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**USACE / NAVFAC / AFCEC** **UFGS-26 23 00 (February 2024)**

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**Preparing Activity: NAVFAC** **Superseding**
**UFGS-26 23 00 (May 2015)**

**UNIFIED FACILITIES GUIDE SPECIFICATIONS**

**References are in agreement with UMRL dated January 2025**
**********

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DIVISION 26 - ELECTRICAL

SECTION 26 23 00

LOW-VOLTAGE SWITCHGEAR

**02/24**

-- End of Section Table of Contents --

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**USACE / NAVFAC / AFCEC** | **UFGS-26 23 00 (February 2024)**

**Preparing Activity: NAVFAC** | **Superseding UFGS-26 23 00 (May 2015)**

**UNIFIED FACILITIES GUIDE SPECIFICATIONS**

**References are in agreement with UMRL dated January 2025**

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SECTION 26 23 00

LOW-VOLTAGE SWITCHGEAR
**02/24**

**********

**NOTE: This is a revised guide specification that, in part, replaces 26 23 00, SWITCHBOARDS AND SWITCHGEAR. The original guide specification was separated into two specifications: 26 23 00, LOW-VOLTAGE SWITCHGEAR, and 26 24 13, SWITCHBOARDS.**

**This guide specification covers the requirements for metal-enclosed low-voltage power circuit-breaker switchgear assemblies in either interior or exterior locations. This guide specification is intended for alternating current applications; additional editing will be necessary to tailor it for direct current applications.**

**Per UFC 3-520-01 3-2.2, specify metal-enclosed switchgear for service entrance equipment only when the service is 1200 amperes or larger, and all branch and feeder circuits are large, above 400A or if any branch or feeder circuit is larger than 800A. Specify switchboards in accordance with 26 24 13 SWITCHBOARDS for service entrance equipment when the equipment feeds circuit breakers 800A or smaller. Utilize switchboards throughout the distribution system where equipment is 1200 amperes or larger.**

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

**This specification is not intended to be used for generator control switchgear without extensive modification and coordination with applicable engine-generator set 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 item(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).**

**********

**********

**NOTE: Verify that the following information is indicated on the project drawings:**

**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 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.**

**6. Arc flash label requirements. Download the label format at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables**

**7. Available fault current label for service entrance equipment. Download the label format at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-table**

**8. Locations with arc energy reduction methods specified.**

**********

**********

**NOTE: In corrosive and humid environments, use materials, systems, components, and coatings that are durable and minimize the need for preventative and corrective maintenance over the expected service life of the component or system. Corrosive project locations are those with Environmental Severity Classification (ESC) of C3, C4, and C5. Humid**

**locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 4C, and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project location.**

**********

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 Reference Identifier (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.**

**********

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI C12.1 | (2014; Errata 2016) Electric Meters - Code for Electricity Metering |

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

| | |
|---|---|
| ASCE 7 | (2017) Minimum Design Loads for Buildings and Other Structures |

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

| | |
|---|---|
| ASHRAE 90.1 - IP | (2019) Energy Standard for Buildings Except Low-Rise Residential Buildings |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A123/A123M | (2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A153/A153M | (2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel |

| | |
|---|---|
| | Hardware |
| ASTM A240/A240M | (2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications |
| ASTM A653/A653M | (2023) 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 1584 | (2018; E 2019) Guide for Performing Arc-Flash Hazard Calculations |
| IEEE C2 | (2023) National Electrical Safety Code |
| IEEE C37.13 | (2024) Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures |
| IEEE C37.20.1 | (2020) Metal-Enclosed Low-Voltage (1000 Vac and below, 3200 Vdc and below) Power Circuit-Breaker Switchgear |
| IEEE C37.20.7 | (2017; Corr 2021) Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults |
| IEEE C37.90.1 | (2023; ERTA) Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus |
| IEEE C57.12.28 | (2023) Standard for Pad-Mounted Equipment - Enclosure Integrity |

| | |
|---|---|
| IEEE C57.12.29 | (2023) Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments |
| IEEE C57.13 | (2016) Standard Requirements for Instrument Transformers |

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

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

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

| | |
|---|---|
| ISO 9001 | (2015) Quality Management Systems-Requirements |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA 250 | (2020) Enclosures for Electrical Equipment (1000 Volts Maximum) |
| NEMA ICS 1 | (2022) Standard for Industrial Control and Systems: General Requirements |
| NEMA ICS 2 | (2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V |
| NEMA ICS 6 | (1993; R 2016) Industrial Control and Systems: Enclosures |
| NEMA LI 1 | (1998; R 2011) Industrial Laminating Thermosetting Products |
| NEMA ST 20 | (2014) Dry-Type Transformers for General Applications |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2023; ERTA 1 2024; TIA 24-1) National Electrical Code |

UL SOLUTIONS (UL)

| | |
|---|---|
| UL 467 | (2022) UL Standard for Safety Grounding and Bonding Equipment |
| UL 508A | (2018; Reprint Jul 2022) UL Standard for Safety Industrial Control Panels |
| UL 1558 | (2016; Reprint Nov 2019) UL Standard for Safety Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear |

1.2 RELATED REQUIREMENTS

**********
**NOTE: Include Section 26 08 00 APPARATUS INSPECTION AND TESTING on all projects involving medium voltage and specialized power distribution equipment**

**Include Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS for all systems where meters are networkable, circuit breakers have communication features built in, or other communication system being provided with switchgear whether being connected to network or not.**
**********

Section 26 08 00 APPARATUS INSPECTION AND TESTING[ and Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS] 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, are as defined in IEEE 100.

1.4 SUBMITTALS

**********
**NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified 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 Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters 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 and Air Force projects.**

**The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.**
**********

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification 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

Switchgear Drawings; G, [_____]

SD-03 Product Data

Switchgear; G, [_____]

SD-06 Test Reports

Switchgear Design Tests; G, [_____]

Switchgear Production Tests; G, [_____]

Acceptance Checks and Tests; G, [_____]

SD-10 Operation and Maintenance Data

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

SD-11 Closeout Submittals

Assembled Operation and Maintenance Manuals; G, [_____]

Equipment Test Schedule; G, [_____]

**********

**NOTE: Select "Request for Settings" below if protective device settings will be government furnished. Select "Required Settings" below if protective device settings are furnished by the Designer of Record. Coordinate with the person developing the Division 1 Sections and ensure that Division 1 Sections identify the person responsible for providing the final protective device settings for design/build versus design/bid/build projects. Do not rely on the manufacturer's default settings.**

**********

[ Request for Settings; G, [_____]

][ Required Settings; G, [_____]

]

**********

**NOTE: NFPA 70 Article 110.24 requires an available fault current label to be applied at the service entrance. Select "Available Fault Current Label" below if the switchgear is part of the service entrance equipment. Coordinate with the person developing the Division 1 Sections and ensure that**

**Division 1 Sections identify the person responsible for providing the short circuit calculation for the project. This may vary for design/build versus design/bid/build projects.**

**********

[ Service Entrance Available Fault Current Label; G, [_____]

]1.5 QUALITY ASSURANCE

1.5.1 Product Data

Include manufacturer's information on each submittal for each component, device and accessory provided with the switchgear 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.

1.5.2 Manufacture Qualifications

Manufacturer must be a firm engaged in the manufacture of switchgear of the types and sizes required and whose products have been in satisfactory use in similar service for a minimum of 5 years.

[ a. Switchgear must be the product of a single manufacturer. The manufacturer of the assembly must be the manufacturer of the major components within the assembly.

][b. For the equipment specified herein, the manufacturer must be ISO 9001 certified.

][c. The manufacturer or their representative must have service, repair, and technical support services available 24 hours, 7 days a week.

][d. Switchgear must be provided by a manufacturer who offers integrated supply of switchgear enclosures, buses, circuit breakers, and associated control hardware. All major components of the switchgear, including but not limited to enclosures, buses, buckets, circuit breakers, and any other major components must be made and offered by the same manufacturer and must be branded, marketed and manufactured by the same manufacturer as part of an integrated product line available as a catalog product offered through distributor networks with readily available spare parts.

][e. The manufacturer of this equipment must have produced similar electrical equipment for a minimum period of 5 years. When requested by the Engineer, provide an acceptable list of installations with similar equipment demonstrating compliance with this requirement.

]1.5.3 Acceptance Testing Qualifications

Testing personal must show at least 3 years of experience testing similar systems.

[ a. Testing personnel must be familiar with NETA ATS and manufacturer's

testing recommendations.

][b. Testing personnel must be experienced in manufacturer's acceptance testing recommendations[ and NETA ATS requirements].

][c. Testing must be performed by a NETA-accredited testing service. Testing service must provide a NETA-certified technician to perform the testing to NETA ATS[ and manufacturer's acceptance testing recommendations].

]1.5.4 Switchgear 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 industry, and technical society publication references on submittals. Include 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)]. Comply with the IEEE C37.20.1 section 7.1.4.1 for minimum information for switchgear assembly nameplates.

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. Use this information (designer of record) to provide breaker settings that ensures protection and coordination are achieved.[ For Navy installations, provide electronic format curves using SKM's Power Tools for Windows device library electronic format or EasyPower device library format depending on installation modeling software requirements.]

[ h. Relaying and SCADA equipment diagrams.

] **********
**NOTE: If selecting provisions for future expansion, ensure the facility and room size is adequate for the additional equipment.**
**********

[ i. Provisions for future expansion by adding switchgear sections.

]1.5.5 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.

1.5.6 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.

1.5.6.1 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.

1.5.6.2 Material and Equipment Manufacturing Date

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

1.6 MAINTENANCE

1.6.1 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 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. Information on metering.

] f. Design test reports.

g. Production test reports.

[1.6.3 Spare Parts

**********
**NOTE: Do not use this paragraph for Navy projects. For other services, coordinate with Contracting Officer on whether this paragraph can be included.**

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

Provide spare parts as specified below. Provide spare parts that are of the same material and workmanship, meet the same requirements, and are interchangeable with the corresponding original parts furnished.

a. Quantity 2 - Fuses of each type and size.

[ b. [_____]

]]1.7 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 switchgear and related accessories are specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION, and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.2 SWITCHGEAR

IEEE C37.20.1 and UL 1558.

2.2.1 Ratings

Provide equipment with the following ratings:

**********
**NOTE: Select "as indicated" if there are multiple switchgear with details of each shown on drawings. Most switchgear will be 4-wire, but might be a**

**3-wire design for delta-connected or ungrounded systems.**

**********

a. Voltage rating: [480Y/277][208Y/120][_____] volts AC, [3][4]-wire [three-phase, [3][4]-wire][as indicated].

b. Continuous current rating of the main bus: [_____ amperes][as indicated].

c. Short-circuit current rating: [_____ rms symmetrical amperes][as indicated].

d. The assembly must be rated to withstand mechanical forces exerted during short-circuit conditions when connected directly to a power source having available fault current of [_____] amperes symmetrical at rated voltage[ as shown on the drawings].

e. The bus system must have a minimum ANSI short-circuit withstand rating of [_____] amperes symmetrical tested in accordance with IEEE C37.20.1, CSA C22.2 No. 31, and UL 1558.

f. UL listed and labeled[ for its intended use][ as service entrance equipment].

2.2.2 Construction

**********

**NOTE: Edit the selection options below as needed for the intended project configuration.**

**Determine if an arc-resistant design will be specified for the installation. A selection of arc-resistant switchgear can affect the installation design. Arc-resistant switchgear is tested and certified to IEEE C37.20.7, and is intended to provide added protection for internal arcing faults. Select Type 1 if arc protection is only required for the freely accessible front of the enclosure. Select Type 2 if arc protection is required for freely accessible front, sides and rear of the enclosure. Select the 'B' suffix for additional protection applied to compartments designated as low voltage control or instrumentation compartments. Select the 'C' suffix where isolation from the effects of an internal arcing fault is desired between all adjacent compartments within a switchgear assembly. Most manufacturers produce Type 2B as a standard product, which could increase the switchgear cost by about 20 percent. Review IEEE C37.20.7 for additional information.**

**********

Provide the following:

a. Switchgear: consisting of vertical sections bolted together to form a rigid assembly and [rear][front and rear] aligned[ as indicated].

b. All circuit breakers: front accessible with rear load connections.

c. Compartmentalized switchgear: 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].

d. Where indicated, "space for future" or "space" means to include all necessary components and hardware to be fully equipped for racking in a circuit breaker element.

e. Insulating barriers: provided in accordance with NEMA LI 1, Type GPO-3, 6.35 mm 0.25 inch minimum thickness.

[ f. Moisture resistant coating: applied to all rough-cut edges of barriers.

][g. Switchgear: Arc-resistant[ Type 1[B][C]][ Type 2[B][C]], tested in accordance with IEEE C37.20.7.

]2.2.2.1 Enclosure

**********

**NOTE: Choose the level of corrosion protection required for the specific project location. Most switchgear products will be constructed of a cold rolled steel and painted, which is adequate for most indoor locations. Use galvanized steel or stainless steel enclosures or bases for outdoor applications where corrosion is a concern; specify stainless steel for project locations with Environmental Severity Classifications (ESC) of C4 and C5, galvanized is acceptable for project locations with ESC of C3. See UFC 1-200-01 for determination of ESC for project locations. Not all manufacturers offer galvanized steel or stainless steel products as a standard design. Stainless steel is not typically available from all manufactures and thus may require integration into an integrated power assembly or e-house with an outdoor rating.**

**Select IEEE C57.12.28 for galvanized enclosures. Select IEEE C57.12.29 for stainless steel enclosures. Galvanized steel may not be standard option and should only be considered when necessary.**

**Infrared viewing windows are typically installed in the switchgear rear covers to facilitate the use of IR cameras for thermally scanning cable terminations. Continuous thermal monitoring sensors are another option.**

**********

Provide the following:

a. Enclosure: [ outdoor] NEMA ICS 6 Type [3R][1][_____][as indicated][fabricated entirely of 12 gauge ASTM A240/A240M type 304 or 304L stainless steel].

b. Enclosure: bolted together with removable bolt-on side and[ hinged]

rear covers[, and sloping roof downward toward rear].

[ c. Front[ and rear] doors: provided with[ stainless steel] 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 3 inches 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][ and][ IEEE C57.12.29 for stainless steel].

][i. Infrared viewing windows: install to allow the use of an infrared camera or thermal imager direct line of site to inspect electrical connections without requiring the opening of panels and doors. These windows are intended to allow thermographers the ability to inspect the electrical equipment without directly exposing themselves to live electrical components and energized devices.

(1) The infrared viewing window must be a UL recognized component.

(2) Switchgear must include solid infrared transmitting media viewports to be used with an infrared camera. Provide viewing windows to allowing viewing of all termination locations.

(3) Viewing window must maintaina the NEMA 250 environmental rating of the switchgear enclosure.

(4) Provide a metallic cover with the viewing window. Cover and fastener must be permanently attached.

][j. Provide a continuous thermal monitoring sensors and system for cable and bus bolted connections.

]2.2.2.2 Arc Resistance Enclosure

**********

**NOTE: Arc resistant switchgear enclosure is an option to be considered for any switchgear design and installation. It is important to note that arc-resistant switchgear provides protection from internal arcing faults when the equipment is closed and operating normally. Arc-resistant switchgear should be considered whenever operator safety is a concern and also must be considered for installations where incident energy anywhere within the structure is anticipated to be 8 calories (Cal) or greater. Arc-resistant switchgear is available in Type 1 (in the front of equipment only), Type 2**

**(entire perimeter of equipment), Type 2B (entire perimeter of equipment even with instrumentation door open), and Type 2C (arc resistant between adjacent equipment compartments within the assembly, as well as around the perimeter of the equipment). Consider that arc resistant switchgear is not designed to preserve the operation condition of the equipment, but rather to only protect operating personnel located outside of the equipment. There are not any additional maintenance requirements for arc resistant switchgear. Arc resistant and arc mitigation are not the same thing. Arc resistant switchgear is to contain and redirect an arc flash event from operating personnel. Arc Flash mitigation is to reduce the severity or likelihood of an arc flash event.**

**********

Provide low-voltage metal enclosed, draw-out switchgear constructed to IEEE C37.20.1 standards and designed to contain the effects of arc flash events inside the switchgear per IEEE C37.20.7. Switchgear must be certified as Type 2B arc-resistant in a NEMA 250 Type 1 enclosure."

[ Provide switchgear with a ventilation system that allows exhaust of arc gases regardless of the origination location of the arc event. The ventilation system must be designed to exhaust arc events originating in the circuit breaker cell, bus compartment, and rear cable compartment.

][ Arc resistant switchgear must not have an arc plenum, and must require 3 meters 10 feet minimum floor-to-ceiling height for arc exhaust, with no obstructions in the space above the switchgear.

][ Provide Arc resistant switchgear with an arc plenum included that has been tested according to IEEE C37.20.7 from the same manufacture as the switchgear. Provide external connections to an arc duct. Coordinate exterior location to ensure duct exhausts are free from obstructions.

]2.2.2.3 Bus Bars

**********

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

**Delete the neutral bus bracketed option if a 3-wire system was selected.**

**Only choose the bracketed option requiring insulation on the bus bars for outdoor locations with a high concentration of airborne contaminants. Choose this option primarily for corrosive and high humidity applications as defined in UFC 3-501-01. Most manufacturers will apply an insulating sleeve rather than an epoxy coating.**

**********

Provide the following:

a. Bus bars: [copper with silver-plated contact surfaces][ or ][aluminum with tin-plated contact surfaces].

(1) Phase bus bars: [uninsulated][insulated with an epoxy finish coating powder 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 switchgear.

d. 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 switchgear.

2.2.2.4 Main Section

**********
**NOTE: Current-limiting fuses should only be needed if the available fault current exceeds the circuit breaker short circuit rating.**
**********

Provide the main section consisting of[ main lugs only][ an individually mounted][ drawout][ air power circuit breaker[ with current-limiting fuses]][ and a separate vertical section for the utility transformer meter compartment].

2.2.2.5 Distribution Sections

**********
**NOTE: Current-limiting fuses should only be needed if the available fault current exceeds the circuit breaker short circuit rating. Utility transformer compartments are rarely used and will require additional review if this bracketed option is selected.**
**********

Provide the distribution section[s] consisting of[ [individually mounted,][drawout,]][ air power circuit breakers[ with current-limiting fuses]][ and utility transformer compartments] as indicated.

[2.2.2.6 Auxiliary Sections

Provide auxiliary sections consisting of indicated[ instruments,][ metering equipment,][ control equipment,][ transformer,][ and][ current transformer compartments] as indicated.

][2.2.2.7 Handles

Provide handles for individually mounted devices 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.

][2.2.2.8 Seismic

**********
**NOTE: Keep this section for sites where the Seismic design class is C or higher. Coordinate with structural for design class determination and Section 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT. If seismic design class A or B delete.**
**********

Equipment must be Seismic Qualified and Certified by 3rd party testing to meet ASCE 7/IBC. Equipment capacity must be determined from tri-axial seismic shake table test results as defined in the International Code Council Evaluation Service (ICC ES) Acceptance Criteria for Seismic Qualification Testing of Nonstructural Components (AC156). Apply an equipment importance factor of 1.5 for seismic test. See 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT for additional requirements.

[ Equipment must have Pre-approval (OSP) under California Office of Statewide Health Planning & Development (OSHPD) Special Seismic Certification program for California Healthcare Facilities.

]]2.2.3 Protective Device

**********
**NOTE: Switchgear should be placed where the ambient temperature is less than 40 degrees C, which is the basis for rating in accordance with IEEE C37.13. However, should the ambient temperature be expected to exceed 40 degrees C, the designer must require a special calibration for the circuit breakers and confirm the equipment ratings.**

**This paragraph assumes that circuit breakers are available rated for the specified short circuit current. For very high short circuit currents, the manufacturer might have to install current-limiting fuses upstream of the circuit 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.**

**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.**
**********

Provide[ main and] branch protective devices as indicated.

Provide the following:

a. IEEE C37.13. [120 Vac][ electrically][ manually] operated drawout, [unfused][fused], low-voltage power circuit breaker with a

short-circuit current rating[ of [_____] rms amperes symmetrical][ as indicated] at [_____] volts.

b. Breaker frame size: [ as indicated][[_____] amperes].

[ c. 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.

] d. Protective relay. Provide relays capable of communicating with [Modbus RTU][Modbus TCP][RS485][_____]. Relays must be equipped with self-checking diagnostics. Coordinate relay requirements with instrument transformers for proper operation. Provide a microprocessor-based relay equipped with the following combination of functions including protection, monitoring, control, automation, and reporting functions. Provide test switches for testing or protective relay. Provide a switch for each function.

[ (1) Overcurrent protection with time overcurrent elements for phase, neutral, and ground.

][ (2) Under- and overvoltage elements for protection and control schemes.

][ (3) Frequency protection with under and overfrequency elements for detection of power system frequency disturbances.

][e. Transformer Terminal Unit

[ (1) Provide a transformer terminal unit which monitors the transformer's running state in real time. Monitoring must include voltage, current, power factor, load unbalance, and temperature. Monitoring must provide data necessary to conduct preventive maintenance and planning.

][ (2) Provide with flexible input and output for connection and disconnection of transformer.

]][2.2.4 Drawout Breakers

Equip drawout breakers with disconnecting contacts, wheels, and interlocks for drawout application. Provide main, auxiliary, and control disconnecting contacts with silver-plated, multifinger, positive pressure, self-aligning type. Provide drawout compartment shutters to protect operators from accidental contact with breaker stabs when the breaker is withdrawn from its cubicle. Provide each drawout breaker with four-position operation with each position clearly identified by an indicator on the circuit breaker front panel as follows.

a. Connected Position: Primary and secondary contacts are fully engaged. Breaker must be tripped before racking into or out of position.[ Red Indicator][ Manufacture standard indicator].

b. Test Position: Primary contacts are disconnected but secondary contacts remain fully engaged. This position allows complete test and operation of the breaker without energizing the primary circuit.[ Yellow Indicator][ Manufacture standard indicator].

c. Disconnected Position: Primary and secondary contacts are disconnected.[ Blue Indicator][ Manufacture standard indicator].

d. Withdrawn (Removed) Position: Places breaker completely out of compartment, ready for removal. Removal of the breaker actuates assembly that isolates the primary stabs. No indicator is required when the breaker is fully withdrawn.

]2.2.5 Arc Mitigation

**********

**NOTE: Arc flash mitigation is code required in some instances per NFPA 70 Article 240.87 with overcurrent protection devices which are either properly rated for or able to be adjusted to 1200A or higher. Mitigation should be considered for both arc-resistant and standard low voltage switchgear. Additionally, the designer is encouraged to address arc flash mitigation to include circuits with feeder circuit breakers 800A to 1200A to help ensure a safer electrical environment. More than one arc flash mitigation strategy or feature may be implemented at the same time. There are seven arc flash mitigation methods listed in NFPA 70. Preliminary power studies prepared by the designer should confirm Arc Energy Reduction Maintenance Setting (ERMS) to reduce arc flash incident energy to Category 2 or below. Not all methods of arc flash mitigation are listed below (e.g., differential relaying). The NFPA 70 2020 version requires proof that the method implemented works and is in use.**

**********

Where indicated on the one-line diagram, provide the following:

[ a. Arc Flash Limiting Feeder breakers

(1) Equip circuit breakers with Flash Limiting Feeder option for arc flash limiting.

(2) Circuit breakers must be suitable for 200kA short circuit rating without the use of current limiting fuses.

(3) Provide circuit breaker published testing data and IEEE 1584 equations to support the reduction of arc flash incident energy and flash protection boundary.

][b. Zone Selective Interlocking

(1) Preserve desired selective coordination between main(s), ties(s), and feeder(s) protective devices.

(2) Provide wired connections between relays or protective devices.

][c. Energy Reduction Maintenance Setting Switch.

(1) For each [Main][Tie][ or Feeder] circuit breaker, provide a maintenance OFF-ON selector switch on the breaker compartment

door to temporarily switch the circuit breaker to ERMS-mode tripping characteristics during maintenance activities.

(2) Provide trip unit with a separate trip curve for the arc energy-reducing maintenance setting.

(3) Operate trip unit in fast instantaneous trip mode (25 to 30 ms), when ERMS trip curve is active.

(4) Provide a lock feature so that the ERMS may be locked in the ON position.

(5) Provide a blue indicating light to indicate the ERMS is enabled.

[ (6) Provide ERMS mode indication via remote communication network to plant control system.

]]d. Arc Flash Detection System

(1) Provide an arc flash detection system to satisfy NFPA 70 Article 240.87 requirements.

(2) Provide a system consisting of an arc flash detection relay, point light sensors and current transformers per source bus.

(3) Place relay light sensors in the cable, bus and circuit breaker compartments to provide comprehensive switchgear protection. Switchgear manufacturer must test and prove effective the locations of point sensors.

(4) For the arc flash detection system, utilize techniques to prevent nuisance tripping from the light emitted when an air circuit breaker interrupts a fault downstream from the switchgear during normal operation.

(5) Install the arc flash detection system at the factory.

(6) Provide control power for the arc flash detection system from[ a power source internal to the switchgear][ an external power source].

][2.2.6 Remote Racking

**********

**NOTE: UFC 3-520-01 requires consideration of remote racking methods for switchgear circuit breakers. Determine if this feature is desired by electrical personnel that will operate and maintain this equipment. The remote racking mechanism design varies among manufacturers; however the method of connection to the racking mechanism tends to be similar. Determine if the project budget can fund this device (might cost as much as $40,000 with all options including camera and wireless system). Do not select this option if other remote racking mechanisms are available within the activity and can be used for this location.**

**********

Provide a remote racking mechanism to allow an operator to rack a circuit breaker in or out from at least 20 feet away from the front of the equipment.

]2.2.7 Electronic Trip Units

**********

**NOTE: Switchgear circuit breakers will be supplied with electronic trip units. Select from the bracketed options below. In the items below, choose the bracketed item "main" when the item only applies to the main breaker.**

**A digital display for the main breaker will typically not be selected if digital metering is provided per the paragraph DIGITAL METERS is selected.**

**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.**

**NFPA 70 requires arc energy reduction where the highest continuous current trip setting for which the actual overcurrent device installed in a circuit breaker is rated or can be adjusted to 1200 amperes or higher. The option identified below is based on an energy-reducing maintenance switch. Add the additional appropriate information if other methods such as differential relaying or an active arc flash mitigation system are included. Identify locations of alternate arc energy reduction methods in the design.**

**********

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][ [_____] amperes][ the same as the breaker frame rating].

b. Trip unit ampere rating: [ as indicated][ [_____] amperes].

[ c. Ground fault protection: [ as indicated][ zero sequence sensing][ residual type sensing].

][d. Electronic trip units: provide additional features[ as indicated]:
]
[ (1) [Indicated ]Breakers: include long delay pick-up and time settings, and indication of cause of circuit breaker trip.

][ (2) Main breakers: include[ short delay pick-up and time settings][ and][, instantaneous settings][ and][ ground fault settings][ as indicated].

][ (3) Distribution breakers: include[ short delay pick-up and time settings][, instantaneous settings][, and ground fault settings][ as indicated].

][ (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) [Main ]Breakers: include provisions for communication via a network twisted pair cable for remote monitoring and control. Provide the following communications protocol:[DNP3][Modbus][IEC 61850].

][ (8) 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.

][2.2.8 Metering

[2.2.8.1 Digital Meters

**********

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

**Digital meters are continually improving. The display capability can be a simple display of numerical values or a more sophisticated display showing waveforms. Over-specification of the meter physical or software characteristics will likely result in specification of an older obsolete meter.**

**********

IEEE C37.90.1 for surge withstand. Provide true rms, plus/minus one percent accuracy, programmable, microprocessor-based meter enclosed in a sealed case with the following features.

a. Display capability:

[ (1) Multi-Function Meter: 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. Include a Form C KYZ pulse output relay on the meter.

][ (2) Power Meter: Display Watts, VARs, and selected KVA/PF. Detected alarm conditions include over/under KVA, over/under PF, over/under VARs, over/under reverse power.

][ (3) Volt Meter: Provide capability to be selectable between 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.

][ (4) Ammeter: Display phase A, B, and C currents. Detected alarm conditions include over/under current, over percent THD.

][ (5) Digital Watthour Meter: Provide a single selectable display for watts, total kilowatt hours (kWh) and watt demand (Wd). Include a Form C KYZ pulse output relay on the meter.

] b. Design meters to accept[ input from standard 5A secondary instrument transformers][ and][ direct voltage monitoring range to [300][600] volts, phase to phase].

c. Provide programming via a front panel display and a communication interface accessible by a computer.

d. Provide password secured programming stored in non-volatile EEPROM memory.

e. Provide digital communications in a Modbus [RTU] protocol via a [RS232C][RS485] serial port[ and an independently addressable [RS232C][RS485] serial port].

f. Provide meter that calculates and stores average max/min demand values with time and date for all readings based on a user selectable sliding window averaging period.

g. Provide meter with programmable hi/low set limits with two Form C dry contact relays when exceeding alarm conditions.

[ h. Provide meter with a display of Total Harmonic Distortion (THD) measurement to a minimum of the thirty-first order.

][i. Include historical trend logging capability with the ability to store up to 100,000 data points with intervals of 1 second to 180 minutes. Provide a unit that can store and time stamp up to 1000 programmable triggered conditions.

][j. Provide event waveform recording triggered by the rms of 2 cycles of voltage or current exceeding programmable set points. Store waveforms for all 6 channels of voltage and current for a minimum of 10 cycles prior to the event and 50 cycles past the event.

]][2.2.8.2 Electronic Watthour Meter

**********

**NOTE: For the Air Force, use Section 26 27 13.10 30 ELECTRIC METERS.**

**For the Navy, use Section 26 27 14.00 20 ELECTRICITY METERING.**

**For the Army, coordinate meter requirements in accordance with Engineering and Construction Bulletin ECB 2015-2, Advanced Metering and Connectivity.**

**********

[ Provide as specified in Section 26 27 14.00 20 ELECTRICITY METERING 26 27 13.10 30 ELECTRIC METERS.

][ANSI C12.1. Provide a switchgear style electronic programmable watthour meter, semi-flush mounted, as indicated. Meter can be either programmed at the factory or programmed in the field. Turn field programming device over to the Contracting Officer at completion of project. Coordinate meter to system requirements.

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).

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

c. Class: 20. Accuracy: plus or minus 1.0 percent. Finish: Class II.

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

e. Demand Register:

(1) Provide solid state.

(2) Display actual values and readings of the metered circuit. No multipliers must be required.

(3) Demand interval length: 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.

g. Provide meter with a communications port, RS485, with Modbus RTU serial or Ethernet, Modbus-TCP communications.

**********

**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 | 4.0 | 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 |
| 2000/5 | 1.5 | 0.3 thru B-1.8 |

**********

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

[ 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.

]]][2.2.8.3 Submetering

**********

**NOTE: For bases and activities that have an active submetering policy in place and written authorization has been received, edit this section as necessary to specify the desired level of submetering and locations.**

**The intended reference for this section is ASHRAE 90.1-2019, which does address submetering criteria.**

**If submetering is selected as an option, coordinate references to ASHRAE 90.1 with the lead person editing the Division 1 Sections.**

**********

ASHRAE 90.1 - IP. Provide submetering for [Interior lighting][, ][Exterior lighting][, ][HVAC equipment][, ][Plug loads][, ][Electric vehicle supply equipment] [_____].

]][2.2.9 Transformer

**********

**NOTE: Coordinate with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, when transformer section is provided.**

**********

Provide transformer section in switchgear in accordance with UL 1558 and as indicated. Provide the transformer and section that is suitable for the installation. Provide a transformer conforming to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

][2.2.10 Heaters

**********
**NOTE: Select the heater option if the switchgear will be installed in a non-environmentally controlled area.**
**********

Provide 120-volt heaters in each switchgear section. Provide heaters of sufficient capacity to control moisture condensation in the section, 250 watts minimum, and controlled by a thermostat[ and humidistat] located in the section. Provide industrial type thermostat, high limit, to maintain sections within the range of 15 to 32 degrees C 60 to 90 degrees F.[ Provide humidistat with a range of 30 to 60 percent relative humidity.] Obtain supply voltage for the heaters from a control power transformer within the switchgear. If heater voltage is different than switchgear 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 switchgear 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.]

]2.2.11 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.

2.2.12 Standard Indicating Light

Provide indicator lights[ showing on, off, stand-by, automatic, manual depending on the application][ as indicated on the plans]. Indicator lights must comply with NEMA ICS 1, NEMA ICS 2, and UL 508A. Lights must be heavy duty, round, [metal bezel ]and must mount in a 22.5 mm 0.875 inch mounting hole. Indicator lights must be LED type and must operate at [120 VAC][24 VDC][125VDC]. Long life bulbs must be used. For each indicator light, provide a legend plate labeled as shown on the drawings. Lens color must be as indicated on the drawings. Lights must be push-to-test type.

2.2.13 Wire Marking

Mark control and metering conductors at each end.[ Provide factory installed, white, plastic tubing, heat stamped with black block type letters.][ Each control wire must be marked to the origin zone/wire name/destination zone over the entire length of the wire using a cured ink

process] on factory-installed wiring. [For all shipping split control wires, provide plug-in terminal blocks. Terminal connections to remote devices or sources must be front accessible via doors near each circuit breaker.] 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

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

ASTM D709. Provide laminated plastic nameplates for each switchgear, 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 0.125 inch thick, white with [black][_____] center core.[ Provide red laminated plastic label with white center core where indicated.] 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 one by 2.5 inches. Provide lettering that is 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.

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 Switchgear Design Tests

**********
**NOTE: Use the first bracketed option for standard switchgear. Use the second bracketed option for arc-resistant switchgear.**
**********

[IEEE C37.20.1 and UL 1558][IEEE C37.20.1, IEEE C37.20.7, 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. Submit UL certification documents to show compliance.

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 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 Switchgear Production Tests

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 tests of continuity and polarity.

[2.5.4 Cybersecurity Equipment

**********
**NOTE: Coordinate equipment certification with Government's cybersecurity requirements and interpretations. Select this option if the switchgear includes remote control or remote access capability.**
**********

Furnish cybersecurity documentation as outlined in Section 25 05 11 CYBERSECURITY FOR FACILITY_RELATED CONTROL SYSTEMS.

][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).**

**For new installations, provide power system study. For replacement installations, provide updated power system study in compliance with NFPA 70E.**
**********

Provide a power system study as specified in Section 26 05 73 POWER SYSTEM STUDIES.

]2.7 ARC FLASH WARNING LABEL

**********
**NOTE: Include the Arc Flash Warning Label detail on the drawings. See the technical note at the beginning of section to obtain the AutoCAD drawing**

**file of the label.**
**********

Provide warning label for switchgear. 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.[ Provide warning label data from Section 26 05 73 POWER SYSTEM STUDIES.]

[2.8 SERVICE ENTRANCE AVAILABLE FAULT CURRENT LABEL

**********
**NOTE: NFPA 70 requires that service equipment in other than dwelling units be legibly marked in the field with the maximum available fault current, including the date the fault-current calculation was performed. In addition, include the contact information for the organization that completed the calculation. Select this option if the switchgear will be used as service entrance equipment.**

**Coordinate with the person developing the Division 1 Sections and ensure that Division 1 Sections identify the person responsible for providing the short circuit calculation for the project. This may vary for design/build versus design/bid/build projects.**
**********

Provide label on exterior of switchgear 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 switchgear. Provide label format as indicated.

][2.9 MIMIC BUS LABELING

**********
**NOTE: Include a mimic bus if the system complexity warrants providing a one-line of the system configuration.**
**********

Provide a mimic bus on the front of the equipment to diagrammatically show the internal bus structure of the lineup.

]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.

**********
**NOTE: Include the grounding section below for installations involving a switchgear installed in an exterior application. If the switchgear is**

**installed adjacent to a pad-mounted distribution transformer, then coordinate the grounding requirements between the applicable specifications.**

**********

[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.**

**Select 25 ohms resistance unless the installation requires a lower resistance to ground.**

**********

[NFPA 70][IEEE C2], except maximum resistance-to-ground of grounding electrode system must be [5][25] ohms under dry conditions. Where the resistance obtained per NFPA 70 exceeds [5][25] ohms, contact the Contracting officer for further instructions.

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" applies.

3.2.3 Connections

Make joints in grounding conductors and loops by exothermic weld or compression connector. Install exothermic welds and compression connectors as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

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 Switchgear

IEEE C37.20.1.

### 3.3.2 Meters and Instrument Transformers

ANSI C12.1.

### 3.3.3 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.

### 3.3.4 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.

### 3.3.5 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 switchgear on concrete slab as follows:

a. Unless otherwise indicated, provide the slab with dimensions 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.

b. Place slab on a 150 mm 6 inch thick, well-compacted gravel base.

c. Install slab such that the top of the concrete slab is approximately 100 mm 4 inches above the finished grade.

d. Provide edges above grade with 15 mm 1/2 inch chamfer.

e. Provide slab of adequate size to project at least 200 mm 8 inches 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 3 inches above slab surface.

i. Provide concrete work as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.4.2 Interior Location

Mount switchgear on concrete slab as follows:

a. Unless otherwise indicated, provide the slab with dimensions at least 100 mm 4 inches thick.

b. Install slab such that the top of the concrete slab is approximately 100 mm 4 inches above the finished grade.

c. Provide edges above grade with 15 mm 1/2 inch chamfer.

d. Provide slab of adequate size to project at least 200 mm 8 inches 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 3 inches above slab surface.

h. Provide concrete work as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.5 FIELD QUALITY CONTROL

**********
**NOTE: Select "Request for Settings" below if protective device settings will be government furnished. Select "Required Settings" below if protective device settings are furnished by the Designer of Record. Coordinate with the person developing the Division 1 Sections and ensure that Division 1 Sections identify the person responsible for providing the final protective device settings for design/build versus design/bid/build projects. Do not rely on the manufacturer's default settings.**

**Coordinate breaker settings with Section 26 05 73 POWER SYSTEM STUDIES.**
**********

[ Submit request for settings of breakers to the Contracting Officer after approval of switchgear and at least 30 days in advance of their requirement.

][Submit Required Settings of breakers to the Contracting Officer after approval of switchgear 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.

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**NOTE: Select the options below that apply to the specified equipment.**

**********

3.5.1.1 Switchgear

a. Visual and Mechanical Inspection[ per NETA ATS 7.1 A and values per 7.1 C.]

[ (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 switchgear 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[ fuse and] circuit breaker sizes and types correspond to approved shop drawings as well as to the circuit breaker’s address for microprocessor-communication packages.

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

(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 filters are in place and vents are clear.

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

(17) Inspect control power transformers.

] b. Electrical Tests[ per NETA ATS 7.1 B and values per 7.1 D.]

(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 switchgear to ensure correct bus phasing from each source.

][ (7) Verify operation of switchgear heaters.

]3.5.1.2 Circuit Breakers - Low Voltage - Power

a. Visual and Mechanical Inspection[ per NETA ATS 7.6.1.2 A and values 7.6.1.2 C.]

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

(2) Inspect physical and mechanical condition.

(3) Inspect anchorage, alignment, and grounding.

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

(5) Inspect arc chutes.

(6) Inspect moving and stationary contacts for condition, wear, and alignment.

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

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

(9) 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.

(10) Verify cell fit and element alignment.

(11) Verify racking mechanism.

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

b. Electrical Tests[ per NETA ATS 7.6.1.2 B and values 7.6.1.2 D.]

(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.

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**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.

3.5.1.3 Current Transformers

a. Visual and Mechanical Inspection[ per NETA ATS 7.10.1 A and values 7.10.1 C.]

[ (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[ per NETA ATS 7.10.1 B and values 7.10.1 D.]

[ (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.

]3.5.1.4 Metering and Instrumentation

a. Visual and Mechanical Inspection[ per NETA ATS 7.11.2 A and values 7.11.2 C.]

(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[ per NETA ATS 7.11.2 B and values 7.11.2 D.]

[ (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.

]3.5.1.5 Grounding System

a. Visual and Mechanical Inspection[ per NETA ATS 7.13 A and values 7.13 C.]

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

] b. Electrical Tests[ per NETA ATS 7.13 B and values 7.13 D.]

[ (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.

][3.5.1.6 Cybersecurity Installation

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**NOTE: Coordinate Government's cybersecurity requirements and interpretations with Cybersecurity specification Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS. Select this option if the switchgear includes remote control, remote access capability, or components with communication ability whether used or not.**

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Provide product information for all components in switchgear that need cybersecurity documentation. See Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS.

]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 --