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USACE / NAVFAC / AFCEC / NASA **UFGS-26 23 00.00 40 (February 2011)**

Preparing Activity: NASA **Superseding UFGS-26 23 00.00 40 (August 2010)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2014
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DIVISION 26 - ELECTRICAL

SECTION 26 23 00.00 40

SWITCHBOARDS AND SWITCHGEAR

02/11

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SECTION 26 23 00.00 40

SWITCHBOARDS AND SWITCHGEAR
02/11

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NOTE: This guide specification covers the requirements for free standing deadfront switchboard assemblies rated 6000 amperes or less, 600 volts or less, and metal-enclosed low-voltage power circuit-breaker switchgear assemblies in either interior or exterior locations. Rename the section appropriately if this section is used to specify only switchboards or only switchgear. Use Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, for power and distribution panelboards rated 1200 amperes or less and consisting of only group mounted stationary molded case circuit breakers and fusible or nonfusible switches designed to be placed in a cabinet or cutout box.

When the proposed switchboard or switchgear is connected to a secondary unit substation, coordinate with Section 26 11 16 SECONDARY UNIT SUBSTATIONS.

This guide specification is not intended to be used for generator control switchboards without extensive modification and coordination with applicable diesel engine-generator guide specifications.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
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NOTE: The following information should be indicated on the project drawings or specified in the project specifications:

1. Single-line diagram showing buses and interrupting devices with interrupting capacities; current transformers with ratings; instruments and meters required; and description of instruments and meters.

2. Location, space available, arrangement, and elevations of switchboards or switchgear.

3. Grounding plan.

4. Type and number of cables, size of conductors for each power circuit, and point of entry (top or bottom).

5. Special conditions, such as altitude, temperature and humidity, exposure to fumes, vapors, dust, and gases; and seismic requirements.
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PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
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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.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.15 (1990) Solid-State Demand Registers for Electromechanical Watthour Meters

ANSI C39.1	(1981; R 1992) Requirements for Electrical Analog Indicating Instruments

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2013) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A167	(1999; R 2009) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A653/A653M	(2013) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780/A780M	(2009) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM B187/B187M	(2011) Standard Specification for Copper, Bus Bar, Rod and Shapes and General Purpose Rod, Bar and Shapes
ASTM B317/B317M	(2007) Standard Specification for Aluminum-Alloy Extruded Bar, Rod, Tube, Pipe, and Structural Profiles for Electrical Purposes (Bus Conductor)
ASTM D149	(2009; R 2013) Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
ASTM D1535	(2013) Specifying Color by the Munsell System
ASTM D709	(2013) Laminated Thermosetting Materials

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 C12.16	(1991) Solid-State Electricity Meters
IEEE C2	(2012; Errata 2012; INT 1-4 2012; INT 5-7 2013) National Electrical Safety Code
IEEE C37.13	(2008; INT 1 2009; AMD 1 2012) Standard

	for Low-Voltage AC Power Circuit Breakers Used in Enclosures
IEEE C37.20.1	(2002; INT 1 2005; AMD A 2005; AMD B 2006; R 2007) Standard for Metal-Enclosed Low-Voltage Power Circuit-Breaker Switchgear
IEEE C37.90.1	(2012) Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
IEEE C57.12.01	(2005) General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid-Cast and/or Resin-Encapsulated Windings
IEEE C57.12.28	(2005; INT 3 2011) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.12.29	(2005) Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments
IEEE C57.13	(2008; INT 2009) Standard Requirements for Instrument Transformers
IEEE Stds Dictionary	(2009) IEEE Standards Dictionary: Glossary of Terms & Definitions

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2013) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

RCBEA GUIDE	(2004) NASA Reliability Centered Building and Equipment Acceptance Guide

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C12.1	(2008) Electric Meters Code for Electricity Metering
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 C12.4	(1984; R 2011) Registers - Mechanical Demand
NEMA ICS 6	(1993; R 2011) Enclosures
NEMA LI 1	(1998; R 2011) Industrial Laminating Thermosetting Products

NEMA PB 2	(2011) Deadfront Distribution Switchboards
NEMA/ANSI C12.10	(2011) Physical Aspects of Watthour Meters - Safety Standards

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1558	(1999; Reprint Apr 2010) Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear
UL 198M	(2003; Reprint Feb 2013) Standard for Mine-Duty Fuses
UL 467	(2007) Grounding and Bonding Equipment
UL 489	(2013) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 512	(1993; R 1993 thru 2008) Standard for Fuseholders
UL 891	(2005; Reprint Oct 2012) Switchboards

1.2 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section, with the additions and modifications specified herein.

1.3 DEFINITIONS

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

1.4 SUBMITTALS

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NOTE: Choose between switchboards and switchgear in brackets throughout this specification. Modify appropriately if both are used in a job.
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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project.

The Guide Specification technical editors have designated those items that require Government

approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

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Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][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][Switchgear] Drawings[; G][; G, [_____]]

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. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Indicate within the drawings adequate clearance for operation, maintenance, and replacement of operating equipment devices. Include submittals for the nameplate data, size, and capacity. Also include submittals for applicable federal, military, industry, and technical society publication references.

SD-03 Product Data

[Switchboard][Switchgear][; G][; G, [_____]]

SD-06 Test Reports

[Switchboard][Switchgear] Design Tests[; G][; G, [_____]]

[Switchboard][Switchgear] Production Tests[; G][; G, [_____]]

Acceptance Checks And Tests[; G][; G, [_____]]

SD-10 Operation and Maintenance Data

[Switchboard][Switchgear] Operation and Maintenance, Data Package 5[; G][; G, [_____]]

SD-11 Closeout Submittals

Assembled Operation and Maintenance Manuals[; G][; G, [_____]]

Equipment Test Schedule[; G][; G, [_____]]

Request for Settings[; G][; G, [_____]]

1.5 QUALITY ASSURANCE

1.5.1 Predictive Testing And Inspection Technology Requirements

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NOTE: The Predictive Testing and Inspection (PT&I) tests prescribed in section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS are MANDATORY for all [NASA] [_____] assets and systems identified as Critical, Configured, or Mission Essential. If the system is non-critical, non-configured, and not mission essential, use sound engineering discretion to assess the value of adding these additional test and acceptance requirements. See Section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS for additional information regarding cost feasibility of PT&I.
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This section contains systems and/or equipment components regulated by NASA's Reliability Centered Building and Equipment Acceptance Program. This program requires the use of Predictive Testing and Inspection (PT&I) technologies in conformance with RCBEA GUIDE to ensure building equipment and systems installed by the Contractor have been installed properly and contain no identifiable defects that shorten the design life of a system and/or its components. Satisfactory completion of all acceptance requirements is required to obtain Government approval and acceptance of the Contractor's work.

Perform PT&I tests and provide submittals as specified in Section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS.

1.5.2 [Switchboard][Switchgear] Product Data

Each submittal shall include manufacturer's information for each component, device and accessory provided with the [switchboard][switchgear] including:

a. Circuit breaker type, interrupting rating, and trip devices, including available settings

b. Manufacturer's instruction manuals and published time-current curves (on full size logarithmic paper) of the main secondary breaker and largest secondary feeder device.

1.5.3 [Switchboard][Switchgear] Drawings

Drawings shall include, but are not limited to the following:

a. One-line diagram including breakers[, fuses][, current transformers, and meters]

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[, including fuse information (manufacturer's name, catalog number, and ratings)]

e. Circuit breaker type, interrupting rating, and trip devices, including available settings

f. Three-line diagrams and elementary diagrams and wiring 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 (on full size logarithmic paper) of the main secondary breaker and largest secondary feeder device. These shall be used by the designer of record to provide breaker settings that will ensure protection and coordination are achieved.

[h. Provisions for future extension.

]1.5.4 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" 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. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.5.5 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. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be 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.

1.5.5.1 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.

1.5.5.2 Material and Equipment Manufacturing Date

Do not use products manufactured more than 3 years prior to date of delivery to site, unless specified otherwise.

1.6 MAINTENANCE

1.6.1 [Switchboard][Switchgear] Operation and Maintenance Data

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

1.6.2 Assembled Operation and Maintenance Manuals

Assemble and bind manuals securely in durable, hard covered, water resistant binders. Assemble and index the manuals in the following order with a table of contents. The contents of the assembled operation and maintenance manuals shall be as follows:

a. Manufacturer's O&M information required by the paragraph entitled "SD-10, Operation and Maintenance Data".

b. Catalog data required by the paragraph entitled, "SD-03, Product Data".

c. Drawings required by the paragraph entitled, "SD-02, Shop Drawings".

d. Prices for spare parts and supply list.

[e. Information on metering]

f. Design test reports

g. Production test reports

1.6.3 [Spare Parts

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NOTE: Spare parts are specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA for Navy projects. Do not use this paragraph for Navy projects.

Edit as required if additional spare parts are required for a specific project.
****

Furnish spare parts as specified below. All spare parts shall be of the same material and workmanship, shall meet the same requirements, and shall be interchangeable with the corresponding original parts furnished.

a. 2 - Fuses of each type and size.

[b. [_____]]

]1.7 WARRANTY

The equipment items shall be supported by service organizations which are

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

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NOTE: For Army projects, refer to Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION; typical throughout this specification.
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NOTE: When project is designated to be designed to Antiterrorism Construction Standards, the electrical design must address limiting critical infrastructure damage. If project scope does not address special (Switchboard) (Switchgear) requirements, designer should check with Project Manager to see if, as a minimum, Seismic Zone 1 criteria should be incorporated.
****

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

2.2 [SWITCHBOARD][SWITCHGEAR]

[NEMA PB 2 and UL 891][IEEE C37.20.1 and UL 1558].

2.2.1 Ratings

The voltage rating of the [switchboard][switchgear] shall be [480Y/277][208Y/120][125][_____] volts [AC][DC], [2][3][4]-wire [[single][3] phase][as indicated]. The continuous current rating of the main bus shall be [[_____] amperes][as indicated]. The short-circuit current rating shall be [[_____] rms symmetrical amperes][as indicated]. The [switchboard][switchgear] shall be UL listed and labeled[for its intended use][as service entrance equipment].

2.2.2 Construction

****
NOTES: The switchboard specified below is not intended for applications where the available fault current is above 65,000 amps. Where drawout-type breakers, and high short circuit current ratings are desired, UFGS Section 26 22 00.00 10 480-VOLT STATION SERVICE SWITCHGEAR AND TRANSFORMERS should be used.

The short-circuit current rating assigned to the switchboard shall be in accordance with NEMA PB 2.
****

[The switchboards shall be dead-front switchboards conforming to NEMA PB 2 and labeled under UL 891. The switchboards shall be completely enclosed self-supporting metal structures with the required number of vertical panel sections, buses, molded-case circuit breakers, [and other devices] as shown on the drawings. Switchboards shall be fully rated for a short-circuit current of [14,000] [22,000] [65,000] [_____] symmetrical amperes RMS AC.

] [Switchboard][Switchgear] shall consist of vertical sections bolted together to form a rigid assembly and shall be [rear][front and rear] aligned[as indicated]. All circuit breakers are to be front accessible.[Rear aligned switchboards are to have front accessible load connections.][Front and rear aligned switchboards are to have rear accessible load connections.][Compartmentalized [switchboards][switchgear] shall have vertical insulating barriers between the front device section, the main bus section, and the cable compartment[with full front to rear vertical insulating barriers between adjacent sections].] Where indicated, "space for future" or "space" shall mean to include bus, device supports, and connections. Provide insulating barriers in accordance with NEMA LI 1, Type GPO-3, 6.35 mm (0.25 inch) 0.25 inch minimum thickness. Apply moisture resistant coating to all rough-cut edges of barriers. Switchboard shall be completely factory engineered and assembled, including protective devices and equipment indicated with necessary interconnections, instrumentation, and control wiring.

2.2.2.1 Enclosure

****

NOTE: Choose the level of corrosion protection required for the specific project location. Use galvanized steel in most indoor applications. Use stainless steel bases for most outdoor applications. In less corrosive environments, galvanized steel can be included as an alternative to stainless steel. Manufacturer's standard construction material is acceptable only in noncoastal and noncorrosive environments.

In last sentence use IEEE C57.12.28 for galvanized enclosures. Use IEEE C57.12.29 for stainless steel enclosures.

****

The [switchboard][switchgear] enclosure shall be a[outdoor] NEMA ICS 6 Type [3R][1][_____][as indicated][fabricated entirely of 12 gauge ASTM A167 type 304 or 304L stainless steel]. Enclosure shall be bolted together with removable bolt-on side and[hinged] rear covers[, and sloping roof downward toward rear].[Front[and rear] doors shall be provided with[stainless steel] padlockable vault handles with a three point catch.] Bases, frames and channels of enclosure shall be corrosion resistant and shall be fabricated of[ASTM A167 type 304 or 304L stainless steel][or][galvanized steel]. Base shall include any part of enclosure that is within 75 mm 3 inches of concrete pad.[Galvanized steel shall be ASTM A123/A123M, ASTM A653/A653M G90 coating, and ASTM A153/A153M, as applicable. Galvanize after fabrication where practicable.] Paint enclosure, including bases, ASTM D1535 light gray No. 61 or No. 49. Paint coating system shall comply with[IEEE C57.12.28 for galvanized steel][and][IEEE C57.12.29 for stainless steel].

****

NOTE: Mounting sills should be included for all new construction to provide structural integrity. NEMA PB2 90" height includes these sills.

****

[Each switchboard enclosure shall be NEMA type [2] [3R], built with selected smooth sheet steel panels of not less than 1.9 mm No. 14 gage. Exposed panels on the front and ends shall have bent angle or channel edges with all corner seams welded and ground smooth. The front outside surfaces shall not be drilled or welded for the purpose of attaching wires or mounting devices if such holes or fastenings will be visible from the front. The front panels shall be made in sections flanged on four sides and attached to the framework by screws and arranged for ready removal for inspection or maintenance. [Rear access to the bus and device connections shall be provided.] Ventilating openings shall be provided as required and shall preferably be of the grille type. All ventilating openings shall be provided with corrosion-resistant insect-proof screens on the inside. [Each switchboard shall be provided with a channel iron base at front, rear, and sides, with exposed ends covered by welded steel plates. Grout holes shall be provided. Bolt the switchboard sections to the base.] [Mount switchboards as shown on the drawings and furnish mounting materials as indicated.] Treat all interior and exterior steel parts to inhibit corrosion and paint.

]2.2.2.2 Bus Bars

****

NOTE: Use copper with silver-plated contact surfaces in exterior or damp locations or for heavy motor loads.

Only choose the bracketed option requiring epoxy coating on the bus bars for outdoor locations with a high concentration of airborne contaminants. Choose this option primarily for outdoor waterfront or dirty industrial applications.

****

[Bus bars shall be[copper with silver-plated contact surfaces][or][aluminum with tin-plated contact surfaces]. Plating shall be a minimum of 0.005 mm 0.0002 inch thick. Make bus connections and joints with hardened steel bolts. The through-bus shall be rated at the full ampacity of the main throughout the switchboard. Provide minimum 6.35 mm by 50.8 mm one-quarter by 2 inch copper ground bus secured to each vertical section along the entire length of the [switchboard][switchgear]. The neutral bus shall be rated [100][_____] percent of the main bus continuous current rating[as indicated].[Phase bus bars shall be insulated with an epoxy finish coating powder providing a minimum breakdown voltage of 16,000 volts per ASTM D149.]

]

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NOTE: When either copper or aluminum bus is allowed the manufacturers will generally provide the less expensive aluminum. Use ASTM 317 when aluminum bus is permitted. Silver plating allows for a greater temperature rise on the bus.

****

[All buses shall be of copper [or aluminum] and [all bolted splices and connections between buses and for extensions or taps for equipment] shall be tin or silver-plated [throughout]. Copper [or aluminum] bars and shapes for bus conductors shall conform to the applicable requirements of ASTM B187/B187M [, and ASTM B317/B317M]. All splices for field assembly shall be bolted with at least two bolts and shall employ the use of "Belleville" washers in the connection. Horizontal and vertical power buses have minimum current ratings as shown on the drawings. The buses shall be insulated for not less than 600 volts. Shop splices and tap connections shall be brazed, pressure-welded or bolted. All splices for field assembly shall be bolted. Mount the buses on insulating supports of wet process porcelain, glass polyester, or suitable molded material, and brace to withstand not less than [14,000] [22,000] [65,000] [_____] symmetrical amperes ac. A copper [or aluminum] ground bus, rated not less than 300 amps, extending the entire length of the assembled structure, shall be mounted near the bottom of enclosure. A full clamp-type solderless copper or copper alloy lug for No. 2/0 AWG stranded copper cable shall be provided at each end of the bus for connection to the station grounding system.

]2.2.2.3 Main Section

The main section shall consist of[main lugs only][an individually mounted[drawout][air power circuit breaker[with current-limiting fuses]][insulated-case circuit breaker][molded-case circuit breaker][bolted pressure switch][fusible switch]][and utility transformer compartment].

2.2.2.4 Distribution Sections

The distribution section[s] shall consist of[[individually mounted,][drawout,]][air power circuit breakers[with current-limiting fuses]][insulated-case circuit breakers][molded-case circuit breakers][bolted pressure switches][fusible switches][and utility transformer compartments] as indicated.

[2.2.2.5 Combination Sections

Combination sections shall consist of[molded-case circuit breakers][fusible switches] for the[main and] branch devices as indicated.

][2.2.2.6 Auxiliary Sections

Auxiliary sections shall consist of indicated[instruments,][metering equipment,][control equipment,][transformer,][and][current transformer compartments] as indicated.

][2.2.2.7 Handles

Handles for individually mounted devices shall be of the same design and method of external operation. Label handles prominently to indicate device ampere rating, color coded for device type. Identify ON-OFF indication by handle position and by prominent marking.

]2.2.3 Protective Device

****

NOTE: Switchboard should be placed where the ambient temperature is less than 40 deg. C.

However, should the ambient temperature be expected to exceed 40 Deg. C, the designer shall call for special calibration for the circuit breakers.

Provide ground fault protection of equipment for solidly grounded wye electrical services of more than 150 volts to ground for each service disconnect rated 1000 amperes or more in accordance with NFPA 70.

If 48 Vdc or 125 Vdc electrically operated circuit breakers are required, the appropriate DC control power supply information must be added to the specification. Reference information can be obtained from Section 26 11 13.00 20 PRIMARY UNIT SUBSTATION.

****

Provide[main and] branch protective devices as indicated.

[2.2.3.1 Power Circuit Breaker

IEEE C37.13. [120 Vac][electrically][manually] operated [stationary][drawout], [unfused][fused],[steel frame,] low-voltage power circuit breaker with a short-circuit current rating[of [_____] rms amperes symmetrical][as indicated] at [_____] volts. Breaker frame size shall be[as indicated][[_____] amperes].[Equip electrically operated breakers with motor-charged, stored-energy closing mechanism to permit rapid and safe closing of the breaker against fault currents within the short time rating of the breaker, independent of the operator's strength or effort in closing the handle.]

][2.2.3.2 Insulated-Case Breaker

UL listed, 100 percent rated,[stationary][drawout],[120 Vac],[electrically] [manually] operated, low voltage, insulated-case circuit breaker, with a short-circuit current rating[of [_____] rms symmetrical amperes][as indicated] at [_____] volts. Breaker frame size is to be[[_____] amperes][as indicated].[Equip electrically operated breaker with motor-charged, stored-energy closing mechanism to permit rapid and safe closing of the breaker against fault currents within the short time rating of the breaker, independent of the operator's strength or effort in closing the handle.]

][2.2.3.3 Molded-Case Circuit Breaker

UL 489. UL listed and labeled, 100 percent rated,[stationary][drawout],[120 Vac],[electrically][manually] operated, low voltage molded-case circuit breaker, with a short-circuit current rating of[[_____] rms symmetrical amperes][as indicated] at [_____] volts. Breaker frame size is to be[[_____] amperes][as indicated]. Series rated circuit breakers are unacceptable.

[Equip each switchboard with molded-case circuit breakers with trip ratings and terminal connectors for attachment of outgoing power cables as shown on the drawings. The circuit breakers shall be operable and removable from the front. Where shown on the drawings, enclose circuit breakers in individual compartments.

]][2.2.3.4 Fusible Switches

Fusible Switches: Quick-make, quick-break, hinged-door type.[Switches serving as motor disconnects shall be horsepower rated.] Fuses shall be current-limiting cartridge type conforming to[UL 198M, Class J for 0 to 600 amperes and Class L for 601 to 6000 amperes][UL 198M, Class [RK1][RK5] for 0 to 600 amperes].

Fuseholders: UL 512.

][2.2.3.5 Integral Combination Breaker and Current-Limiting Fuses

UL 489. Provide integral combination molded-case circuit breaker and current-limiting fuses[as indicated][rated [_____] amperes] with a minimum short-circuit-current rating equal to the short-circuit-current rating of the [switchboard][switchgear] in which the circuit breaker will be mounted. Series rated circuit breakers are unacceptable. Coordination of overcurrent devices of the circuit breaker and current-limiting fuses shall be such that on overloads or fault currents of relatively low value, the overcurrent device of the breaker will be operated to clear the fault. For high magnitude short circuits above a predetermined value[crossover point], the current-limiting fuses shall operate to clear the fault. Housing for the current-limiting fuses shall be an individual molding readily removable from the front and located at the load side of the circuit breaker. If the fuse housing is removed, a blown fuse shall be readily evident by means of a visible indicator. Removal of fuse housing shall cause the breaker contacts to open, and it shall not be possible to close the breaker contacts with the fuse housing removed. It shall not be possible to insert the fuse housing with a blown fuse or with one fuse missing. The blowing of any of the fuses shall cause the circuit breaker contacts to open.

][2.2.4 Drawout Breakers

Equip drawout breakers with disconnecting contacts, wheels, and interlocks for drawout application. The main, auxiliary, and control disconnecting contacts are to be silver-plated, multifinger, positive pressure, self-aligning type. Provide each drawout breaker with four-position operation. Clearly identify each position by an indicator on the circuit breaker front panel.

a. Connected Position: Primary and secondary contacts are fully engaged. Breaker must be tripped before racking into or out of position.

b. Test Position: Primary contacts are disconnected but secondary contacts remain fully engaged. Position shall allow complete test and operation of the breaker without energizing the primary circuit.

c. Disconnected Position: Primary and secondary contacts are disconnected.

d. Withdrawn (Removed) Position: Places breaker completely out of compartment, ready for removal. Removal of the breaker shall actuate assembly that isolates the primary stabs.

][2.2.5 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 will provide true rms sensing

adjustable time-current circuit protection. The ampere rating of the current sensors are to be[as indicated][[_____] amperes][the same as the breaker frame rating]. The trip unit ampere rating shall be[as indicated][[_____] amperes].[Ground fault protection shall be[as indicated][zero sequence sensing][residual type sensing].][The electronic trip units shall have the following features[as indicated].]

****

NOTE: In the items below, choose the bracketed item "main" when the item only applies to the main breaker.

Provide ground fault protection of equipment for solidly grounded wye electrical services of more than 150 volts to ground for each service disconnect rated 1000 amperes or more in accordance with NFPA 70.

****

[a. [Indicated]Breakers shall have long delay pick-up and time settings, and LED indication of cause of circuit breaker trip.

][b. Main breakers shall have[short delay pick-up and time settings][and][, instantaneous settings][and][ground fault settings][as indicated].

][c. Distribution breakers shall have[short delay pick-up and time settings][, instantaneous settings][, and ground fault settings][as indicated].

][d. [Main]Breakers shall have a digital display for phase and ground current.

][e. [Main]Breakers shall have a digital display for watts, vars, VA, kWh, kvarh, and kVAh.

][f. [Main]Breakers shall have a digital display for phase voltage, and percent THD voltage and current.

][g. [Main]Breakers shall have provisions for communication via a network twisted pair cable for remote monitoring and control.

]][2.2.6 Electronic Trip Unit Central Monitor

Provide a microprocessor-based device designed to monitor and display parameters of the circuit breaker electronic trip units. The central monitor shall have the following features:

a. Alphanumeric display.

b. Indication of circuit breaker status; tripped, open, closed.

c. Cause of circuit breaker trip.

d. Phase, neutral, and ground current for each breaker.

e. Energy parameters for each breaker.

f. Provisions for communicating directly to a remote computer.

][2.2.7 Instruments

ANSI C39.1 for electrical indicating switchboard instruments, with 2 percent accuracy. The ac ammeters and voltmeters shall be a minimum of 50.8 mm square 2 inches square, with 4.36 rad 250-degree scale. Provide single phase indicating instruments with flush-mounted transfer switches for reading three phases.

[2.2.7.1 Ac Ammeters

[Self-contained,][Transformer rated, 5-ampere input, for use with a [_____] to 5-ampere current transformer ratio,]0 to [_____]-ampere scale range, 60 hertz.

][2.2.7.2 Ac Voltmeters

Self-contained.

][2.2.7.3 Instrument Control Switches

Provide rotary cam-operated type with positive means of indicating contact positions. Switches shall have silver-to-silver contacts enclosed in a protective cover which can be removed to inspect the contacts.

]][2.2.8 Watthour and Digital Meters

****
NOTE: When Section 23 09 23.13 20 BACnet DIRECT DIGITAL CONTROL SYSTEM FOR HVAC or Section 23 09 23 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS is used, coordinate meter requirements. Form 9S, in text below, is for three-phase, four-wire wye systems, for other system configurations, designer shall determine the appropriate form designation.
****

[2.2.8.1 Digital Meters

****
NOTE: Digital metering incorporates the latest technology and provides additional information, often without additional cost. A control power transformer (115 V or 130 V) is normally required with this type of metering.
****

IEEE C37.90.1 for surge withstand. Provide true rms, plus/minus one percent accuracy, programmable, microprocessor-based meter enclosed in sealed cases with a simultaneous three line, twelve value LED display. Meters shall have 16 mm) 0.56 inch, minimum, LEDs.[Watthour meter shall have 16 mm 0.56 inch, minimum, LEDs.] The meters shall accept[input from standard 5A secondary instrument transformers][and][direct voltage monitoring range to [300][600] volts, phase to phase]. Programming shall be via a front panel display and a communication interface with a computer. Password secured programming shall be stored in non-volatile EEPROM memory. Digital communications shall be Modbus [ASCII][RTU] protocol via a [RS232C][RS485] serial port[and an independently

addressable [RS232C][RS485] serial port]. The meter shall calculate and store average max/min demand values for all readings based on a user selectable sliding window averaging period. The meter shall have programmable hi/low set limits with two Form C dry contact relays when exceeding alarm conditions.[Meter shall provide Total Harmonic Distortion (THD) measurement to the thirty-first order.][Historical trend logging capability shall include ability to store up to 100,000 data points with intervals of 1 second to 180 minutes. The unit shall also store and time stamp up to 100 programmable triggered conditions.][Event waveform recording shall be triggered by the rms of 2 cycles of voltage or current exceeding programmable set points. Waveforms shall be stored for all 6 channels of voltage and current for a minimum of 10 cycles prior to the event and 50 cycles past the event.]

[a. Multi-Function Meter: Meter shall simultaneously display a selected phase to neutral voltage, phase to phase voltage, percent phase to neutral voltage THD, percent phase to phase voltage THD; a selected phase current, neutral current, percent phase current THD, percent neutral current; selected total PF, kW, KVA, kVAR, FREQ, kVAh, kWh. Detected alarm conditions include over/under current, over/under voltage, over/under KVA, over/under frequency, over/under selected PF/kVAR, voltage phase reversal, voltage imbalance, reverse power, over percent THD. The meter shall have a Form C KYZ pulse output relay.

][b. Power Meter: Meter shall simultaneously display Watts, VARs, and selected KVA/PF. Detected alarm conditions include over/under KVA, over/under PF, over/under VARs, over/under reverse power.

][c. Volt Meter: Meter shall be selectable between simultaneous display of the three phases of phase to neutral voltages and simultaneous display of the three phases of the phase to phase voltages. Detected alarm conditions include over/under voltage, over/under voltage imbalance, over percent THD.

][d. Ammeter: Meter shall simultaneously display phase A, B, and C currents. Detected alarm conditions include over/under current, over percent THD.

][e. Digital Watthour Meter: Meter shall have a single selectable display for watts, total kilowatt hours (kWh) and watt demand (Wd). The meter shall have a Form C KYZ pulse output relay.

]][2.2.8.2 Electronic Watthour Meter

Provide a switchboard style electronic programmable watthour meter, semi-drawout, semi-flush mounted, as indicated. Meter shall either be programmed at the factory or shall be programmed in the field. When field programming is performed, turn field programming device over to the Contracting Officer at completion of project. Meter shall be coordinated to system requirements and conform to IEEE C12.16.

a. Design: Provide meter designed for use on a 3-phase, 4-wire, [208Y/120][480Y/277] volt system with 3 current transformers. Include necessary KYZ pulse initiation hardware for Energy Monitoring and Control System (EMCS)[as specified in[Section 23 09 23 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS]].

b. Coordination: Provide meter coordinated with ratios of current transformers and transformer secondary voltage.

c. Class: 20. Form: [9S][___]. Accuracy: plus/minus 1.0 percent. Finish: Class II.

d. Kilowatt-hour Register: 5 digit electronic programmable type.

e. Demand Register:

(1) Provide solid state ANSI C12.15.

(2) Meter reading multiplier: Indicate multiplier on the meter face.

(3) Demand interval length: shall be programmed for [15][30][60] minutes with rolling demand up to six subintervals per interval.

f. Meter fusing: Provide a fuse block mounted in the metering compartment containing one fuse per phase to protect the voltage input to the watthour meter. Size fuses as recommended by the meter manufacturer.

][2.2.8.3 Electro-Mechanical Watthour Meters

****
NOTE: On standard projects, use of the electronic meter versus the optional electromechanical meter is recommended due to decreasing availability of electromechanical meters.
****

NEMA/ANSI C12.10. Kilowatt-hour meters shall be[two][three][four]-stator, transformer rated, polyphase, 60 hertz,[surface][semiflush] mounted,[drawout][semidrawout] switchboard meters[120 volt for use on a four-wire wye, three phase, 208Y/120 volt system][240 volt for use on a four-wire wye, three-phase 480Y/277 volt system]. Meter shall have a five-dial pointer type register.[The kilowatt-hour meter shall have a[sweep-hand][cumulative] type kilowatt demand register with [15][30][60]-minute interval conforming to NEMA C12.4.] Provide correct multiplier on face of meter.

]]2.2.9 Current Transformers

****
NOTE: Select the appropriate current transformer (CT) ratio, continuous-thermal-current rating factor (RF) at 30 degrees C and ANSI Metering Accuracy Class values based on the CT Ratio which is just below the rating of the main protective device.

Select an ANSI Metering Accuracy Class in accordance with the following table:

CT Ratio	RF	Accuracy Class
200/5	4.0	0.3 thru B-0.1
300/5	3.0	0.3 thru B-0.2
400/5	4.0	0.3 thru B-0.2
600/5	3.0	0.3 thru B-0.5
800/5	2.0	0.3 thru B-0.5
1200/5	1.5	0.3 thru B-0.5
1500/5	1.5	0.3 thru B-0.9

****

IEEE C57.13. Transformers shall be single ratio, 60 hertz, [_____] to 5-ampere ratio, [_____] rating factor, with a metering accuracy class of 0.3 through [_____].

[2.2.10 Transformer

****
NOTE: Coordinate with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, when transformer section is provided. Use UL 891 for switchboards and UL 1558 for switchgear.
****

Provide transformer section in [switchboard][switchgear] in accordance with [UL 891][UL 1558] and as indicated. The transformer and section shall be suitable for the installation.[Transformers greater than 10 kVA shall be tested in accordance with UL 891.] Transformer shall conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

][2.2.11 Meter Fusing

Provide a fuse block mounted in the metering compartment containing one fuse per phase to protect the voltage input to voltage sensing meters. Size fuses as recommended by the meter manufacturer.

][2.2.12 Heaters

Provide 120-volt heaters in each [switchboard][switchgear] section. Heaters shall be of sufficient capacity to control moisture condensation in the section, shall be 250 watts minimum, and shall be controlled by a thermostat[and humidistat] located in the section. Thermostat shall be industrial type, high limit, to maintain sections within the range of 15 to 32 degrees C 60 to 90 degrees F.[Humidistat shall have a range of 30 to 60 percent relative humidity.] Supply voltage for the heaters shall be obtained from a control power transformer within the [switchboard][switchgear]. If heater voltage is different than switchboard voltage, provide transformer rated to carry 125 percent of heater full load rating. Transformer shall have 220 degrees C insulation system with a temperature rise not exceeding 115 degrees C and shall conform to IEEE C57.12.01.[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.]

]2.2.13 Terminal Boards

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

2.2.14 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. Each sleeve shall contain a single letter or number, shall be elliptically shaped to securely grip the wire, and shall be keyed in such a manner to ensure alignment with adjacent sleeves. Provide specific wire markings using the appropriate combination of individual sleeves. Each wire marker shall indicate the device or equipment, including specific terminal number to which the remote end of the wire is attached.

2.3 MANUFACTURER'S NAMEPLATE

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

2.4 FIELD FABRICATED NAMEPLATES

****
NOTE: Use the bracketed sentence to specify labels for switchboards or switchgear where emergency breakers are located within the switchboards or switchgear. Provide note on the drawings to indicate where red labels are required.
****

ASTM D709. Provide laminated plastic nameplates for each[switchboard,][switchgear,] equipment enclosure, relay, switch, and device; as specified in this section or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 3 mm 0.125 inch thick, white with [black][_____] center core.[Provide red laminated plastic label with white center core where indicated.] Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be 25 by 65 mm one by 2.5 inches. Lettering shall be a minimum of 6.35 mm 0.25 inch 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.

a. Test Instrument Calibration

(1) The manufacturer shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy.

(2) The accuracy shall be directly traceable to the National Institute of Standards and Technology.

(3) Instrument calibration frequency schedule shall not exceed 12 months for both test floor instruments and leased specialty equipment.

(4) Dated calibration labels shall be visible on all test equipment.

(5) Calibrating standard shall be of higher accuracy than that of the instrument tested.

(6) 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:

(a) Maintain up-to-date instrument calibration instructions and procedures for each test instrument.

(b) Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

2.5.2 [Switchboard][Switchgear] Design Tests

****
NOTE: Use the first bracketed option for switchboards and the second bracketed option for switchgear.
****

[NEMA PB 2 and UL 891][IEEE C37.20.1 and UL 1558].

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

2.5.2.2 [Additional design tests

****
NOTE: Include additional design tests when the switchboard or switchgear main bus is rated greater than 4000 amperes.
****

In addition to normal design tests, perform the following tests on the actual equipment. Furnish reports which include results of design tests performed on the actual equipment.

a. Temperature rise tests

b. Continuous current

]2.5.3 [Switchboard][Switchgear] Production Tests

****
NOTE: Use the first bracketed option for switchboards and the second bracketed option for switchgear.
****

[NEMA PB 2 and UL 891][IEEE C37.20.1 and UL 1558]. 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

2.6 [COORDINATED POWER SYSTEM PROTECTION

****
NOTE: Use this paragraph only for Army projects.

The requirement for studies in this section depends on the complexity and extent of the power system. Delete this requirement for projects of limited scope, projects having protective devices which are not adjustable or for which coordination is not possible (standard molded case circuit breakers); projects involving simple extension of 600 volt level service to a building or facility from an existing transformer (750 kVA or less); or projects involving simple extension of 600 volt level service to a building or facility from a new transformer (750 kVA or less).
****

Provide a power system study as specified in Section 26 28 01.00 10 COORDINATED POWER SYSTEM PROTECTION.

]PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein.

3.2 GROUNDING

****
NOTE: Where rock or other soil conditions prevent obtaining a specified ground value, specify other methods of grounding. Where it is impractical to obtain the indicated ground resistance values, make every effort to obtain ground resistance values as

near as possible to the indicated values.
****

NFPA 70 and IEEE C2, except that grounds and grounding systems shall have a resistance to solid earth ground not exceeding 5 ohms.

3.2.1 Grounding Electrodes

Provide driven ground rods as specified in[Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION]. 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 No. 4/0 AWG not less than 610 mm 24 inches 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" shall apply.

3.2.3 Connections

Make joints in grounding conductors and loops by exothermic weld or compression connector. Exothermic welds and compression connectors shall be installed as specified in[Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION, paragraph entitled, "Grounding Connections."]

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 [Switchgear

IEEE C37.20.1.

]3.3.3 [Meters and Instrument Transformers

ANSI C12.1.

]3.3.4 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.

3.3.5 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.

3.3.6 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

****
NOTE: Mounting slab connections may have to be given in detail depending on the requirements for the seismic zone in which the equipment is located. Include construction requirements for concrete slab only if slab is not detailed in drawings.
****

3.4.1 Exterior Location

Mount [switchboard][switchgear] on concrete slab. Unless otherwise indicated, the slab shall be at least 200 mm 8 inches thick, reinforced with a 150 by 150 mm 6 by 6 inch No. 6 mesh placed uniformly 100 mm 4 inches from the top of the slab. Slab shall be placed on a 150 mm 6 inch thick, well-compacted gravel base. The top of the concrete slab shall be approximately 100 mm 4 inches above the finished grade. Edges above grade shall have 15 mm 1/2 inch chamfer. The slab shall be of adequate size to project at least 200 mm 8 inches beyond the equipment. Provide conduit turnups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits 75 mm 3 inches above slab surface. Concrete work shall be as specified in Section [03 30 00 CAST-IN-PLACE CONCRETE][03 30 00.00 10 CAST-IN-PLACE CONCRETE][03 35 00.00 10 CONCRETE FINISHING][03 39 00.00 10 CONCRETE CURING].

3.4.2 Interior Location

Mount [switchboard][switchgear] on concrete slab. Unless otherwise indicated, the slab shall be at least 100 mm 4 inches thick. The top of the concrete slab shall be approximately 100 mm 4 inches above finished floor. Edges above floor shall have 15 mm 1/2 inch chamfer. The slab shall be of adequate size to project at least 100 mm 8 inches beyond the equipment. Provide conduit turnups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits 75 mm 3 inches above slab surface. Concrete work shall be as specified in Section[03 30 00 CAST-IN-PLACE CONCRETE][03 30 00.00 10 CAST-IN-PLACE CONCRETE][03 35 00.00 10 CONCRETE FINISHING][03 39 00.00 10 CONCRETE CURING].

3.5 FIELD QUALITY CONTROL

Contractor shall submit request for settings of breakers to the Contracting Officer after approval of [switchboard][switchgear] and at least 30 days in advance of their requirement.

3.5.1 Performance of Acceptance Checks and Tests

****

NOTE: If the specified system is identified as critical, configured, or mission essential, use Section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS to establish predictive and acceptance testing criteria, above and beyond that listed below.

****

Perform PT&I tests and provide submittals as specified in Section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS.

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) Confirm correct application of manufacturer's recommended lubricants.

(4) Verify appropriate anchorage, required area clearances, and correct alignment.

(5) Inspect all doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.

(6) Verify that[fuse and] circuit breaker sizes and types correspond to approved shop drawings.

[(7) Verify that current transformer ratios correspond to approved shop drawings.

] (8) 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.

(9) Confirm correct operation and sequencing of electrical and mechanical interlock systems.

(10) Clean switchboard.

(11) Inspect insulators for evidence of physical damage or contaminated surfaces.

(12) Verify correct barrier[and shutter] installation[and operation].

(13) Exercise all active components.

(14) Inspect all mechanical indicating devices for correct operation.

(15) Verify that vents are clear.

(16) Test operation, alignment, and penetration of instrument transformer withdrawal disconnects.

(17) Inspect control power transformers.

b. Electrical Tests

(1) Perform insulation-resistance tests on each bus section.

(2) Perform overpotential 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 Switchgear

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical, electrical, and mechanical condition.

(3) Confirm correct application of manufacturer's recommended lubricants.

(4) Verify appropriate anchorage, required area clearances, and correct alignment.

(5) Inspect all doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.

(6) Verify that[fuse and] circuit breaker sizes and types correspond to approved shop drawings.

[(7) Verify that current transformer ratios correspond to approved shop drawings.

] (8) 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.

(9) Confirm correct operation and sequencing of electrical and mechanical interlock systems.

(10) Clean switchgear.

(11) Inspect insulators for evidence of physical damage or contaminated surfaces.

(12) Verify correct barrier[and shutter] installation[and operation].

(13) Exercise all active components.

(14) Inspect all mechanical indicating devices for correct operation.

(15) Verify that vents are clear.

(16) Test operation, alignment, and penetration of instrument transformer withdrawal disconnects.

(17) Inspect control power transformers.

b. Electrical Tests

(1) Perform insulation-resistance tests on each bus section.

(2) Perform overpotential 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 switchgear to ensure correct bus phasing from each source.

][(7) Verify operation of switchgear heaters.

]]3.5.1.3 Circuit Breakers - Low Voltage - Power

a. Visual and Mechanical Inspection

(1) Compare nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Confirm correct application of manufacturer's recommended lubricants.

(4) Inspect anchorage, alignment, and grounding. Inspect arc chutes. Inspect moving and stationary contacts for condition, wear, and alignment.

(5) Verify that all maintenance devices are available for servicing and operating the breaker.

(6) Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of the breaker are correct.

(7) Perform all mechanical operator and contact alignment tests on both the breaker and its operating mechanism.

(8) 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.

(9) Verify cell fit and element alignment.

(10) Verify racking mechanism.

b. Electrical Tests

(1) Perform contact-resistance tests on each breaker.

(2). Perform insulation-resistance tests.

(3) Adjust Breaker(s) for final settings in accordance with Government provided settings.

(4).. Determine long-time minimum pickup current by primary current injection.

(5) Determine long-time delay by primary current injection.

****
NOTE: Coordinate each option with each breaker type.
****

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

[] (7) Determine ground-fault pickup and delay by primary current injection.

][(8) Determine instantaneous pickup value by primary current injection.

][(9) Activate auxiliary protective devices, such as ground-fault or undervoltage relays, to ensure operation of shunt trip devices; Check the operation of electrically-operated breakers in their cubicle.

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

(11) Verify operation of charging mechanism.

3.5.1.4 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.

****
NOTE: Coordinate each option with each breaker type.
****

[(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.

]3.5.1.5 Current Transformers

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify correct connection.

(4) Verify that adequate clearances exist between primary and secondary circuit.

(5) 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.

(6) Verify that all required grounding and shorting connections provide good contact.

b. Electrical Tests

(1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

(2) Perform insulation-resistance tests.

(3) Perform polarity tests.

(4) Perform ratio-verification tests.

3.5.1.6 Metering and Instrumentation

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify tightness of electrical connections.

b. Electrical Tests

(1) Determine accuracy of meters at 25, 50, 75, and 100 percent of full scale.

(2) Calibrate watthour meters according to manufacturer's published data.

(3) Verify all instrument multipliers.

(4) Electrically confirm that current transformer and voltage transformer secondary circuits are intact.

3.5.1.7 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 testing megger in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument shall be 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.

3.5.2 Follow-Up Verification

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

-- End of Section --