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OUTLINE OF INVESTIGATION

FOR

US NAVAL COMMERCIAL OFF THE SHELF (COTS) THREE-POLE, RATED
MAXIMUM VOLTAGE 4.76, 8.25, AND 15KV, AC, VACUUM CIRCUIT
BREAKERS, DRAWOUT TYPE, WITHOUT INTERNAL OVERCURRENT
PROTECTION, AND ACCESSORIES/COMPONENTS FOR USE ON
NON-NUCLEAR NAVAL COMBATANT SHIPS

ISSUE NO. 1

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Summary of Topics

*This is the first issue of the Outline of Investigation for US Naval
Commercial Off the Shelf (COTS) Three-Pole, Rated Maximum Voltage
4.76, 8.25, and 15kV, AC, Vacuum Circuit Breakers, Drawout Type, without
Internal Overcurrent Protection, and Accessories/Components for Use
on Non-Nuclear Naval Combatant Ships*

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INTRODUCTION

1 Scope

1.1 These requirements cover three-pole, rated maximum voltage 4.76kV, 8.25kV, and 15kV, AC, vacuum circuit breakers, drawout-mounted type, without internal overcurrent protection, and applicable accessories/functional components intended for use aboard non-nuclear Naval combatant ships in electrical assemblies (switchgear) installed on shock isolators (mounts). These requirements cover only the removable element (circuit breaker) and require testing in a representative switchgear interface as detailed in this Outline.

1.2 Successful initial qualification testing and requalification testing of circuit breakers/ accessories/functional components to the requirements of this Outline shall allow their use in shock-mounted electrical assemblies in non-nuclear Naval combatant ships.

2 Normative References

2.1 This Outline references the following COTS specifications:

- a) ANSI/NEMA C37.54, Indoor Alternating Current High-Voltage Circuit Breakers Applied as Removable Elements in Metal-Enclosed Switchgear – Conformance Test Procedures
- b) IEEE C37.04, IEEE Standard Rating Structure for AC High-Voltage Circuit Breakers
- c) IEEE C37.06, American National Standard AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis – Preferred Ratings and Related Required Capabilities
- d) IEEE C37.09, IEEE Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
- e) IEEE C37.100, Standard Definitions for Power Switchgear

2.2 This Outline references the following military specifications/documents. Specifications/documents can be accessed at <https://assist.daps.dla.mil/quicksearch/>.

- a) MIL-E-917, Electric Power Equipment, Basic Requirements
- b) MIL-HDBK-454, General Guidelines for Electronic Equipment
- c) MIL-STD-202, Test Method Standard, Electronic and Electrical Component Parts
- d) MIL-STD-130, Department of Defense Standard Practice, Identification Marking of U.S. Military Property
- e) MIL-STD-461, Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment
- f) DI-EMCS-80200, Electromagnetic Interference Test Report (EMITR)
- g) DI-EMCS-80201, Electromagnetic Interference Test Procedures (EMITP)
- h) MIL-STD-108, Definitions of and Basic Requirements for Enclosures for Electrical and Electronic Equipment

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- i) MIL-STD-1399-300, Interface Standard Section 300, Electric Power, Alternating Current

3 Glossary

3.1 See IEEE C37.100 for standard definitions for power switchgear.

3.2 CRADLE OR CASSETTE – See stationary portion of a drawout-mounted device from IEEE C37.100.

3.3 WITHDRAWN POSITION – See Disconnected position from IEEE C37.100. In addition, the circuit breaker is fully extended on the cradle tray/rails or lifting device tray.

3.4 ELECTRONIC DEVICES – Includes active electrical components such as transistors, diodes and integrated circuits, and associated passive interconnection technologies as would typically be found on a printed circuit board.

CONSTRUCTION

4 General

4.1 General

4.1.1 Circuit breakers shall meet construction requirements specified herein for position indicators, ground connection, mechanical operations counter, and wiring.

4.1.2 A reliable, easily readable mechanical position indicator shall be furnished to indicate the open and closed positions of the circuit breaker. The word “open” in contrasting letters shall be displayed on a green background and the word “closed”, in contrasting letters, shall be displayed on a red background. On spring-charged mechanisms, the mechanism indicator shall display the word “charged,” in black letters on a yellow background and the word “discharged,” in black letters, on a white background.

4.1.3 Each circuit breaker shall be provided with facilities for automatically making a low resistance ground connection capable of carrying fault currents of the control circuits as the circuit breaker is inserted in the enclosure.

4.1.4 Each circuit breaker shall be equipped with a non-resetting operation counter. The counter should preferentially operate only during the opening operation of the circuit breaker.

4.1.5 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. This identification shall be the same as that shown on the circuit breaker elementary and wiring drawings.

4.1.6 Required accessories shall include auxiliary switches.

4.1.7 Required functional components shall include the power operated mechanism, shunt trip, mechanical operations counter, cell switch, racking position indicator, stored energy (springs charged) indicator, primary and secondary disconnects, manual trip, ground connection, and contact position (open/closed) indicator.

4.1.8 The following materials and coatings are non-preferred and shall be identified in the qualification and requalification reports:

- a) Navy-prohibited materials as defined by MIL-E-917 including estimated maximum weight per circuit breaker and per accessory or functional component.
- b) Insulating materials which contain halogens, e.g. chlorine, fluorine, and bromine, which evolve gases during combustion including estimated maximum weight per circuit breaker and per accessory or functional component.
- c) Corrosion-susceptible materials and coatings that are not in accordance with MIL-E-917 requirements.
- d) Organic materials not inherently fungus resistant or validated to be fungus resistant. Refer to MIL-HDBK-454, Guideline 4.
- e) Lead free solder.

4.1.9 All printed circuit boards shall be conformal coated.

4.1.10 Aluminum or aluminum alloy conductors or terminals shall not be used.

4.1.11 Minimum design creepage and clearance distances for primary conductors shall be identified in the qualification and requalification reports. Creepage and clearance distances for low voltage components that are not in accordance with MIL-E-917, Set C, and enclosed requirements shall be clearly identified as maintenance items in the qualification and requalification reports.

4.1.12 Circuit breakers shall be provided with construction suitable for overhead lifting using lifting yokes or other means.

4.1.13 Test enclosures shall meet the requirements of ANSI/NEMA C37.54.

4.1.14 Test lead holes shall have non-conductive plugs installed to ensure personnel safety and to prevent debris from entering the holes.

4.2 Drawout-mounted

4.2.1 Circuit breakers shall be drawout-mounted type to be used with stationary elements and/or switchgear interfaces.

4.2.2 Circuit breaker/cradle configurations shall be provided with connected, test, disconnected, and withdrawn positions as defined by IEEE C37.100 and/or Section 3 of this Outline. The connected, test, and disconnected positions shall be shown on the racking position indicator. If the disconnected and withdrawn positions are the same for a particular design, the manufacturer shall state this in the qualification and requalification reports.

RATINGS

5 General

5.1 Rated maximum voltage shall be greater than or equal to one of the values specified in Table 5.1.

Table 5.1
Voltage ratings based on rated maximum voltage

Rating type	Rating (minimum)		
Rated maximum voltage	4.76 kV rms	8.25 kV rms	15 kV rms
Nominal operating voltage	4.16 kV	7.2 kV	11 / 13.8 kV
Power frequency withstand voltage (minimum for one minute)	19 kV	36 kV	36 kV
Lightning impulse withstand voltage (BIL) minimum	60 kV	95 kV	95 kV

5.2 Rated frequency shall be 60 Hz.

5.3 Nominal operating voltage, power frequency withstand voltage, and lightning impulse withstand voltage (BIL) shall be greater than or equal to the values specified in Table 5.1 that correspond to the applicable rated maximum voltage.

5.4 Recommended frame sizes (maximum continuous current ratings) are shown in Table 5.2 of this specification.

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Table 5.2
Recommended frame sizes and associated rated maximum voltage/short-circuit ratings

Frame size (amps)	60 Hz Rated maximum voltage	60 Hz Short-circuit current rating O-0.3s-CO-3m-CO test sequence (rms symmetrical kA)	60 Hz Short-time current withstand duty rating for 2 second duration (rms symmetrical kA)
1600	15 kV	37 kA	37 kA
4000	4.76 kV	50 kA	50 kA

5.5 Short-circuit current rating as defined by IEEE C37.04 shall be stated by the manufacturer in rms symmetrical amperes. Circuit breakers shall be rated for one short-circuit operating sequence of O-0.3s-CO-3m-CO at levels greater than or equal to the applicable values specified in Table 5.2. Additional ratings associated with short-circuit current rating shall be in accordance with Table 5.3.

Table 5.3
Additional ratings associated with short-circuit current

Rating type	Requirement
1. Rated voltage range factor K	1.0
2. Rated interrupting time	Less than or equal to 3.0 cycles
3. Rated transient recovery voltage	As specified in IEEE C37.04, ANSI C37.06, and IEEE C37.09.
4. Rated close/latch current (kA peak)	2.6x rated short circuit current in kA rms
5. DC time constant	45 ms

5.6 Short-time current withstand duty rating as defined by IEEE C37.04 shall be stated by the manufacturer in rms symmetrical amperes. Short-time current duty ratings shall be greater than or equal to the applicable values specified in Table 5.2.

5.7 Rated load current switching capability shall be greater than or equal to rated continuous current root mean square (rms) amperes.

5.8 All circuit breakers shall have a rated standard operating duty of 10,000 close and open cycles: 2,000 electrical cycles at maximum continuous current rating and rated maximum voltage and 8,000 no-load mechanical cycles.

5.9 Recommended nominal operating voltages for accessories and applicable functional components are 120VAC and 125VDC. Accessories and functional components shall remain functional over their entire rated operating voltage range as stated by the manufacturer.

5.10 Frame sizes and associated ratings differing from values in Tables 5.2 and 5.3 shall be submitted to Naval Sea Systems Command (NAVSEA) Technical Warrant Holder (TWH) and TWH representative prior to the start of testing. NAVSEA TWH or TWH representative shall provide final approval of new circuit breaker characteristics prior to the start of testing.