified.

e. Manual handle is adaptable for dead-front, flush-mounted circuit breaker application.

f. All electric closing devices are mounted on the removable element of the circuit breaker.

g. Control transformer is located as specified.

h. All attachments provided as specified.

i. Manual operating handle is provided for an electrically operated circuit breaker.

j. Mechanical position indicator is provided.

k. Outline and mounting dimensions are as specified.

l. Overcurrent protection devices are provided as specified.

m. Indicator furnished as specified.

n. Secondary disconnects provided as specified.

o. Designation and marking are as specified.

p. Painting and insulation as specified.

4.5.2 Creepage and clearance. Creepage and clearance distances shall be demonstrated by actual measurement. Unless otherwise specified in the specification sheets, distances shall be in accordance with MIL-E-917.

4.5.3 Attachment operating characteristics. Electric closing devices, undervoltage release devices, undervoltage lockout devices, shunt trips, auxiliary switches, secondary disconnecting devices, hold-closed mechanisms, operations counters, mechanical position indicators, indicator lights, TOPU devices, position indicators for rack-in/rack-out, and cell switches shall be tested to verify they operate in accordance with requirements specified herein. See Table V for details on how and when to test attachments.

4.5.3.1 Undervoltage lockout device operation.

4.5.3.1.1 Energized. The undervoltage lockout device shall remain energized during test numbers 3A through 3F(2) of Table V. It shall be verified that the undervoltage lockout device does not affect the circuit breaker operation and does not trip a closed circuit breaker.

4.5.3.1.2 De-energized. The undervoltage lockout device shall be de-energized for test number 3G of Table V. It shall be verified that the undervoltage lockout device prohibits closing of an open circuit breaker.

4.5.3.2 Electric closing device voltage range/characteristics.

4.5.3.2.1 Operating voltage range/closing time. With the circuit breaker initially in the open position, the rated minimum, nominal, and maximum operating voltages in the specified range shall be applied to the electric closing device during three separate checks. The electric closing device shall reclose the circuit breaker during each check. Closing time shall not exceed ½ second during any check. Closing time shall be measured from the initial rise in the close signal voltage to the first indication of continuity across the circuit breaker poles.

4.5.3.2.2 Charging mechanism stall test. The circuit breaker shall be electrically operated by reducing the charging mechanism operating voltage below the rated minimum voltage in increments of 2 volts until the charging mechanism fails to operate. This voltage shall be held for 15 seconds and it shall be verified that the circuit breaker is not damaged and does not become misaligned in any of its parts.

4.5.3.3 Undervoltage release.

4.5.3.3.1 Operating voltage range. With the circuit breaker in the closed position, the rated minimum, nominal, and maximum operating voltage in the specified range shall be applied to the undervoltage release device during three separate checks. The circuit breaker shall not open during any check.

4.5.3.3.2 Dropout voltage range. With voltage applied in the specified dropout range, the undervoltage release shall trip the circuit breaker. It shall then be verified that the circuit breaker shall not have the ability to be reclosed while applied voltage is in the specified dropout range.

4.5.3.4 Shunt trip voltage range/tripping current. With the circuit breaker in the closed position, the rated minimum, nominal, and maximum rated operating voltage in the specified range shall be applied to the shunt trip device during three separate checks. The circuit breaker shall trip during each check. For the 20S DC shunt trip, the tripping current shall be measured to verify that it does not exceed 30A at the maximum voltage.

4.5.3.5 Indicator light, operations counter, mechanical position indicator, and auxiliary switch operation. The circuit breaker shall be cycled electrically and the following criteria met:

a. The indicator lights shall be visually verified to have illuminated as specified when the circuit breaker is in the closed and open positions.

b. The operations counter shall be visually verified to have advanced as the circuit breaker is cycled.

c. The mechanical position indicator shall be visually verified to have shown the proper position of the main contacts (open/closed) as the circuit breaker is cycled.

d. One “a” (normally closed) and one “b” (normally open) auxiliary switch shall be verified by measurement to have changed state with the circuit breaker main contacts when the circuit breaker is cycled.

4.5.3.6 Operation of cell switch and rack-in/rack-out position indicator. The following criteria shall be met:

a. The cell switch shall be verified by measurement to be in the open position.

b. It shall be verified that the rack-in/rack-out position indicator shows that the circuit breaker is in the connect position.

4.5.3.7 Trip on power up (TOPU) device operation and control power removal/reapplication. Circuit breakers with electronic trip devices and a TOPU or similar device, shall undergo the tests of 4.5.3.7.1, 4.5.3.7.2, and 4.5.3.7.3. Electronic circuit breakers without a TOPU or similar device shall undergo the tests of 4.5.3.7.1 and 4.5.3.7.3. All undervoltage release/lockout devices shall be removed/defeated prior to testing.

4.5.3.7.1 TOPU device turned off (if applicable) and circuit breaker closed. With control power initially applied, remove control power to the circuit breaker and then reapply control power after 15 seconds. Circuit breaker shall not open or trip. Repeat this sequence twice more.

4.5.3.7.2 TOPU device turned on (if applicable) and circuit breaker closed.

4.5.3.7.2.1 15-second test. With control power initially applied, remove control power to the circuit breaker and then reapply control power after 15 seconds. Circuit breaker shall open without intentional delay. Repeat this sequence twice more.

4.5.3.7.2.2 20-millisecond test. With control power initially applied, remove control power to the circuit breaker and then reapply control power after 20 milliseconds. Circuit breaker shall not open. Repeat this sequence twice more.

4.5.3.7.3 TOPU device turned off (if applicable) and circuit breaker open. With control power initially applied, remove control power to the circuit breaker and then reapply control power after 15 seconds. Circuit breaker shall not close. Repeat this sequence twice more.

4.5.3.8 Hold-closed mechanism. The following tests shall be conducted:

a. With the circuit breaker initially in the open position, demonstrate that the hold-closed mechanism will permit closing of the circuit breaker.

b. With the circuit breaker initially in the closed position and an electrical trip signal applied, demonstrate that the hold-closed mechanism will keep the circuit breaker closed.

4.5.3.9 Auxiliary switch and associated secondary disconnecting device rating verification. One "a" (normally closed) auxiliary switch and its associated secondary disconnecting device contact shall have rated voltage and current applied in accordance with 3.4.17.7.d. The current and voltage shall be applied for the duration of the circuit breaker pre-interruption temperature rise test at rated current and the post-interruption temperature rise test at rated current. There shall be no pitting or burning noted on the auxiliary switch at the end of the test.

4.5.4 Trip-free operation and anti-pump operation.

4.5.4.1 Mechanical. The following tests shall be performed:

a. With the circuit breaker closed, press and hold the manual open (trip) button; the circuit breaker shall open. Then press and hold the close button; the circuit breaker contacts shall not close, even momentarily. The lack of a contact closure shall be verified with an appropriate detection circuit and oscilloscope connected across the main contacts.

b. With the circuit breaker open and the open (trip) button held, apply and remove the electrical close signal; the circuit breaker contacts shall not close, even momentarily. The lack of a contact closure shall be verified with an appropriate detection circuit and oscilloscope connected across the main contacts.

c. With the circuit breaker open, press and hold the close button; the circuit breaker shall close. While holding the close button, press and release the open (trip) button; the circuit breaker shall open and remain open.

d. Release the close button and then press it again; the circuit breaker shall close and remain closed.

4.5.4.2 Electrical. The following tests shall be performed:

a. Apply control power to the circuit breaker. With the circuit breaker closed, apply and maintain an open (trip) signal to the breaker; the circuit breaker shall open.

b. With the open signal still applied, apply a close signal to the circuit breaker; the circuit breaker shall not close. During this test it is acceptable if the circuit breaker main contacts and auxiliary contacts make contact momentarily.

c. With the circuit breaker open, apply and maintain a close signal to the circuit breaker; the circuit breaker shall close. While maintaining the close signal, apply and remove an open signal; the circuit breaker shall open and remain open.

d. Remove the close signal and re-apply; the circuit breaker shall close and remain closed.

4.5.5 Circuit breaker positions in or on cradle for rack-in/rack-out.

4.5.5.1 Rack-out. With the circuit breaker initially in the connect position and closed, the circuit breaker shall then be racked-out to the test, disconnect, and withdrawn positions and meet the criteria of 4.5.5.1.1, 4.5.5.1.2, and 4.5.5.1.3.

4.5.5.1.1 Test position.

4.5.5.1.1.1 Main contact de-energization and rack-in/rack-out position indicator operation. Verify by measurement that the main contacts are de-energized and visually verify that the rack-in/rack-out position indicator is in the “test” position.

4.5.5.1.1.2 Cell switch operation. The cell switch shall be verified by measurement to be in the open position.

4.5.5.1.1.3 Electrical cycling and mechanical position indicator operation. The circuit breaker shall be cycled electrically to verify that control power is still available. Visually verify that the mechanical position indicator properly shows the open/closed state of the main contacts as the circuit is cycled.

4.5.5.1.1.4 Manual cycling and mechanical position indicator operation. The circuit breaker shall be cycled manually. Visually verify that the mechanical position indicator properly shows the open/closed state of the main contacts as the circuit breaker is cycled.

4.5.5.1.1.5 Anti-rolling verification. With a 25-pound force applied to the front of the circuit breaker in the horizontal direction towards the cradle backplane, the following criteria shall be met. The force shall be applied as close to the center of the circuit breaker as possible. An instrument or device shall be used to measure and verify that a 25-pound force is applied.

a. The circuit breaker shall not move in and out on the cradle rails/tray.

b. The circuit breaker shall not fall off the cradle rails/tray.

c. No part of the circuit breaker shall come off the cradle rails/tray in such a manner as to require manual repositioning of the circuit breaker.

4.5.5.1.2 Disconnect position.

4.5.5.1.2.1 Withdrawal interlock mechanism and rack-in/rack-out position indicator operation. As the circuit breaker is racked out to the disconnect position, verify by measurement that the withdrawal interlock mechanism opens the circuit breaker main contacts and visually verify that the rack-in/rack-out position indicator is in the “disconnect” position.

4.5.5.1.2.2 Cell switch operation. The cell switch shall be verified by measurement to be in the closed position.

4.5.5.1.2.3 Manual cycling and mechanical position indicator operation. The circuit breaker shall be cycled manually. Visually verify that the mechanical position indicator properly shows the open/closed state of the main contacts as the circuit breaker is cycled.

4.5.5.1.2.4 Anti-rolling verification. With a 25-pound force applied to the front of the circuit breaker in the horizontal direction towards the cradle backplane, the following criteria shall be met. The force shall be applied as close to the center of the circuit breaker as possible. An instrument or device shall be used to measure and verify that a 25-pound force is applied.

a. The circuit breaker shall not move in and out on the cradle rails/tray.

b. The circuit breaker shall not fall off the cradle rails/tray.

c. No part of the circuit breaker shall come off the cradle rails/tray in such a manner as to require manual repositioning of the circuit breaker.

4.5.5.1.3 Withdrawn position.

4.5.5.1.3.1 Manual cycling and mechanical position indicator operation. The circuit breaker shall be cycled manually. Visually verify that the mechanical position indicator properly shows the open/closed state of the main contacts as the circuit breaker is cycled.

4.5.5.1.3.2 Anti-rolling verification. With a 25-pound force applied to the front of the circuit breaker in the horizontal direction towards the cradle backplane, the following criteria shall be met. The force shall be applied as close to the center of the circuit breaker as possible. An instrument or device shall be used to measure and verify that a 25-pound force is applied.

a. The circuit breaker shall not move in and out on the cradle rails/tray.

b. The circuit breaker shall not fall off the cradle rails/tray.

c. No part of the circuit breaker shall come off the cradle rails/tray in such a manner as to require manual repositioning of the circuit breaker.

4.5.5.1.3.3 Cradle strength test. A weight equal to 50 percent of the circuit breaker weight shall be added with the circuit breaker in the withdrawn position on the cradle rails/tray. A dummy weight equal to the size and weight of the circuit breaker can be used instead of an actual breaker. One-half the additional weight shall be attached on the left and right sides of the cradle as follows:

a. With weight hanging straight down, attach 25 percent of the additional weight to the right side cradle rail or bottom right side of cradle tray with a rope or cable at no more than ¼ the depth of the circuit breaker measuring from the front of the circuit breaker.

b. With weight hanging straight down, attach 25 percent of the additional weight to the left side cradle rail or bottom left side of cradle tray with a rope or cable at no more than ¼ the depth of the circuit breaker measuring from the front of the circuit breaker.

The circuit breaker and additional weight shall remain on the cradle rails/tray in the withdrawn position for 10 minutes. During that time period, there shall be no collapse or failure of the cradle. After the 10-minute period, the weight shall be removed and the circuit breaker shall be fully racked in and racked out to the withdrawn position without any failure.

4.5.5.2 Rack-in. With the circuit breaker in the withdrawn position and closed, the circuit breaker shall then be racked-in to the disconnect, test, and connect positions and meet the criteria of 4.5.5.2.1, 4.5.5.2.2, and 4.5.5.2.3.

4.5.5.2.1 Disconnect position. The criteria of 4.5.5.1.2 shall be met except that the withdrawal interlock mechanism operation shall be checked in the test position per 4.5.5.2.2.

4.5.5.2.2 Test position. The criteria of 4.5.5.1.1 shall be met except that it shall be verified that the withdrawal interlock mechanism opens the circuit breaker main contacts as the circuit breaker is racked in to the test position.

4.5.5.2.3 Connect position.

4.5.5.2.3.1 Main contact energization and rack-in/rack-out position indicator operation. Verify by measurement that the main contacts are energized and visually verify that the rack-in/rack-out position indicator is in the “connect” position.

4.5.5.2.3.2 Cell switch operation. The cell switch shall be verified by measurement to be in the open position.

4.5.6 Endurance.

4.5.6.1 Circuit breakers. Circuit breakers shall be subjected to the endurance tests of 4.5.6.1.1 and 4.5.6.1.2 without failure or operating irregularities. At the completion of each endurance test, the circuit breakers shall be closely examined to identify any evidence of undue wear or development of operating irregularities in any part.

4.5.6.1.1 Mechanical endurance test.

4.5.6.1.1.1 Test setup and method of cycling. No power shall be applied to the circuit breaker primary studs and close-open operation shall be accomplished by the manual operating mechanism on all circuit breakers.

4.5.6.1.1.2 Number and rate of operations. Circuit breakers shall be operated at any convenient speed of operation for the number of close-open cycles specified in the applicable specification sheet.

4.5.6.1.2 Electrical endurance test.

4.5.6.1.2.1 Test setup and method of cycling. Rated voltage and current shall be applied to the circuit breakers at the power factor specified in the applicable specification sheet. Circuit breakers shall be electrically operated with applicable attachments as discussed in 4.5.6.2.

4.5.6.1.2.2 Number and rate of operations. The number of operations shall be in accordance with the applicable specification sheet. Circuit breaker types rated up to 1,600 A shall be operated four times a minute for 10 minutes. Circuit breaker types rated above 1,600 A shall be operated three times a minute for 10 minutes. The remainder of the tests for all circuit breaker types shall be conducted at no less than one close-open operation every 2 minutes.

4.5.6.2 Attachments. Electric closing devices, undervoltage release devices, and shunt trips shall be used to cycle the circuit breaker during electrical endurance. Circuit breaker electrical endurance rate of operations as specified in the applicable specification sheet shall be maintained. Rate of operations as specified in the applicable specification sheets for the circuit breaker electrical endurance shall be maintained. The operations counter shall indicate the correct number of cycling operations at the conclusion of mechanical and electrical endurance testing.

4.5.7 Calibration.

4.5.7.1 Long-time delay. Circuit breakers shall be tested in accordance with Tables VII, VIII, and IX as applicable.

TABLE VII. Long-time delay pickup testing (electromechanical and electronic trip units).

Long-time pickup setting /1	Applied current (amps)	Trip status							
		Left pole		Center pole		Right pole		All poles /2	
		Required	Actual	Required	Actual	Required	Actual	Required	Actual
Min. setting	90% of nominal LTDPU	No trip		No trip		No trip		No trip	
	110% of nominal LTDPU	Trip		Trip		Trip		Trip	
Intmd. setting	90% of nominal LTDPU	No trip		No trip		No trip		No trip	
	110% of nominal LTDPU	Trip		Trip		Trip		Trip	
Max. setting	90% of nominal LTDPU	No trip		No trip		No trip		No trip	
	110% of nominal LTDPU	Trip		Trip		Trip		Trip	

NOTES:

/1 Minimum, intermediate (or as close to middle as possible) and maximum long-time delay pickup (LTDPU) setting available on the circuit breaker, as specified in the applicable specification sheet.

/2 For electromechanical circuit breakers, current shall flow through all poles simultaneously with poles in series. For electronic circuit breakers, three-phase current shall flow through all poles simultaneously (not three poles in series).

TABLE VIII. Long-time delay trip timing test (electromechanical trip units).

Long-time pickup setting /1	Applied current (amps)	Left pole		Center pole		Right pole	
		Trip time		Trip time		Trip time	
		Required /2	Actual	Required /2	Actual	Required /2	Actual
Min. Setting	2 times nominal LTDPU						
	3 times nominal LTDPU						
	4 times nominal LTDPU						
Intmd. setting	2 times nominal LTDPU						
	3 times nominal LTDPU						
	4 times nominal LTDPU						

TABLE VIII. Long-time delay trip timing test (electromechanical trip units) - Continued.

Long-time pickup setting /1	Applied current (amps)	Left pole		Center pole		Right pole	
		Trip time		Trip time		Trip time	
		Required /2	Actual	Required /2	Actual	Required /2	Actual
Max. setting	2 times nominal LTDPU						
	3 times nominal LTDPU						
	4 times nominal LTDPU						

NOTES:

/1 Minimum, intermediate (or as close to middle as possible) and maximum long-time delay pickup (LTDPU) setting available on the circuit breaker, as specified in the applicable specification sheet.

/2 Allowable time band as specified in the applicable specification sheet for long-time tripping.

TABLE IX. Long-time delay trip timing test (electronic trip units).

Long-time pickup setting /1	Applied current (amps)	Left pole (long-time delay set at min. band)		Center pole (long-time delay set at intmd. band) /2		Right pole (long-time delay set at max. band)	
		Trip time		Trip time		Trip time	
		Required /3	Actual	Required /3	Actual	Required /3	Actual
Min. Setting	2 times nominal LTDPU						
	3 times nominal LTDPU						
	4 times nominal LTDPU						
Intmd. setting	2 times nominal LTDPU						
	3 times nominal LTDPU						
	4 times nominal LTDPU						

TABLE IX. Long-time delay trip timing test (electronic trip units) - Continued.

Long-time pickup setting /1	Applied current (amps)	Left pole (long-time delay set at min. band)		Center pole (long-time delay set at intmd. band) /2		Right pole (long-time delay set at max. band)	
		Trip time		Trip time		Trip time	
		Required /3	Actual	Required /3	Actual	Required /3	Actual
Max. setting	2 times nominal LTDPU						
	3 times nominal LTDPU						
	4 times nominal LTDPU						

NOTES:

/1 Minimum, intermediate (or as close to middle as possible) and maximum long-time delay pickup (LTDPU) setting available on the circuit breaker, as specified in the applicable specification sheet.

/2 Intermediate (or as close to middle as possible) long-time delay band setting available on the circuit breaker.

/3 Allowable time band as specified in the applicable specification sheet for long-time tripping.

4.5.7.2 Short-time delay. Circuit breakers shall be tested in accordance with Tables X, XI, and XII.

TABLE X. Short-time delay pickup testing (electromechanical and electronic trip units).

STDPU switch setting /1	Applied current (amps)	Trip status					
		Left pole (short-time delay set at min. band)		Center pole (short-time delay set at intmd. band) /2		Right pole (short-time delay set at max. band)	
		Required	Actual	Required	Actual	Required	Actual
Min. Setting	90% of nominal STDPU	No trip		No trip		No trip	
	110% of nominal STDPU	Trip		Trip		Trip	
Intmd. setting	90% of nominal STDPU	No trip		No trip		No trip	
	110% of nominal STDPU	Trip		Trip		Trip	
Max. setting	90% nominal STDPU	No trip		No trip		No trip	
	110% of nominal STDPU	Trip		Trip		Trip	

NOTES:

/1 Minimum, intermediate (or as close to middle as possible) and maximum short-time delay pickup (STDPU) setting available on the circuit breaker, as specified in the applicable specification sheet.

/2 Intermediate (or as close to middle as possible) short-time delay band setting available on the circuit breaker, as specified in the applicable specification sheet.

TABLE XI. Short-time delay trip timing test (electromechanical and electronic trip units).

STDPU switch setting /1	Applied current (amps)	Actual trip time					
		Left pole (short-time delay set at min. band)		Center pole (short-time delay set at intmd. band) /3		Right pole (short-time delay set at max. band)	
		Trip time		Trip time		Trip time	
		Required /2	Actual	Required /2	Actual	Required /2	Actual
Min. Setting	2 times nominal STDPU						
	3 times nominal STDPU						
	4 times nominal STDPU						
Intmd. setting	2 times nominal STDPU						
	3 times nominal STDPU						
	4 times nominal STDPU						

TABLE XI. Short-time delay trip timing test (electromechanical and electronic trip units) - Continued.

STDPU switch setting /1	Applied current (amps)	Actual trip time					
		Left pole (short-time delay set at min. band)		Center pole (short-time delay set at intmd. band) /3		Right pole (short-time delay set at max. band)	
		Trip time		Trip time		Trip time	
		Required /2	Actual	Required /2	Actual	Required /2	Actual
Max. setting	2 times nominal STDPU						
	3 times nominal STDPU						
	4 times nominal STDPU						

NOTES:

/1 Minimum, intermediate (or as close to middle as possible) and maximum short-time delay pickup (STDPU) setting available on the circuit breaker, as specified in the applicable specification sheet.

/2 Allowable time band as specified in the applicable specification sheet for short-time tripping.

/3 Intermediate (or as close to middle as possible) short-time delay band setting available on the circuit breaker, as specified in the applicable specification sheet.

TABLE XII. Short-time resettable delay testing (electromechanical and electronic trip units).

STDPU switch setting /1	Applied current (amps) /2	Trip status					
		Left pole (short-time delay set at min. band)		Center pole (short-time delay set at intmd. band) /3		Right pole (short-time delay set at max. band)	
		Required	Actual	Required	Actual	Required	Actual
Intmd. setting	150% of nominal STDPU	No trip		No trip		No trip	
Max. setting	150% of nominal STDPU	No trip		No trip		No trip	

NOTES:

/1 Intermediate (or as close to middle as possible) and maximum short-time delay pickup (STDPU) setting available on the circuit breaker, as specified in the applicable specification sheet.

/2 Duration of applied current shall be one-half (1/2) cycle less than the circuit breaker short-time delay setting bandwidth minimum as specified in the applicable specification sheet.

/3 Intermediate (or as close to middle as possible) short-time delay band setting available on the circuit breaker, as specified in the applicable specification sheet.

4.5.7.3 Instantaneous. Circuit breakers shall be tested in accordance with Tables XIII and XIV.

TABLE XIII. Instantaneous pickup testing (electromechanical and electronic trip units) /1.

Instantaneous pickup setting /2	Applied current (amps)	Trip status					
		Left pole		Center pole		Right pole	
		Reqd	Actl	Reqd	Actl	Reqd	Actl
Min. setting	90% of nominal instantaneous pickup setting	No trip		No trip		No trip	
	110% of nominal instantaneous pickup setting	Trip		Trip		Trip	
Intmd. setting	90% of nominal instantaneous pickup setting	No trip		No trip		No trip	
	110% of nominal instantaneous pickup setting	Trip		Trip		Trip	
Max. setting	90% of nominal instantaneous pickup setting	No trip		No trip		No trip	
	110% of nominal instantaneous pickup setting	Trip		Trip		Trip	

NOTES:

/1 Short-time delay band and short-time delay pickup (STDPU) settings shall be set to maximum.

/2 Minimum, intermediate (or as close to middle as possible) and maximum instantaneous setting available on the circuit breaker, as specified in the applicable specification sheet.

TABLE XIV. Instantaneous timing test (electromechanical and electronic trip units) /1.

Instantaneous pickup setting /2	Applied current (amps)	Left pole		Center pole		Right pole	
		Trip time		Trip time		Trip time	
		Reqd /3	Actl	Reqd /3	Actl	Reqd /3	Actl
Min. Setting	**3 times nominal instantaneous pickup**						
Intmd. setting	**3 times nominal instantaneous pickup**						

NOTES:

/1 Short-time delay band and short-time delay pickup (STDPU) settings shall be set to maximum.

/2 Minimum and intermediate (or as close to middle as possible) instantaneous setting available on the circuit breaker, as specified in the applicable specification sheet.

/3 Circuit breakers shall trip without intentional delay and shall trip in less time than the fastest published time of the lowest short-time delay band setting as specified in the applicable specification sheet.

4.5.7.4 Abbreviated calibration.

4.5.7.4.1 Long-time delay. LTD calibration shall be tested in accordance with 4.5.7.1 and Tables VII, VIII, and IX as applicable but at the intermediate LTDPU setting only.

4.5.7.4.2 Short-time delay. STD calibration shall be tested in accordance with 4.5.7.2 and Tables X, XI, and XII but at the intermediate STDPU setting only.

4.5.7.4.3 Instantaneous. Instantaneous calibration shall be tested in accordance with 4.5.7.3 and Tables XIII and XIV but at the intermediate instantaneous pickup setting only.

4.5.8 Inclined operation. Circuit breakers, attachments, and cradles shall be subjected to an inclined operation test with the circuit breaker inclined forward, backward, and to each side, at an angle of 30 degrees from the normal vertical/horizontal orientation. In each direction of inclination, the circuit breaker shall be tested in the connect, test, disconnect, and withdrawn positions and shall meet the criteria specified in this section.

4.5.8.1 Connect position.

4.5.8.1.1 Abbreviated calibration (electromechanical trip units only). Circuit breakers with electromechanical trip units shall be tested in accordance with 4.5.7.4.

4.5.8.1.2 Attachment operational checks.

4.5.8.1.2.1 Undervoltage lockout device operation.

4.5.8.1.2.1.1 Energized. The undervoltage lockout device shall be energized for test numbers 8A(2)(a) through 8A(2)(f) of Table V. It shall be verified that the undervoltage lockout device does not affect the circuit breaker operation and does not trip a closed circuit breaker.

4.5.8.1.2.1.2 De-energized. The undervoltage lockout device shall be de-energized for test number 8A(2)(g) of Table V. It shall be verified that the undervoltage lockout device prohibits closing of an open circuit breaker.

4.5.8.1.2.2 Electric closing device nominal voltage/closing time. Testing shall be conducted in accordance with 4.5.3.2.1 except that a voltage check shall be made at the nominal rated operating voltage only.

4.5.8.1.2.3 Undervoltage release device nominal operating voltage/dropout voltage range. Testing shall be conducted in accordance with 4.5.3.3.1 and 4.5.3.3.2 except that a voltage check shall be made at the nominal rated operating voltage only.

4.5.8.1.2.4 Shunt trip nominal operating voltage/tripping current. Testing shall be conducted in accordance with 4.5.3.4 except that a voltage check shall be made at the nominal rated operating voltage only.

4.5.8.1.2.5 Operation of indicator light, operations counter, mechanical position indicator, and auxiliary switch. Testing shall be conducted in accordance with 4.5.3.5.a through 4.5.3.5.d.

4.5.8.1.2.6 Operation of cell switch and rack-in/rack-out position indicator. Testing shall be conducted in accordance with 4.5.3.6.a and 4.5.3.6.b.

4.5.8.1.2.7 Trip on power up (TOPU) device operating characteristics and control power removal/reapplication (electronic trip units only). Circuit breakers with electronic trip devices and a TOPU or similar device shall be tested in accordance with 4.5.3.7.

4.5.8.2 Test position. The circuit breaker shall be racked-out to the test position. The circuit breaker may be racked-out in the normal vertical/horizontal orientation then inclined. The circuit breaker shall be inclined when conducting tests and verifications of 4.5.8.2.1 through 4.5.8.2.5.

4.5.8.2.1 Main contact de-energization and rack-in/rack-out position indicator operation. Testing shall be conducted in accordance with 4.5.5.1.1.1.

4.5.8.2.2 Cell switch operation. Testing shall be conducted in accordance with 4.5.5.1.1.2.

4.5.8.2.3 Electrical cycling and mechanical position indicator operation. Testing shall be conducted in accordance with 4.5.6.1.1.3.

4.5.8.2.4 Manual cycling and mechanical position indicator operation. Testing shall be conducted in accordance with 4.5.6.1.1.4.

4.5.8.2.5 Anti-rolling verification. Testing shall be conducted in accordance with 4.5.5.1.1.5 except that the 25-pound force shall not be applied.

4.5.8.3 Disconnect position. The circuit breaker shall be racked-out to the disconnect position. The circuit breaker may be racked-out in the normal vertical/horizontal orientation then inclined. The circuit breaker shall be inclined when conducting tests and verifications of 4.5.8.3.1 through 4.5.8.3.4.

4.5.8.3.1 Withdrawal interlock mechanism and rack-in/rack-out position indicator operation. Testing shall be conducted in accordance with 4.5.5.1.2.1.

4.5.8.3.2 Cell switch operation. Testing shall be conducted in accordance with 4.5.5.1.2.2.

4.5.8.3.3 Manual cycling and mechanical position indicator operation. Testing shall be conducted in accordance with 4.5.5.1.2.3.

4.5.8.3.4 Anti-rolling verification. Testing shall be conducted in accordance with 4.5.5.1.2.4 except that the 25-pound force shall not be applied.

4.5.8.4 Withdrawn position. The circuit breaker shall be racked-out to the withdrawn position. The circuit breaker may be racked-out in the normal vertical/horizontal orientation then inclined. The circuit breaker shall be inclined when conducting tests and verifications of 4.5.8.4.1 and 4.5.8.4.2.

4.5.8.4.1 Manual cycling and mechanical position indicator operation. Testing shall be conducted in accordance with 4.5.5.1.3.1.

4.5.8.4.2 Anti-rolling verification. Testing shall be conducted in accordance with 4.5.5.1.3.2 except that the 25-pound force shall not be applied.

4.5.9 Temperature rise.

4.5.9.1 Circuit breaker temperature rise at rated current (pre-interruption and post-interruption).

4.5.9.1.1 Test circuit. At room ambient, circuit breakers shall be operated in their specified enclosures at any convenient voltage and maximum rated continuous current on all main contacts and overcurrent coils. If no enclosures are specified, test enclosures simulating the minimum volume compartment of a MIL-DTL-16036 standardized switchgear unit shall be used. Circuit breaker enclosures shall be protected from drafts and from abnormal heat convection by a shield, if necessary. Copper bus bars shall be used for connecting to the top studs, and cable shall be used for connecting to the bottom studs. Size of the bus bar and cable shall be as specified in the applicable specification sheet. The copper cross-section of leads shall remain constant for at least 3 feet from each stud on the circuit breaker.

4.5.9.1.2 Sensor locations.

4.5.9.1.2.1 Ambient. The ambient temperature shall be determined by two temperature sensors (thermometers, thermocouples, or other approved method). The sensors shall be located within two feet of each side of the circuit breaker at half the depth and half the height of the circuit breaker.

4.5.9.1.2.2 Circuit breaker and cradle. Temperature rise shall be measured at the hottest point where the following current-carrying parts are in touch with the insulating material:

a. Circuit breaker line and load side terminals on each phase.

b. Cradle line and load terminals on each phase.

c. Circuit breaker main contacts on each phase.

d. Conducting mechanical joints on each phase.

4.5.9.1.3 Temperature stabilization and temperature rise determination. All temperature readings shall be recorded during the same time frame and shall be of sufficient duration to allow stabilization of the measured temperatures to a rate of rise within 2 °C per hour. Ambient temperature shall be maintained at room temperature ±5 °C. An average ambient temperature shall be determined by averaging together the ambient sensor readings. The average ambient temperature shall be used to determine the temperature rise of monitoring points specified in 4.5.9.1.2.2.

4.5.9.1.4 Pass/fail criteria. Temperature rise shall not exceed the limits as specified in Table I.

4.5.9.2 Temperature rise above rated current. Immediately following the temperature rise test at rated continuous current, an additional test of 5 minutes duration shall be conducted with the current increased to 150 percent on all main contacts and spare auxiliary contacts. At the end of this test, the temperature rise of the hottest terminal and mechanical conducting joint shall not exceed the applicable values in Table I.

4.5.9.3 Attachment temperature rise.

4.5.9.3.1 Electric closing device and shunt trip. Temperature rise of electric closing device and shunt trip shall be measured during electrical endurance testing while the attachments are used to cycle the circuit breaker. Sensors shall be located on the housing of the electric closing device and shunt trip to determine the temperature rise. The temperature rise shall not exceed the pre-interruption (rated current) limits for insulation as specified in Table I.

4.5.9.3.2 Undervoltage release device, auxiliary contacts, and secondary disconnecting device contacts. During electrical endurance testing, a sensor shall be located on insulation material nearest to the “a” auxiliary contact used as the shunt trip cut-off switch. The temperature rise shall not exceed the pre-interruption (rated current) limits for insulation as specified in Table I. During pre-interruption and post-interruption temperature rise testing at rated current, sensors shall be located on the housing of the undervoltage release device and the insulation material nearest to an “a” auxiliary contact and an associated secondary disconnecting contact. The temperature rise shall not exceed the pre-interruption (rated current) limits for insulation as specified in Table I.

4.5.10 Dielectric strength.

4.5.10.1 Test equipment. Tests for dielectric strength shall be made with an alternating potential from a 1 kilowatt or larger power source having a sinusoidal wave shape. Semiconductors shall be shunted or disconnected for protection during tests.

4.5.10.2 Voltage magnitude.

4.5.10.2.1 Full voltage. The applicable voltage magnitude specified in 3.4.10.3 shall be applied as specified in Table V.

4.5.10.2.2 Reduced voltage. Sixty percent of the applicable voltage magnitude specified in 3.4.10.3 shall be applied as specified in Table V.

4.5.10.3 Voltage application/duration and pass/fail criteria. The voltage shall be applied for a period of 1 minute without insulation breakdown between the test points and under the conditions specified in 4.5.10.3.1. The applied potential shall be increased gradually until the correct test value is reached.

4.5.10.3.1 Circuit breaker, attachments, and cradle configuration. The circuit breaker shall have all applicable attachments installed and this entire configuration shall be installed in the cradle.

4.5.10.3.1.1 Circuit breaker poles and ground used as test points. The voltage shall be applied between the points marked with an "X" in Tables XV and XVI with the circuit breaker in the state (open, closed) specified in Tables XV and XVI.

TABLE XV. Dielectric strength test points (circuit breaker poles and ground) with circuit breaker open.

Circuit breaker open		Load side terminals on cradle			Ground		
Line side terminals on cradle		Left pole	Center pole	Right pole			
	Left pole	X			X		
	Center pole		X			X	
	Right pole			X			X
Ground		X					
			X				
				X			

TABLE XVI. Dielectric strength test points (circuit breaker poles and ground) with circuit breaker closed.

Circuit breaker closed		Circuit breaker load side terminals on cradle		
		Left pole	Center pole	Right pole
Circuit breaker line side terminals on cradle	Left pole		X	X
	Center pole			X
	Right pole			
Ground		X		
			X	
				X

4.5.10.3.1.2 Control wiring and ground used as test points.

4.5.10.3.1.2.1 Charging motor. Tie all charging motor leads together and apply 900 volts between lead bundle and charging motor housing.

4.5.10.3.1.2.2 All other secondary disconnect control wiring. With the circuit breaker closed, the voltage shall be applied between secondary disconnect control wiring of the same voltage rating and test points as marked with an "X" in Table XVII.

TABLE XVII. Dielectric strength test points [secondary disconnect control wiring (excluding charging motor), circuit breaker poles, and ground] with circuit breaker closed.

	Circuit breaker terminals on cradle			Ground
	Left pole	Center pole	Right pole	
Secondary disconnect control wiring of same voltage rating /1	X	X	X	X

NOTE:

/1 Secondary disconnect control wiring leads shall be tied together and voltage applied between the tied bundle and the points specified.

4.5.11 Insulation resistance.

4.5.11.1 Test equipment. Unless otherwise specified in the specification sheets, insulation resistance shall be measured with a 500-volt insulation resistance testing device.

4.5.11.2 Test points and conditions. Insulation resistance shall be measured between the same test points and under the same conditions as specified in4.5.10.3.1 through 4.5.10.3.1.2.2.

4.5.11.3 Pass/fail criteria.

4.5.11.3.1 10-megohm threshold. The insulation resistance shall be greater than 10 megohms as specified in Table V.

4.5.11.3.2 1-megohm threshold. The insulation resistance shall be greater than 1 megohm as specified in Table V.

4.5.12 Short-time duty cycle performance (withstand rating). Circuit breakers shall be subjected to their rated short-time current at rated voltage for a time duration as shown in the applicable specification sheet. No repairs or replacement of parts shall be required after the test.

4.5.12.1 Short-time current characteristics. The short-time current is expressed in root mean square (rms) symmetrical A and is measured from the envelope of the available current wave at 0.5 cycles after current is established. For three-phase circuits, the symmetrical current value shall be the average of the phase currents. The test circuit shall demonstrate that circuit breakers perform their short-circuit duty cycle with all degrees of current asymmetry produced by three-phase circuits, having a short-circuit power factor of 0.15 lagging or less (X/R ratio of 6.6 or greater).

4.5.12.2 Test circuit.

4.5.12.2.1 AC test circuit. AC test circuit and test procedures shall be in accordance with the requirements of ANSI C37.50 as modified by the requirements of this specification.

4.5.12.2.2 DC test circuit. DC circuit breakers may be tested for the required short-time current on an AC circuit in which the peak currents do not exceed the specified level of short-time current.

4.5.13 Interrupting current duty cycle performance. Circuit breakers shall be subjected to their rated short-circuit interruption current at rated voltage in accordance with the applicable specification sheet. When specified in the qualification package, the emission indicator (cheesecloth) shall not ignite during testing. Scorching of the cheesecloth shall not be considered as ignition. No repairs or replacement of parts shall be required after the test.

4.5.13.1 Interrupting duty cycle. The interruption duty cycle of circuit breakers with instantaneous overcurrent trip elements shall consist of an opening operation, followed by a 2-minute interval, then by a close-open operation, and after a 5-minute interval, by another close-open operation.

4.5.13.2 Interrupting current characteristics. The short-circuit current is expressed in rms symmetrical amperes and is measured from the envelope of the available current wave at 0.5 cycle after current is established. For three-phase circuits, the symmetrical current value shall be the average of the phase currents. The test circuit shall demonstrate that circuit breakers perform their short-circuit duty cycle with all degrees of current asymmetry produced by three-phase circuits, having a short-circuit power factor of 0.15 lagging or less (X/R ratio of 6.6 or greater). The rms symmetrical current shall be calculated in accordance with ANSI/IEEE C37.09.

4.5.13.3 Test circuit/setup.

4.5.13.3.1 AC test circuit. AC test circuit and test procedures shall be in accordance with the requirements of ANSI C37.50, as modified by the requirements of this specification.

4.5.13.3.2 DC test circuit. In DC test circuits, the test shall be performed on the two poles connected in series. The test circuit shall be so adjusted that the requirements in Table XVIII are met.

TABLE XVIII. Requirements for DC interrupting test.

Short circuit current (amperes)	**Time constant L/R (milliseconds)**	**Maximum initial current rise E/L (at 240 V) (amperes per microsecond)**
50,000	16.0	3.1
75,000	15.6	4.8
150,000	12.5	12.0

4.5.13.3.3 Emission indicator. When specified in the qualification package, an indicator consisting of three layers of cheesecloth shall be employed to detect any excessive emission of flame, hot gases, or molten particles during the interruption test. The cheesecloth shall be loosely stretched on a frame at least as large as the front of the circuit breaker enclosure and shall be located 1 inch from, and parallel to, the front door of the circuit breaker enclosure. The cheesecloth may be displaced as necessary to accommodate projections such as handles.

4.5.13.4 Post-interrupting current duty cycle performance. See Table V for testing required after interrupting current duty cycle.

4.5.14 Shock. Circuit breakers with attachments shall be installed in the cradle and the entire configuration mounted in the bottom compartment of the switchgear unit as specified in 3.4.5, and shall withstand the Grade A, Type I shock requirements of MIL-S-901. Circuit breakers shall be tested in both the closed and open positions in accordance with MIL-S-901. All testing shall be conducted on one sample.

4.5.14.1 Test setup. The following criteria shall be met:

a. All continuous current duty attachments shall be energized to simulate actual operating conditions.

b. Circuit breakers shall be energized at 12 VDC and any convenient current level.

c. A recording oscillograph or other means shall be used to check the status of the contacts under shock.

4.5.14.2 Performance during shock tests. Circuit breakers shall meet the following criteria during shock:

a. Shall not open when closed. Momentary opening of the main and auxiliary contacts of not more than 0.02-second duration shall be acceptable.

b. Shall not close when open.

4.5.14.3 Post-shock performance. See Table V for testing required after shock.

4.5.15 Vibration. Circuit breakers with attachments shall be installed in the cradle and shall be subjected to Type I vibration tests of MIL-STD-167-1. The switchgear unit shall be supported at each corner near the top of the circuit breaker compartment, by a 0.375-inch by 4-inch angle iron brace, extending diagonally on a 30-degree angle to the platform of the vibration machine. The tests shall be performed with the circuit breakers in the open position and repeated with the circuit breakers in the closed position. Circuit breakers shall be tested in the closed position while energized at 12 VDC and any convenient current level. Attachments shall be energized during all tests, to simulate actual operating performance.

4.5.15.1 Performance during vibration tests. The criteria of 4.5.14.2 shall be met with the exception that no contact opening or chatter shall be acceptable during the tests.

4.5.15.2 Post-vibration performance. See Table V for testing required after vibration.

4.5.16 Electromagnetic interference (EMI). Circuit breakers with electronic trip devices shall meet and demonstrate compliance with the requirements of MIL-STD-461 for Surface Ship, Below Deck, Metallic Hull installations.

4.5.17 Voltage spike. Circuit breakers with electronic trip devices shall be tested in accordance with MIL-STD-1399-300. Voltage spikes shall not cause failure of trip units (including false tripping) and attachments.

4.5.18 Post EMI and voltage spike performance. See Table V for testing required after EMI and voltage spike.

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

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

6.1 Intended use. Circuit breakers and their attachments covered by this specification are intended for use in Naval shipboard applications, as a device which:

a. Maintains a closed circuit when closed.

b. Maintains an open circuit when open.

c. Interrupts the circuit under normal operation (current not in excess of the rated continuous current of the circuit breaker) and under abnormal conditions (currents in excess of the rated continuous current of the circuit breaker, such as a short circuit) in accordance with the intended operation of the trip devices. In application, circuit breakers are selected whose rated short-circuit current is as great or greater than the maximum current which they may be called upon to interrupt.)

6.2 Acquisition requirements. Acquisition documents should specify the following:

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

b. Type required (see 1.2 and the applicable specification sheet).

c. Creepage and clearance set spacing and enclosure type, if other than set C spacing and enclosed type of enclosure (see 3.3.2).

d. Quantity of special tools, if required (see 3.4.4).

e. Applicable switchgear unit or circuit breaker enclosure (see 3.4.5).

f. Selected parts to be made from thermoplastic material (see 3.4.8).

g. Powder coating, method of application, curing, repair (see 3.4.9.1) and alternate test methods/acceptance criteria for adhesion (see 3.4.9.1.5.1).

h. Manual operation for circuit breaker types ACB-900RC, ACB-901R, ACB-902R, or ACB-2000RC, if not required (see 3.4.13.2.1).

i. Types of overcurrent protection required (see 3.4.16.2):

(1) Overcurrent coil rating and use (see 3.4.16.1).

(2) Short-time delay – required pickup current setting (see 3.4.16.2.1.2.1) and time band (see 3.4.16.2.1.2.2).

(3) Instantaneous – required pickup current setting (see 3.4.16.2.1.3).

j. Mounting location of transformer, if required, for electric closing power (see 3.4.17.3.e).

k. Undervoltage release device, if required, and voltage rating (see 3.4.17.4).

l. Undervoltage lockout device, if required (see 3.4.17.5).

m. Shunt trip device, if required (see 3.4.17.6); voltage rating. If 20S nominal voltage selected, specify whether trip current exceeds 30 A (see Table IV).

n. Special auxiliary switches, if required (see 3.4.17.7).

o. Secondary disconnecting devices, quantity required (see 3.4.17.8).

p. Hold-closed mechanism, if required (see 3.4.17.9).

q. Operations counter (see 3.4.17.10).

r. Indicator light with lens color, if required; indicate special type, if required (see 3.4.17.12).

s. Trip on power up (TOPU) device (see 3.4.17.13).

t. By-pass switches, if required (see 3.4.17.15).

u. Conformal coating (see 3.4.18.2).

v. Sockets, if required (see 3.4.18.3).

w. Conformance inspection sampling requirements, if required (see 4.3.1).

x. Requirements for rework and suspension of shipment of circuit breakers when circuit breakers do not meet acceptance criteria (see 4.3.2).

y. Packaging requirements (see 5.1).

z. Provisioning requirements (see 6.4).

6.3 Definitions. Circuit breaker terminology used in this specification is in accordance with common commercial technology, except as noted below. Commonly used terms can be found in ANSI C37.100.

6.3.1 By-pass switch. The by-pass switch is comprised of a normally closed limit switch (cell switch) mounted on the cradle and connected to the stationary secondary contacts in parallel with a normally closed auxiliary switch.

6.3.2 Cell switch. A cell switch is a normally closed limit switch mounted on the cradle that opens when the circuit breaker is in the connect or test position and closes when the circuit breaker is in the disconnect or withdrawn position.

6.3.3 Charging motor. A charging motor is the motor which moves the closing spring or springs to the position necessary, so that the spring(s) has (have) sufficient force to close the circuit breaker.

6.3.4 Closing release. A closing release is an electrical or mechanical device which releases the charged springs to close the circuit breaker contacts.

6.3.5 Closing spring. A closing spring is a spring that supplies power for closing the circuit breaker.

6.3.6 Enclosure. See MIL-STD-108.

6.3.7 Hold-closed mechanism. A hold-closed mechanism is a mechanism which renders the trip device and trip-free mechanism ineffective, thus permitting the circuit breaker to be closed from the open position or be held closed when in the closed position against an overload, as long as the hold-closed device is held in position by the operator.

6.3.8 Lockout mechanism. A lockout mechanism mechanically prevents the circuit breaker from closing, either electrically or manually.

6.3.9 Operating mechanism of a circuit breaker. The operating mechanism of a circuit breaker is a power-operating or manual mechanism, by which the contact of all poles of the circuit breaker is actuated.

6.3.10 Operating time of a circuit breaker. The operating time of a circuit breaker is the total time interval of elapsed time, from the moment of energizing the circuit breaker's trip coil to the completion of the interruption of the circuit at rated voltage.

6.3.11 Overcurrent device. An overcurrent device is an assembly which detects a current exceeding a predetermined value and which will directly initiate an operation or the circuit breaker trip mechanism.

6.3.12 Overcurrent coil. Overcurrent coil is a thermal or magnetic overcurrent device.

6.3.13 Overcurrent sensors. Overcurrent sensors are elements associated with electrical overcurrent trip devices, which sense current magnitude and supply a corresponding signal to an electrical network.

6.3.14 Pickup setting. The average minimum current required to activate a trip element between 30 and 70 °C ambient temperature.

6.3.15 Rated AC short-circuit current. The rated AC short-circuit current of a circuit breaker is the stated limit of available (prospective) current, at which it is required to perform its short-circuit current duty cycle at rated maximum voltage and frequency under the prescribed test conditions.

6.3.16 Rated continuous current. The rated continuous current of a circuit breaker is the stated limit in rms amperes at rated frequency, or DC amperes, which a circuit breaker will carry continuously under stated ambient conditions without either tripping or exceeding the limit of observable temperature rise.

6.3.17 Rated DC short-circuit current. The rated DC short-circuit current of a circuit breaker is the designated limit in available (prospective) sustained current at the specified operating voltage, at which it is required to perform its short-circuit current duty cycle at rated maximum voltage, under the prescribed test conditions.

6.3.18 Rated short-time current. The rated short-time current of a circuit breaker is the designated limit of available (prospective) current at which it is required to perform its short-time current duty cycle at rated maximum voltage under the prescribed test conditions.

6.3.19 Removable element of a circuit breaker assembly. The removable element of a circuit breaker assembly is that portion which carries the circuit-switching and circuit-interrupting devices and the removable part of the primary and secondary disconnecting devices. It can be withdrawn from the stationary element for maintenance purposes.

6.3.20 Resettable delay of a circuit breaker. Resettable delay is defined as the maximum time the circuit breaker will carry current in excess of the pickup current setting and still not trip when the circuit current is suddenly reduced without interruption to the rated continuous current of the circuit breaker.

6.3.21 Stationary component of a circuit breaker assembly. The stationary component of a circuit breaker assembly is that portion which is bolted to its enclosure and to which external current-carrying connections are made. The removable component of the circuit breaker assembly can be inserted (connected) into the stationary component or withdrawn (disconnected) from it.

6.3.22 Terminal. The terminal is the end of the stationary primary disconnect to which external bus or cable connections are made.

6.3.23 Total clearing time of a circuit breaker. Total clearing time is the maximum time, measured from when current reaches a trip value, until the interruption is completed and consists of the mechanical operating time, the arcing time and the intentional delay time of the circuit breaker. The total clearing time is represented by the upper limit of the time band envelope on the applicable time-current characteristic curve.

6.3.24 Trip device, AC solid-state overcurrent. An AC solid-state overcurrent trip device obtains its tripping energy from the circuit breaker current via an overcurrent sensor. This energy is supplied to an electrical network, which in turn operates a trip mechanism. Three sensors may be required to derive enough energy to actuate the tripper.

6.3.25 Trip device, DC solid-state overcurrent. A DC solid-state overcurrent trip device obtains its tripping energy from a preferred control source and senses current levels via a low-powered sensor. This energy and signal is supplied to an electrical network, which in turn operates a trip mechanism. Multiple sensors may be required to derive enough energy to actuate the tripper.

6.3.26 Trip device, electromechanical overcurrent. An electromechanical overcurrent trip device operated directly by circuit breaker current to mechanically trip the circuit breaker on overcurrent. The current through the circuit breaker directly provides the magnetic force to trip the circuit breaker.

6.3.27 Trip on power up (TOPU) device. A feature that trips a circuit breaker when the circuit breaker is left closed in the absence of control power and the control power is subsequently restored. The purpose of a TOPU device is to prevent unintended energization of circuit breaker loads.

6.3.28 Type. The circuit breaker type is a designation used to differentiate performance characteristics.

6.3.29 Undervoltage lockout device. A solenoid or other electronic device that will prevent a circuit breaker from being closed if the applied voltage is below a prescribed level. Once closed, a low voltage condition will not trip the circuit breaker.

6.3.30 Undervoltage release device. A solenoid or other electronic device that will trip the circuit breaker (or prevent it from being closed) if the applied voltage falls below a prescribed level.

6.3.31 Withdrawal interlock mechanism. A mechanical device which will prevent the main studs from being disconnected while the circuit breaker is closed.

6.4 Provisioning. Provisioning Technical Documentation (PTD), spare parts, and repair parts should be furnished as specified (see 6.2). When ordering spare parts or repair parts for the equipment covered by this specification, the contract should state that such spare parts and repair parts should meet the same requirements and quality assurance provisions as the parts used in the manufacture of the equipment. Packaging for such parts should also be specified.

6.5 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 QPL No. 17587-34 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 Commander, Naval Sea Systems Command, ATTN: SEA 05Q, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or emailed to CommandStandards@navy mil.

6.6 Subject term (key word) listing.

Cradle

Short-time current duty cycle performance

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 extent of the changes.

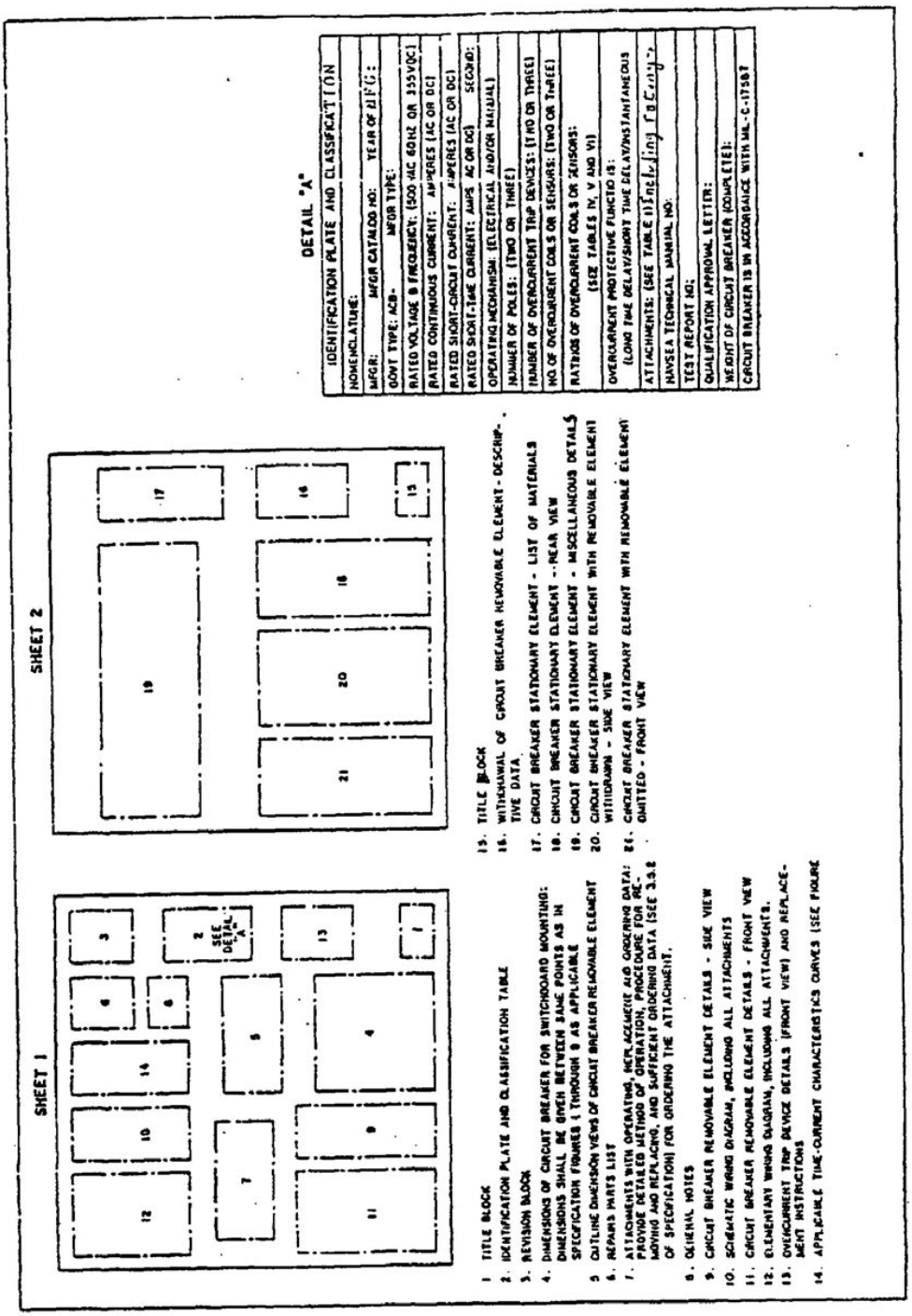

FIGURE 1. Typical master diagram.

Preparing Activity:
Navy – SH
(Project 5925-N184-000)

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at http://assist.daps.dla mil.