

## SECTION 26 24 13

## SWITCHBOARDS

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2016a) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A240/A240M	(2020) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A653/A653M	(2020) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM D149	(2020) Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials
ASTM D1535	(2014; R 2018) Standard Practice for Specifying Color by the Munsell System

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 81	(2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2017; Errata 1-2 2017; INT 1 2017)

## National Electrical Safety Code

IEEE C57.12.28 (2014) Standard for Pad-Mounted Equipment  
- Enclosure Integrity

## INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS (2021) Standard for Acceptance Testing  
Specifications for Electrical Power  
Equipment and Systems

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA PB 2.1 (2013) General Instructions for Proper  
Handling, Installation, Operation and  
Maintenance of Deadfront Distribution  
Switchboards Rated 600 V or Less

NEMA ICS 6 (1993; R 2016) Industrial Control and  
Systems: Enclosures

NEMA PB 2 (2011) Deadfront Distribution Switchboards

NEMA ST 20 (2014) Dry-Type Transformers for General  
Applications

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA  
20-1; TIA 20-2; TIA 20-3; TIA 20-4)  
National Electrical Code

## UNDERWRITERS LABORATORIES (UL)

UL 467 (2013; Reprint Jun 2017) UL Standard for  
Safety Grounding and Bonding Equipment

UL 489 (2016) UL Standard for Safety Molded-Case  
Circuit Breakers, Molded-Case Switches and  
Circuit-Breaker Enclosures

UL 891 (2005; Reprint Oct 2012) Switchboards

## 1.2 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE 100.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Switchboard Drawings; G M

SD-03 Product Data

Switchboard; G M/R

SD-06 Test Reports

Switchboard Design Tests; G M

Switchboard Production Tests; G M

Acceptance Checks and Tests; G M

SD-07 Certificates

Cybersecurity Equipment Certification

Submit certification indicating conformance with the paragraph  
CYBERSECURITY EQUIPMENT CERTIFICATION.

Cybersecurity Installation Certification

Submit certification indicating conformance with the paragraph  
CYBERSECURITY INSTALLATION CERTIFICATION.

SD-10 Operation and Maintenance Data

Switchboard Operation and Maintenance, Data Package 5; G R

SD-11 Closeout Submittals

Assembled Operation and Maintenance Manuals; G M/R

Equipment Test Schedule; G M/R

Required Settings; G M/R

Service Entrance Available Fault Current Label; G M/R

NOTE:

M designates Middle East District to receive "G" submittals.

R designates Resident Office to receive "G" submittals.

M/R designates both offices to receive "G" submittals.

No designation implies "For Information Only".

1.4 QUALITY ASSURANCE

1.4.1 Product Data

Include manufacturer's information on each submittal for each component, device and accessory provided with the switchboard including:

- a. Circuit breaker type, interrupting rating, and trip devices, including available settings.
- b. Manufacturer's instruction manuals and published time-current curves (in electronic format) of the main secondary breaker and largest

secondary feeder device.

#### 1.4.2 Switchboard Drawings

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Identify circuit terminals on wiring diagrams and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Indicate on the drawings adequate clearance for operation, maintenance, and replacement of operating equipment devices. Include the nameplate data, size, and capacity on submittal. Also include applicable federal, military, industry, and technical society publication references on submittals. Include the following:

- a. One-line diagram including breakers.
- b. Outline drawings including front elevation, section views, footprint, and overall dimensions.
- c. Bus configuration including dimensions and ampere ratings of bus bars.
- d. Markings and NEMA nameplate data.
- e. Circuit breaker type, interrupting rating, and trip devices, including available settings.
- f. Wiring diagrams and elementary diagrams with terminals identified, and indicating prewired interconnections between items of equipment and the interconnection between the items.
- g. Manufacturer's instruction manuals and published time-current curves (in electronic format) of the main secondary breaker and largest secondary feeder device.

#### 1.4.3 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" or "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Provide equipment, materials, installation, and workmanship in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

#### 1.4.4 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship, and:

- a. Have been in satisfactory commercial or industrial use for 2 years prior to bid opening including applications of equipment and materials under similar circumstances and of similar size.
- b. Have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

- c. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

#### 1.4.4.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

#### 1.4.4.2 Material and Equipment Manufacturing Date

Products manufactured more than 1 year prior to date of delivery to site are not acceptable.

### 1.5 MAINTENANCE

#### 1.5.1 Switchboard Operation and Maintenance Data

Submit Operation and Maintenance Manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

#### 1.5.2 Assembled Operation and Maintenance Manuals

Assemble and securely bind manuals in durable, hard covered, water resistant binders. Assemble and index the manuals in the following order with a table of contents:

- a. Manufacturer's O&M information required by the paragraph SD-10, OPERATION AND MAINTENANCE DATA.
- b. Catalog data required by the paragraph SD-03, PRODUCT DATA.
- c. Drawings required by the paragraph SD-02, SHOP DRAWINGS.
- d. Prices for spare parts and supply list.
- e. Design test reports.
- f. Production test reports.

### 1.6 WARRANTY

Provide equipment items that are supported by service organizations reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

## PART 2 PRODUCTS

### 2.1 PRODUCT COORDINATION

Products and materials not considered to be switchboards and related accessories are specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION, and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

## 2.2 SWITCHBOARD

NEMA PB 2 and UL 891.

### 2.2.1 Ratings

Provide equipment with the following ratings:

- a. Voltage rating: as indicated.
- b. Continuous current rating of the main bus: as indicated.
- c. Short-circuit current rating: as indicated.
- d. UL listed and labeled.

### 2.2.2 Construction

Provide the following:

- a. Switchboard: consisting of one or more vertical sections bolted together to form a rigid assembly and rear aligned.
- b. All circuit breakers: front accessible.
- c. Rear aligned switchboards: front accessible load connections.
- d. Where indicated, "space for future" or "space" means to include a vertical bus provided behind a blank front cover. Where indicated, "provision for future" means full hardware provided to mount a breaker suitable for the location.
- e. Completely factory engineered and assembled, including protective devices and equipment indicated with necessary interconnections, instrumentation, and control wiring.

#### 2.2.2.1 Enclosure

Provide the following:

- a. Enclosure: NEMA ICS 6 Type 1.
- b. Enclosure: bolted together with removable bolt-on side and hinged rear covers, and sloping roof downward toward rear.
- c. Front doors: provided with padlockable vault handles with a three point catch.
- d. Bases, frames and channels of enclosure: corrosion resistant and fabricated of ASTM A240/A240M type 304 or 304L stainless steel or galvanized steel.
- e. Base: includes any part of enclosure that is within 75 mm of concrete pad.
- f. Galvanized steel: ASTM A123/A123M, ASTM A653/A653M G90 coating, and ASTM A153/A153M, as applicable. Galvanize after fabrication where practicable.

- g. Paint color: ASTM D1535 light gray No. 61 or No. 49 over rust inhibitor.
- h. Paint coating system: comply with IEEE C57.12.28 for galvanized steel.

#### 2.2.2.2 Bus Bars

Provide the following:

- a. Bus bars: copper with silver-plated contact surfaces.
  - (1) Phase bus bars: insulated with a tape wrap or insulating sleeve providing a minimum breakdown voltage of 16,000 volts per ASTM D149.
  - (2) Neutral bus: rated 100 percent of the main bus continuous current rating as indicated.
- b. Make bus connections and joints with hardened steel bolts.
- c. Main-bus (through bus): rated at the full ampacity of the main throughout the switchboard.
- d. Minimum 6.35 mm by 50.8 mm copper ground bus secured to each vertical section along the entire length of the switchboard.

#### 2.2.2.3 Main Section

Provide the main section consisting of a combination section with molded-case circuit breakers for the main and branch devices as indicated.

#### 2.2.2.4 Distribution Sections

Provide the distribution sections consisting of molded-case circuit breakers as indicated.

#### 2.2.3 Protective Device

Provide main and branch protective devices as indicated.

##### 2.2.3.1 Insulated-Case Breaker

Provide the following:

- a. UL 489. UL listed and labeled, 100 percent rated main breaker standard rated branch breakers, electrically operated, low voltage, insulated-case circuit breaker, with a short-circuit current rating as indicated.
- b. Breaker frame size: as indicated.
- c. Series rated circuit breakers are unacceptable.

##### 2.2.3.2 Molded-Case Circuit Breaker

Provide the following:

- a. UL 489. UL listed and labeled, standard rated branch breakers, manually operated, low voltage molded-case circuit breaker, with a short-circuit current rating as indicated.

- b. Breaker frame size: as indicated.
- c. Series rated circuit breakers are unacceptable.

#### 2.2.4 Electronic Trip Units

Equip main and distribution breakers as indicated with a solid-state tripping system consisting of three current sensors and a microprocessor-based trip unit that provides true rms sensing adjustable time-current circuit protection. Include the following:

- a. Current sensors ampere rating: as indicated.
- b. Trip unit ampere rating: as indicated.
- c. Ground fault protection: as indicated.
- d. Electronic trip units: provide additional features as indicated:
  - (1) Indicated Breakers: include long delay pick-up and time settings, and LED indication of cause of circuit breaker trip.
  - (2) Main breakers: include short delay pick-up and time settings and instantaneous settings.
  - (3) Distribution breakers: include short delay pick-up and time settings.
  - (4) Main Breakers: include a digital display for phase and ground current.
  - (5) Main Breakers: include a digital display for watts, vars, VA, kWh, kvarh, and kVAh.
  - (6) Main Breakers: include a digital display for phase voltage, and percent THD voltage and current.
  - (7) For electronic trip units that are rated for or can be adjusted to 1,200 amperes or higher, provide arc energy reduction capability with an energy-reducing maintenance switch with local status indicator.

#### 2.2.5 Heaters

Provide heaters in each switchboard section. Provide heaters of sufficient capacity to control moisture condensation in the section, 250 watts minimum, and controlled by a thermostat located in the section. Provide industrial type thermostat, high limit, to maintain sections within the range of 15 to 32 degrees C. Obtain supply voltage for the heaters from a control power transformer within the switchboard. If heater voltage is different than switchboard voltage, provide transformer rated to carry 125 percent of heater full load rating. Provide transformer with a 220 degrees C insulation system with a temperature rise not exceeding 115 degrees C and conforming to NEMA ST 20. Energize electric heaters in switchboard assemblies while the equipment is in storage or in place prior to being placed in service. Provide method for easy connection of heater to external power source. Provide temporary, reliable external power source if commercial power at rated voltage is not



available on site.

#### 2.2.6 Terminal Boards

Provide with engraved plastic terminal strips and screw type terminals for external wiring between components and for internal wiring between removable assemblies. Provide short-circuiting type terminal boards associated with current transformer. Terminate conductors for current transformers with ring-tongue lugs. Provide terminal board identification that is identical in similar units. Provide color coded external wiring that is color coded consistently for similar terminal boards.

#### 2.2.7 Wire Marking

Mark control and metering conductors at each end. Provide factory installed, white, plastic tubing, heat stamped with black block type letters on factory-installed wiring. On field-installed wiring, provide white, preprinted, polyvinyl chloride (PVC) sleeves, heat stamped with black block type letters. Provide a single letter or number on each sleeve, elliptically shaped to securely grip the wire, and keyed in such a manner to ensure alignment with adjacent sleeves. Provide specific wire markings using the appropriate combination of individual sleeves. Indicate on each wire marker the device or equipment, including specific terminal number to which the remote end of the wire is attached.

#### 2.3 MANUFACTURER'S NAMEPLATE

Provide a nameplate on each item of equipment bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent is not acceptable. This nameplate and method of attachment may be the manufacturer's standard if it contains the required information.

#### 2.4 FIELD FABRICATED NAMEPLATES

ASTM D709. Provide laminated plastic nameplates for each switchboard, equipment enclosure, relay, switch, and device; as specified in this section or as indicated on the drawings. Identify on each nameplate inscription the function and, when applicable, the position. Provide nameplates of melamine plastic, 3 mm thick, white with black center core. Provide matte finish surface. Provide square corners. Accurately align lettering and engrave into the core. Provide nameplates with minimum size of 25 by 65 mm. Provide lettering that is a minimum of 6.35 mm high normal block style.

#### 2.5 SOURCE QUALITY CONTROL

##### 2.5.1 Equipment Test Schedule

The Government reserves the right to witness tests. Provide equipment test schedules for tests to be performed at the manufacturer's test facility. Submit required test schedule and location, and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled date.

Provide the following as part of test equipment calibration:

- a. Provide a calibration program which assures that all applicable test

instruments are maintained within rated accuracy.

- b. Accuracy: Traceable to the National Institute of Standards and Technology.
- c. Instrument calibration frequency schedule: less than or equal to 12 months for both test floor instruments and leased specialty equipment.
- d. Dated calibration labels: visible on all test equipment.
- e. Calibrating standard: higher accuracy than that of the instrument tested.
- f. Keep up-to-date records that indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third party calibration, include the following:
  - (1) Maintain up-to-date instrument calibration instructions and procedures for each test instrument.
  - (2) Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

#### 2.5.2 Switchboard Design Tests

NEMA PB 2 and UL 891.

##### 2.5.2.1 Design Tests

Furnish documentation showing the results of design tests on a product of the same series and rating as that provided by this specification.

- a. Short-circuit current test.
- b. Enclosure tests.
- c. Dielectric test.

#### 2.5.3 Switchboard Production Tests

NEMA PB 2 and UL 891. Furnish reports which include results of production tests performed on the actual equipment for this project. These tests include:

- a. 60-hertz dielectric tests.
- b. Mechanical operation tests.
- c. Electrical operation and control wiring tests.
- d. Ground fault sensing equipment test.

#### 2.5.4 Cybersecurity Equipment Certification

Furnish a certification that control systems are designed and tested in accordance with DoD Instruction 8500.01, DoD Instruction 8510.01, and as required by individual Service Implementation Policy.

## 2.6 ARC FLASH WARNING LABEL

Provide warning label for switchboards. Locate this self-adhesive warning label on the outside of the enclosure warning of potential electrical arc flash hazards and appropriate PPE required. Provide label format as indicated.

## 2.7 SERVICE ENTRANCE AVAILABLE FAULT CURRENT LABEL

Provide label on exterior of switchboards used as service equipment listing the maximum available fault current at that location. Include on the label the date that the fault calculation was performed and the contact information for the organization that completed the calculation. Locate this self-adhesive warning label on the outside of the switchboard. Provide label format as indicated.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Conform to IEEE C2, NFPA 70, and to the requirements specified herein. Provide new equipment and materials unless indicated or specified otherwise.

## 3.2 GROUNDING

NFPA 70 and IEEE C2, except that grounds and grounding systems with a resistance to solid earth ground not exceeding 25 ohms.

### 3.2.1 Grounding Electrodes

Provide driven ground rods as specified. Connect ground conductors to the upper end of the ground rods by exothermic weld or compression connector. Provide compression connectors at equipment end of ground conductors.

### 3.2.2 Equipment Grounding

Provide bare copper cable not smaller than 120 mm<sup>2</sup> not less than 610 mm below grade connecting to the indicated ground rods. When work in addition to that indicated or specified is directed to obtain the specified ground resistance, the provision of the contract covering "Changes" applies.

### 3.2.3 Connections

Make joints in grounding conductors and loops by exothermic weld or compression connector.

### 3.2.4 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

## 3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect equipment furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

### 3.3.1 Switchboard

ANSI/NEMA PB 2.1.

### 3.3.2 Field Applied Painting

Where field painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.

### 3.3.3 Galvanizing Repair

Repair damage to galvanized coatings using ASTM A780/A780M, zinc rich paint, for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces that repair paint has been applied to.

### 3.3.4 Field Fabricated Nameplate Mounting

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

## 3.4 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

### 3.4.1 Exterior Location

Mount switchboard on concrete slab as follows:

- a. Unless otherwise indicated, provide the slab with dimensions at least 200 mm thick, reinforced with a 150 by 150 mm No. 6 mesh placed uniformly 100 mm from the top of the slab.
- b. Place slab on a 150 mm thick, well-compacted gravel base.
- c. Install slab such that the top of the concrete slab is approximately 100 mm above the finished grade.
- d. Provide edges above grade with 15 mm chamfer.
- e. Provide slab of adequate size to project at least 200 mm beyond the equipment.
- f. Provide conduit turnups and cable entrance space required by the equipment to be mounted.
- g. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant.
- h. Cut off and bush conduits 75 mm above slab surface.
- i. Provide concrete work as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

### 3.4.2 Interior Location

Mount switchboard on concrete slab as follows:

- a. Unless otherwise indicated, provide the slab with dimensions at least 100 mm thick.
- b. Install slab such that the top of the concrete slab is approximately 100 mm above the finished grade.
- c. Provide edges above grade with 15 mm chamfer.
- d. Provide slab of adequate size to project at least 200 mm beyond the equipment.
- e. Provide conduit turnups and cable entrance space required by the equipment to be mounted.
- f. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant.
- g. Cut off and bush conduits 75 mm above slab surface.
- h. Provide concrete work as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

### 3.5 FIELD QUALITY CONTROL

Submit Required Settings of breakers to the Contracting Officer after approval of switchboard and at least 30 days in advance of their requirement.

#### 3.5.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

##### 3.5.1.1 Switchboard Assemblies

- a. Visual and Mechanical Inspection
  - (1) Compare equipment nameplate data with specifications and approved shop drawings.
  - (2) Inspect physical, electrical, and mechanical condition.
  - (3) Verify appropriate anchorage, required area clearances, and correct alignment.
  - (4) Clean switchboard and verify shipping bracing, loose parts, and documentation shipped inside cubicles have been removed.
  - (5) Inspect all doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.
  - (6) Verify that circuit breaker sizes and types correspond to approved shop drawings as well as to the circuit breaker's address for microprocessor-communication packages.
  - (7) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method,

or performing thermographic survey.

- (8) Confirm correct operation and sequencing of electrical and mechanical interlock systems.
- (9) Confirm correct application of manufacturer's recommended lubricants.
- (10) Inspect insulators for evidence of physical damage or contaminated surfaces.
- (11) Verify correct barrier installation.
- (12) Exercise all active components.
- (13) Inspect all mechanical indicating devices for correct operation.
- (14) Verify that filters are in place and vents are clear.
- (15) Test operation, alignment, and penetration of instrument transformer withdrawal disconnects.
- (16) Inspect control power transformers.

b. Electrical Tests

- (1) Perform insulation-resistance tests on each bus section.
- (2) Perform dielectric withstand voltage tests.
- (3) Perform insulation-resistance test on control wiring; Do not perform this test on wiring connected to solid-state components.
- (4) Perform control wiring performance test.
- (5) Perform primary current injection tests on the entire current circuit in each section of assembly.
- (6) Perform phasing check on double-ended switchboard to ensure correct bus phasing from each source.
- (7) Verify operation of switchboard heaters.

3.5.1.2 Circuit Breakers

Low Voltage - Insulated-Case and Low Voltage Molded Case with Solid State Trips

a. Visual and Mechanical Inspection

- (1) Compare nameplate data with specifications and approved shop drawings.
- (2) Inspect circuit breaker for correct mounting.
- (3) Operate circuit breaker to ensure smooth operation.
- (4) Inspect case for cracks or other defects.

(5) Inspect all bolted electrical connections for high resistance using low resistance ohmmeter, verifying tightness of accessible bolted connections and/or cable connections by calibrated torque-wrench method, or performing thermographic survey.

(6) Inspect mechanism contacts and arc chutes in unsealed units.

b. Electrical Tests

(1) Perform contact-resistance tests.

(2) Perform insulation-resistance tests.

(3) Perform Breaker adjustments for final settings in accordance with Government provided settings.

(4) Perform long-time delay time-current characteristic tests

(5) Determine short-time pickup and delay by primary current injection.

(6) Determine ground-fault pickup and time delay by primary current injection.

(7) Determine instantaneous pickup current by primary injection.

(8) Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and anti-pump function.

3.5.1.3 Grounding System

a. Visual and Mechanical Inspection

(1) Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

(1) IEEE 81. Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground resistance tester in accordance with manufacturer's instructions to test each ground or group of grounds. Use an instrument equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

(2) Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

3.5.1.4 Cybersecurity Installation Certification

Furnish a certification that control systems are installed in accordance

with DoD Instruction 8500.01, DoD Instruction 8510.01, and as required by individual Service Implementation Policy.

### 3.5.2 Follow-Up Verification

Upon completion of acceptance checks, settings, and tests, show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. Trip circuit breakers by operation of each protective device. Test each item to perform its function not less than three times. As an exception to requirements stated elsewhere in the contract, provide the Contracting Officer 5 working days advance notice of the dates and times for checks, settings, and tests.

-- End of Section --