UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2024
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DIVISION 26 - ELECTRICAL

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METAL-CLAD SWITCHGEAR

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USACE / NAVFAC / AFCEC **UFGS-26 13 13 (November 2021)**

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2024
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SECTION 26 13 13

METAL-CLAD SWITCHGEAR
11/21

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NOTE: This guide specification covers the requirements for metal-clad switchgear. Metal-Clad Switchgear as used in this specification is switchgear rated 1000 volts and above, normally in the medium voltage range of 5 kV to 35 kV. This specification includes indoor and outdoor applications.

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-tables

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

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	(2017) 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	(2023a) 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 32	(1972; R 1997) Standard Requirements, Terminology, and Test Procedures for Neutral Grounding Devices
IEEE 48	(2020) Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV
IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2023) National Electrical Safety Code
IEEE C37.04	(2018; Erta 2019; Corr 2021) Ratings and Requirements for AC High-Voltage Circuit Breakers with Rated Maximum Voltage Above 1000 V Corrigendum 1
IEEE C37.06	(2009) Standard for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis - Preferred Ratings and Related Required Capabilities for Voltage Above 1000 V
IEEE C37.09	(2018; Errata 2019; Corr 2021) Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
IEEE C37.2	(2022 Standard for Electrical Power System Device Function Numbers, Acronyms and Contact Designations
IEEE C37.20.2A	(2020) Metal-Clad Switchgear Amendment 1: Control and Secondary Circuits and Devices, and All Wiring
IEEE C37.20.3	(2013) Standard for Metal-Enclosed Interrupter Switchgear
IEEE C37.20.7	(2017; Corr 2021) Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults
IEEE C37.90	(2005; R 2011) Standard for Relays and Relay Systems Associated With Electric Power Apparatus
IEEE C37.90.1	(2013) Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric

	Power Apparatus
IEEE C57.12.28	(2014) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.12.29	(2014) Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments
IEEE C57.13	(2016) Standard Requirements for Instrument Transformers
IEEE C62.11	(2020) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

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

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA C12.4	(1984; R 2011) Registers - Mechanical Demand
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
NEMA/ANSI C12.10	(2011; R 2021) Physical Aspects of Watthour Meters - Safety Standard

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 4 2023; ERTA 5 2023; ERTA 6 2023) National Electrical Code

U.S. DEPARTMENT OF DEFENSE (DOD)

DOD 8500.01	(2014; Change 1-2019) Cybersecurity
DOD 8510.01	(2022) Risk Management Framework (RMF) for DoD Systems

UNDERWRITERS LABORATORIES (UL)

UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 1437	(2006) Electrical Analog Instruments - Panel Board Types

1.2 SYSTEM DESCRIPTION

****

NOTE: Do not use this paragraph for Navy projects.

For Army projects, select the features and fill in blanks with selections appropriate for the design condition and in accordance with guidance contained in UFC 3-550-01, "Exterior Electrical Power Distribution".

See UFC 3-550-01 for guidance regarding service conditions. Retain or add the required conditions.

Provide seismic requirements, if a Government designer is the Engineer of Record, and show on the drawings. Delete the inappropriate bracketed phrase. Pertinent portions of UFC 3-310-04, "Seismic Design for Buildings" and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT properly edited, must be included in the contract documents.

****

Items provided under this section must be specifically suitable for the following service conditions. Seismic details must [conform to UFC 3-310-04, "Seismic Design for Buildings" and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT] [be as indicated].

a. Fungus Control [_____]

b. Altitude [_____] m feet

c. Ambient Temperature [_____] degrees C F

d. Frequency [_____]

e. Ventilation [_____]

f. Seismic Parameters [_____]

g. Humidity Control [_____]

h. Corrosive Areas [_____]

i. [_____]

1.3 RELATED REQUIREMENTS

****

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

****

Sections 26 08 00 APPARATUS INSPECTION AND TESTING and 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS apply to this section,

with the additions and modifications specified herein.

1.4 DEFINITIONS

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

1.5 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.

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

****

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.][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 Test; G[, [_____]]

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

SD-07 Certificates

[Cybersecurity Equipment Certification; G[, [_____]]

Submit certification indicating conformance with the paragraph CYBERSECURITY EQUIPMENT CERTIFICATION.

][Cybersecurity Installation Certification; G[, [_____]]

Submit certification indicating conformance with the paragraph CYBERSECURITY INSTALLATION CERTIFICATION.

] 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[, [_____]]

]1.6 QUALITY ASSURANCE

1.6.1 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.

1.6.2 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. The drawings must show adequate clearance for operation, maintenance, and replacement of operating equipment devices. Include the nameplate data, size, and capacity on submittal. Also include applicable federal, military, industry, and technical society publication references on submittals. Include the following:

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

b. Outline drawings including front elevation, section views, footprint, shipping splits, rigging plan, 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. 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.]

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

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

]1.6.3 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "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.

1.6.4 Standard Products

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

a. Have been in satisfactory commercial or industrial use for not less than 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.

1.6.4.1 Alternative Qualifications

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

1.6.4.2 Material and Equipment Manufacturing Date

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

1.7 MAINTENANCE

1.7.1 Switchgear Operation and Maintenance Data

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

1.7.2 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.

1.7.3 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. [_____]

1.8 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 METAL-CLAD SWITCHGEAR

IEEE C37.20.2A.

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: [4.76] [8.25] [15.0] [27] kilo-volts AC, three-phase, [grounded] [high resistance grounded] [ungrounded] [as indicated].[For high resistance grounded systems, the conductors from the neutral point to the connection point at the impedance must utilize [copper] [aluminum] conductors, employing the same insulation level and construction as the phase conductors.]

b. Short Circuit Rating: [[_____] rms symmetrical amperes] [as indicated].

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

d. Impulse Withstand (Basic Impulse Level): [60] [95] [125] KV.

e. Power Frequency Withstand: [19] [36] [60] KV, 1 minute test.

f. Momentary Current Ratings must be equal to the circuit breaker close and latch rating.

g. System voltage: [_____] KV nominal, three-phase [grounded] [ungrounded], [60 hertz] [50 hertz].

h. Continuous current rating of the main bus: [[1200] [2000] [3000 or 2750 at 27KV] amperes][as indicated].

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. Dead-front, metal-clad, draw-out, switchgear assembly of vertical sections, each with vacuum circuit breakers. Switchgear must be front and rear accessible. Provide front and rear vertical section covers with full length hinges. Provide additional vertical sections to house accessories related to the switchgear functions.

b. Switchgear: Vertical sections bolted together to form a rigid assembly and[rear][front and rear] aligned[as indicated].

c. All circuit breakers: Front accessible with rear load connections.

d. 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].

e. 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.

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

[g. Moisture resistant coating: Applied to all rough-cut edges of barriers.

][h. 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.

Select IEEE C57.12.28 for galvanized enclosures.
Select IEEE C57.12.29 for stainless steel enclosures.

Infrared viewing windows are typically installed in the switchgear rear covers to facilitate the use of IR cameras for thermally scanning cable terminations.

****

Provide the following:

a. Stationary Structure:

(1) The switchgear must consist of sections including circuit breaker compartments and auxiliary compartments assembled to form a rigid self-supporting completely enclosed structure providing steel barriers between sections.

(2) The sections must be divided by metal barriers into the following separate compartments: Circuit breaker, instrument, main bus, auxiliary device and cable. Each feeder section may have up to two circuit breaker compartments.

b. Indoor Enclosure: NEMA ICS 6 Type 1. [_____]

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

d. Enclosure: Bolted together with removable bolt-on side and[hinged] rear covers[, and sloping roof downward toward rear].

[e. Front[and rear] doors: Provided with[stainless steel] pad-lockable vault handles with a three point catch.

][f. Bases, frames and channels of enclosure: Corrosion resistant and fabricated of[ASTM A240/A240M type 304 or 304L stainless steel][or][galvanized steel].

] g. Base: Includes any part of enclosure that is within 75 mm 3 inches of concrete pad.

h. Galvanized steel: ASTM A123/A123M, ASTM A653/A653M G90 coating, and ASTM A153/A153M, as applicable. Galvanize after fabrication where practicable.

i. Paint color: Factory applied finish, ASTM D1535 light gray No. 61 or No. 49 over rust inhibiting primer on treated metal.

j. Paint coating system: Comply with[IEEE C57.12.28 for galvanized steel][and][IEEE C57.12.29 for stainless steel].

k. 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.

2.2.2.2 Bus Bars

****

NOTE: 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.

(1) Phase bus bars: [Uninsulated][Insulated with an epoxy finish coating powder or insulating sleeve providing a minimum breakdown voltage per ASTM D149].

b. Make bus connections and joints with hardened steel bolts and nuts. Provide conical disk spring washers under each nut and bolt.

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 1/4 by 2 inch copper ground bus secured to each vertical section along the entire length of the switchgear.

2.2.2.3 Circuit Breaker Compartments

a. Each circuit breaker must be draw-out metal-clad vacuum circuit breaker. The stationary primary disconnecting contacts must be silver-plated copper and mounted within[glass polyester][porcelain][molded cycloaliphatic epoxy at 27kV] support bushings. The movable contacts and springs must be mounted on the circuit breaker element for ease of inspection/maintenance.

b. Entrance to the stationary primary disconnecting contacts must be automatically covered by metal shutters when the circuit breaker is withdrawn from the connected position to the test or disconnected position or removed from the circuit breaker compartment. Ground bus must be extended into the circuit breaker compartment to automatically ground the breaker frame with high-current spring type grounding contacts located on the breaker chassis when in the test and connected positions. Guide rails for positioning the circuit breaker and all other necessary hardware must be an integral part of the circuit breaker compartment. Blocking devices must interlock breaker frame sizes to prevent installation of a lower ampere rating or interrupting capacity element into a compartment designed for one of a higher rating.

2.2.2.4 Auxiliary Vertical Sections and Compartments

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

[b. Utility metering compartment that complies with[utility company][base utility] requirements.

][c. Metering: A vertical section with a front hinged door for isolated access to meters and associated terminal and fuse blocks for

maintenance, calibration, or testing while the gear is energized.

][d. Metering: Hinged panel in switch or breaker section, for isolated access to meters and associated terminal and fuse blocks for maintenance, calibration, or testing while the gear is energized.

]2.2.2.5 Medium Voltage Cable Terminations

****

NOTE: Provide indoor terminator/outdoor terminations with skirts. By including skirts for "indoor" and "within equipment" locations, tracking resistance is significantly improved. Provision of skirts for indoor terminations automatically makes them IEEE 48 Class 1.

****

a. IEEE 48 Class 1; of the molded elastomer, pre-stretched elastomer, or heat-shrinkable elastomer. Acceptable elastomers are track-resistant silicone rubber or track-resistant ethylene propylene compounds, such as ethylene propylene rubber or ethylene propylene diene monomer. Terminations, where required, must be provided with mounting brackets suitable for the intended installation and with grounding provisions for the cable shielding, metallic sheath, or armor. Terminations must be provided in a kit, including: skirts, stress control terminator, ground clamp, connectors, lugs, and complete instructions for assembly and installation. Terminations must be the product of one manufacturer, suitable for the type, diameter, insulation class and level, and materials of the cable terminated. Do not use separate parts of copper or copper alloy in contact with aluminum alloy parts in the construction or installation of the terminator.

b. Cold-Shrink Type: Terminator must be a one-piece design, utilizing the manufacturer's latest technology, where high-dielectric constant (capacitive) stress control is integrated within a skirted insulator made of silicone rubber. Termination must not require heat or flame for installation. Termination kit must contain all necessary materials (except for the lugs). Termination must be designed for installation in low or highly contaminated indoor and outdoor locations and must resist ultraviolet rays and oxidative decomposition.

c. Heat Shrinkable Type: Terminator must consist of a uniform cross section heat shrinkable polymeric construction stress relief tubing and environmentally sealed outer covering that is non-tracking, resists heavy atmospheric contaminants, ultra-violet rays and oxidative decomposition. Provide heat shrinkable sheds or skirts of the same material. Termination must be designed for installation in low or highly contaminated indoor or outdoor locations.

2.2.2.6 Circuit Breakers

****

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.

****

The vacuum circuit breakers must be electrically-operated, three-pole, circuit interrupting devices rated for [_____] amperes continuous at [_____] kV and [_____] kV BIL. Breakers must be designed for service on a [_____] kV system with a short-circuit capacity of not less than [_____] [amperes symmetrical] [MVA]. Rating must be based on IEEE C37.04 and IEEE C37.06. Circuit breakers must be draw-out mounted with position indicator, operation counter, auxiliary switches, and primary and secondary disconnect devices. Circuit breakers must have one vacuum circuit interrupter per phase.

Circuit breaker must be operated by an electrically charged, mechanically and electrically trip-free, stored-energy operating mechanism normally charged by a universal motor. Provide for manual charging of the mechanism through a manual handle on the vacuum circuit breaker. Circuit breaker control voltage must be[[_____] VDC][[_____] VAC][from an external power source][from a fused control transformer integral to the switchgear]. Provide one capacitor trip unit for each breaker when AC control power is required.

a. Contacts: Silver-plated, multi-finger, positive pressure, self-aligning type for main draw-out contacts.

b. Each draw-out breaker must be provided with three-position operation. The connected position and the test/disconnect position must be clearly identified by an indicator on the circuit breaker front panel.

   (1) Connected position: Contacts are fully engaged. Breaker must be tripped before it can be racked into or out of this position.

   (2) Test/disconnect position: Position must allow for complete testing and operation of the breaker without energizing the primary circuit.

   (3) Withdrawn (removed) positions: Places breaker completely out of compartment, ready for removal.

c. Secondary control circuits must be connected automatically with a self-aligning, self-engaging plug and receptacle arrangement when the circuit breaker is racked into the connected position.

d. An interlocking system must be provided to prevent racking a closed circuit breaker to or from any position. An additional interlock must automatically discharge the stored-energy operating mechanism springs upon removal of the breaker out of the compartment.

e. Provision for secondary control plug to be manually connected in test position.

[f. A minimum of 4 auxiliary contacts (2a 2b) for external use.

][2.2.2.7 Circuit Breaker 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. 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 6096 mm 20 feet away from the front of the equipment.

][2.2.2.8 Control Power Supply

****

NOTE: Retain paragraph below if an internal control power source utilizing step-down transformers is provided.

****

Control power transformer must supply [120] [___]V AC control circuits through secondary disconnect and overcurrent protective devices. Provide [dry type] [oil insulated] transformer, in separate draw-out compartment, with primary and secondary fuses to provide current-limiting and overload protection.

][2.2.2.9 Control Power Supply

****

NOTE: Retain paragraph below if an external control power source utilizing batteries is provided.

****

a. Dedicated [48 V DC] [120 V DC] [240 V DC] battery system.

b. System Requirements: Battery must have number of cells and ampere-hour capacity based on an initial specific gravity of 1.210 at 25 degrees C with electrolyte at normal level and minimum ambient temperature of 13 degrees C. Cycle battery before shipment to guarantee rated capacity on installation. Arrange to operate ungrounded. Battery system capacity must be as recommended by switchgear manufacturer to operate the circuit breakers for a 1-minute discharge ampere rate down to 1.75V. Cell for Lead-Acid batteries.

c. Battery:

(1) [Standard VRLA][Premium VRLA] batteries, with system disconnect and overcurrent protective device.

(2) Rack: [Two][_____]-step rack with electrical connections between battery cells and between rows of cells; include two flexible

connectors with bolted-type terminals for output leads.[Rate battery rack, cell supports, and anchorage for seismic requirements.]

(3) Accessories: Set of cell numerals. Monitoring system.

(4) Battery Ground-Fault Detector: Initiates alarm when resistance to ground of positive or negative bus of battery is less than 5000 ohms.

(5) Control Wiring: Factory installed, complete with bundling, lacing, and protection. Conductors across Hinges and for Interconnections between Shipping units must utilize flexible conductors.

(6) Charger: Static-type silicon rectifier equipped with automatic regulation and provision for manual and automatic adjustment of charging rate. Unit must automatically maintain output voltage within 0.5 percent from no load to rated charger output current, with ac input-voltage variation of plus or minus 10 percent and input-frequency variation of plus or minus 3 Hz. Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of AC input or DC output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.

d. DC ammeter.

e. DC Voltmeter: Maximum error of 5 percent at full-charge voltage, with toggle switch to select between battery and charger voltages.

f. Ground Indication: Two appropriately labeled lights to indicate circuit ground, connected in series between negative and positive terminals, with midpoint junction connected to ground by NO push-button contact.

g. Capacity: Sufficient to supply steady load, float-charge battery between 2.20 and 2.25 V per cell and equalizing charge at 2.33 V per cell.

h. Charging-Rate Switch: Manually operated switch to transfer to higher charging rate. Charger operation must be automatic until manually reset.

i. AC Power Supply: 120 V, 60 Hz, subject to plus or minus 10 percent variation in voltage and plus or minus 3-Hz variation in frequency. Automatic charger operation must resume after loss of ac power supply for any interval.

j. Charging Regulator: Protect charger from damage due to overload, including short circuit on output terminals. The device must regulate charging current but must not disconnect charger from either battery or ac supply.

k. Charger's Audible Noise: Less than 26 dB.

]2.2.3 Protective Relays

****

NOTE: The definition and application of device function numbers used in electrical switchgear are found in ANSI C37.2, "IEEE Standard Electrical Power System Device Function Numbers." This guide specification does not cover all possible relays. Choose only the relay types applicable to the specific project.

****

Relays must conform to IEEE C37.90. Protective relays must be solid-state microprocessor based, multi-function type enclosed in rectangular, semi flush, switchboard-type draw-out cases with indicating targets and provisions for testing in place by use of manufacturer's standard test blocks or test switches. One complete set of test blocks or test switches to fit each type of relay in the equipment must be provided. Auxiliary and lockout relays are not required to have draw-out cases or test provisions. Controls, relays, and protective functions must be provided completely assembled and wired.

a. Overcurrent and Ground-Fault Protective Relays:

(1) IEEE C37.2 device functions [51/50 and 51/50N][_____].

(2) Field-Selectable Relay Settings.

(3) Primary Current-Transformer Ratings: Programmable from 5 to 5000 A.

(4) Phase and Ground Protection (ANSI): Field-selectable curves from definite time, moderately inverse, normally inverse, very inverse, or extremely inverse.

(5) Phase and Ground Protection (IEC): Field-selectable curves from Curve A (BS142), Curve B (BS142), Curve C (BS142) or short inverse.

(6) Phase and Ground Protection (IAC): Field-selectable curves from extremely inverse, very inverse, inverse or short inverse.

(7) Phase Instantaneous Overcurrent Trip Pickup Point: Field selectable as "none" or from 1.0 to 25 times current-transformer primary rating. Include discriminator circuit with "on" and "off" switch so that when phase instantaneous overcurrent has been programmed to "none," the discriminator circuit protects against currents exceeding 11 times current-transformer primary rating when the breaker is being closed and must be deactivated after approximately eight cycles.

(8) Contacts: Two Form-C contacts, field selectable into contact pairs.

(9) Alphameric display to show the following parameters with metering accuracy not to exceed 2 percent of full scale:

b. Individual phase currents.

c. Ground current.

d. Cause of trip.

e. Magnitude and phase of current-causing trip.

f. Phase or ground indication.

g. Peak current demand for each phase and ground since last reset.

h. Current-transformer primary rating.

i. Programmed phase and ground set points.

j. Relay alarm and trip contacts must not change state if power is lost or an undervoltage occurs. These contacts must only cause a trip on detection of an overcurrent or fault condition based on programmed settings. A "protection off" alarm must be normally energized when the relay is powered and the self-diagnostics indicates the unit is functional. On loss of power or relay failure, this alarm relay must be de-energized, providing a fail-safe protection off alarm.

****

NOTE: Insert other relay types in paragraph below when adding other relays to operate circuit breakers in the switchgear. The 51/50 overcurrent relay described in "Overcurrent and Ground-Fault Protective Relays" (paragraph above) is typical of microprocessor-based protective relays. Show each relay system on the one-line diagram. Specify setting and testing of microprocessor-based relays for specific applications.

****

[k. Insert other relay types.

]2.2.3.1 Instruments

****

NOTE: Select essential instruments and meters. Add to the specification any special metering not listed which is required for a specific project. Use of an Electronic Monitoring System may eliminate the need for many individual electro-mechanical meters. This may also be accomplished on simpler systems by using the electronic watthour meter and identifying the desired special programming features. For NAVFAC SE projects, provide three thermal demand ammeters.

****

ANSI C39.1 for electrical indicating switchgear instruments, with one percent accuracy class, antiparallax pointer, and glare-free face with scales as indicated and coordinated to the ratios of the current and potential transformers provided. AC ammeters and voltmeters must be a minimum of [50] [115] mm [2] [4 1/2] inches square, with 4.36 rad 250 degree scale. Provide single-phase indicating instruments with flush-mounted transfer switches for reading three phases.

a. AC ammeters: Transformer rated, 5-ampere input, 60 Hz.

b. AC voltmeters: Transformer rated, 150-volt input, 60 Hz.[Provide external dropping resistors.]

c. AC wattmeters: Transformer rated for 120-volt input, 60 Hz, three-phase, four-wire, with scale range coordinated to the ratios of the associated current transformers and potential transformers.[Provide external dropping resistors.]

d. Frequency meters: Rated for 120-volt input, 60 Hz nominal frequency, [_____] to [_____] Hz scale range.

e. Power-factor meters: Transformer rated 5-ampere, [120][208]-volt input, [_____] scale range for use on [three][four]-wire, three-phase circuits. The accuracy must be plus or minus 0.01.

f. DC ammeters: [Self-contained][Shunt-rated],[0 to [_____] ampere][[_____] to 0 to [_____] ampere] scale range.

g. DC voltmeters: Self-contained,[0 to [_____] volt][[_____] to 0 volt] scale range. Furnish resistors, if required, with the voltmeter.

2.2.3.2 Instrument Control Switches

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

[2.2.3.3 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][3-wire][_____] 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.

]][2.2.3.4 Electro-mechanical Watthour Meters

****

NOTE: On bases that employ Energy Monitoring and Control Systems (EMCS) and monitor each building individually, add the following to this paragraph: "Provide watthour meter with a three-wire, single-pole double-throw, quick-make, quick-break pulse initiator. Coordinate pulse output ratio with main circuit breaker rating."

****

NEMA/ANSI C12.10. Kilowatt-hour meters must be transformer rated, polyphase, 60 Hz, semi-flush mounted, draw-out or semi draw-out switchboard meters for use on a four-wire wye, three-phase system. Kilowatt-hour meters must be[two and one-half][three]-stator.[Totalizing kilowatt-hour meters must be four-stator, two-circuit. For totalizing meters, provide devices and equipment required to provide single point metering of real power and reactive power from two inputs as indicated.] Each meter must have a five-dial pointer type register and must be secondary reading. Register ratio must be selected to provide a meter reading multiplier of even hundreds after applying the product of the current transformer ratio and the potential transformer ratio. Indicate the meter reading multiplier on the meter face. The kilowatt-hour meter must have a [sweep hand] [cumulative] type KW demand register with 15-minute interval conforming to NEMA C12.4.

][2.2.3.5 Electric Strip-Chart Recording AC Wattmeter

UL 1437 for [surface] [semi-flush] mounting. Chart speed must be [_____] mm [_____] inches per [hour] [minute] and chart drive motor must be rated [240] [120] [120/240] V, 60 Hz. The instrument must have a full scale accuracy of one percent.

]2.2.4 Instrument Transformers

IEEE C57.13, as applicable.

a. Current transformers: Each breaker compartment must have provision for front-accessible mounting of up to four current transformers per phase (ANSI standard relay accuracy), two on bus side and two on cable side of circuit breaker. The current transformer assembly must be insulated for the full voltage rating of the switchgear. The current transformers wiring must be Type SIS No. 10 AWG copper.

b. Potential transformers: Transformers must be drawout type, 60 Hz, with voltage ratings and ratios coordinated to the ratings of the associated switchgear, relays, meters, and instruments. Potential transformers must be with [one fuse] [two fuses] in the primary. Fuses must be current limiting and sized as recommended by the potential transformer manufacturer.

2.2.5 Heaters

Provide 120-volt heaters in each switchgear section. Heaters must be of sufficient capacity to control moisture condensation in the compartments and must be sized 250 watts minimum. Heaters must be controlled by a thermostat[and humidistat] located inside each section. Thermostats must be industrial type, high limit, to maintain compartments within the range of 15 to 32 degrees C 60 to 90 degrees F.[Humidistats must have a range of 30 percent to 60 percent relative humidity.] Provide transformer rated to carry 125 percent of heater full load rating. Transformers must have 220 degrees C insulation system with a temperature rise not exceeding 115 degrees C and must conform to NEMA ST 20. Provide panelboard and circuit breakers in each switchgear assembly to serve the heaters in that switchgear assembly. 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.

2.2.6 Pilot and Indicating Lights

Provide LED type pilot and indicating lights, color as indicated on the drawings.

2.2.7 Metering

2.2.7.1 Digital Metering

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 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.

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 [_____].

]2.2.9 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. Identify each terminal to indicate the load served.

2.2.10 Wire Marking

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

2.2.11 Surge Arresters

Provide one surge arrester for each conductor on circuits where indicated. Surge arresters must conform to IEEE C62.11 for [distribution class] [station class] [class as indicated] and must be rated [_____] kV.

2.2.12 Control Wiring

The switchgear control wiring must be type SIS No. 14 AWG copper minimum, except where larger size wire is required.

[2.2.13 Grounding Resistor

****
NOTE: Time ratings greater than 10-seconds are required only when the system is not taken off line by a ground fault, but merely monitored.
****

The neutral grounding resistor assembly must comply with IEEE 32. The assembly shall meet the following:

a. The resistor element must be [stainless steel] [cast-iron] and rated [_____] amperes for a [10-second] [1-minute] [10-minutes] [extended time] duty.

b. The resistor must be installed in an aluminized screened or expanded galvanized steel enclosure of the personnel safety type and shall be provided with any necessary supports and mounting hardware. The enclosure, including screening and support framing, must have two finish coats applied over a prepared substrate. The color of the finish coats shall be the same as the color of the associated transformer.

c. A stress-relief terminator must be provided and arranged to permit the proper termination of the No. [_____] AWG, [_____] [5] [15] kV shielded transformer neutral cable entering the enclosure [from the [bottom] [top]] [as recommended by the manufacturer]. If the terminal bushing is external to the enclosure, the bushing and terminal provisions shall be enclosed by a solid metal cable box equipped with conduit fittings correctly sized for the conduit required. An approved type and size of terminal lug must also be provided and arranged for the field termination of the No. 4/0 AWG bare copper

grounding cable entering the enclosure from the bottom.

d. One current transformer conforming must be provided and housed in the resistor enclosure. The current transformer shall have the ratio shown.

]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 mm 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.

a. Perform production tests on each circuit breaker housing for this Project, complying with IEEE C37.09.

(1) Perform mechanical operation tests to ensure proper functioning of shutters, operating mechanism, mechanical interlocks, and interchangeability of removable elements that are designed to be interchangeable.

(2) Conduct an alignment test with master circuit breaker to verify all interfaces.

(3) Verify that control wiring is correct by verifying continuity. Perform electrical operation of relays and devices to ensure they function properly and in the intended sequence.

(4) Perform the control wiring dielectric test at 1500 V for one minute.

(5) Perform the dielectric test on primary and secondary circuits.

b. Perform production tests, on each circuit breaker supplied for this Project, complying with IEEE C37.09.

(1) Perform mechanical operation tests to ensure proper functioning of the switch.

(2) Conduct an alignment test with master cell to verify all interfaces and interchangeability.

(3) Verify the contact gap. Perform terminal-to-terminal resistance test.

(4) Verify that control wiring is correct by verifying continuity. Perform electrical operation of relays and devices to ensure they function properly and in the intended sequence. Operate the circuit breakers over the range of minimum to maximum of the control voltage.

(5) Perform the control wiring dielectric test at 1500 V for one minute.

(6) Set the contact gap.

[2.5.2 Cybersecurity Equipment Certification

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

]2.5.3 Switchgear Design Tests

IEEE C37.20.2A or IEEE C37.20.3 as applicable. Furnish documentation showing the results of design tests on a product of the same series and rating as that provided by this specification. Required tests shall be as follows:

a. Design Tests

1. Dielectric test

2. Rated continuous current test

3. Short-circuit current withstand tests

4. Mechanical endurance tests

5. Flame-resistance tests

6. Rod entry tests

[7. Rain test for outdoor MV switchgear

][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.
****

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.
****

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.

[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.

3.2 GROUNDING

****

NOTE: Include this grounding section 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.

****

****

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

3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Connect ground conductors to the upper end of the ground rods by exothermic weld or irreversible 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 Medium-Voltage Switchgear

IEEE C37.20.2A and IEEE C37.20.3 as applicable.

3.3.2 Meters and Instrument

Transformers ANSI C12.1.

3.3.3 Galvanizing Repair

Repair damage to galvanized coatings caused by handling, transporting, cutting, welding, or bolting. Make repairs in accordance with ASTM A780/A780M, zinc rich paint. Do not heat surfaces that repair paint has been applied to.

3.4 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

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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. Curbs or raised edges may also be required around liquid filled transformers.

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[3.4.1 Exterior Location

Mount switchgear on concrete slab. Unless otherwise indicated, the slab must be at least 200 mm 8 inches thick, reinforced with a 152 by 152 - MW19 by MW19 6 by 6 - W2.9 by W2.9 mesh, placed uniformly 100 mm 4 inches from the top of the slab. Slab must be placed on a 150 mm 6 inch thick, well-compacted gravel base. Top of concrete slab must be approximately 100 mm 4 inches above finished grade. Edges above grade must have 15 mm 1/2 inch chamfer. Slab must be of adequate size to project at least 200 mm 8 inches beyond equipment, except that front of slab must be large enough to serve as a platform to withdraw breakers or to operate two-high breaker lifters. Provide conduit turnups and cable entrance space required by the equipment to be mounted[and as indicated]. 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 must be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

][3.4.2 Interior Location

Mount switchgear on concrete slab. Unless Otherwise indicated, the slab must be at least 100 mm 4 inches thick. Top of concrete slab must be approximately 100 mm 4 inches above finished floor. Edges above floor must have 15 mm 1/2 inch chamfer. Slab must be of adequate size to project at least 200 mm 8 inches beyond the equipment, except that front of slab must be large enough to serve as a platform to withdraw breakers or to operate two-high breaker lifters. 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 must be 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.
****

[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.[The [_____] Division, Naval Facilities Engineering Systems Command will witness formal tests after receipt of written certification that preliminary tests have been completed and that system is ready for final test and inspection.]

****
NOTE: Thermographic surveying is not required on most projects. NETA recommends that surveys be performed during periods of maximum possible loading but with not less than 40 percent of rated load on the electrical equipment being inspected. Testing at start-up will therefore not be beneficial except for hard-to-reach areas where solid connections cannot be verified by mechanical methods. Thermographic surveying may be useful if equipment operates under load for a specified period of time,

preferably 3 to 6 months, before testing. The additional costs and the additional trip (3 to 6 months after the initial inspection) for the NETA contractor to perform the survey should be considered prior to specifying the requirement.

****

3.5.1.1 Medium-Voltage Vacuum Circuit Breakers

a. Visual and mechanical inspection

(1) Compare equipment 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.

(5) Perform all mechanical operational tests on both the circuit breaker and its operating mechanism.

(6) Measure critical distances such as contact gap as recommended by manufacturer.

(7) Verify tightness of accessible bolted connections by calibrated torque-wrench method. Thermographic survey [is not] [is] required.

(8) Record as-found and as-left operation counter readings.

b. Electrical Tests

(1) Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to ground with switch closed, and across each open pole. Apply voltage according to manufacturer's published data, in the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Insulation-resistance values must be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than this table or manufacturer's recommendations. Dielectric-withstand-voltage tests must not proceed until insulation-resistance levels are raised above minimum values.

(2) Perform a contact/pole-resistance test. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value. Microhm or dc millivolt drop values must not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

(3) Perform minimum pickup voltage tests on trip and close coils according to manufacturer's published data. Minimum pickup

voltage of the trip and close coils must comply with manufacturer's published data. In the absence of the manufacturer's published data, comply with NETA ATS, Table 100.20.

(4) Verify correct operation of any auxiliary features, such as electrical close and trip operation, trip-free operation, and anti-pump function. Auxiliary features must operate according to manufacturer's published data.

(5) Trip circuit breaker by operation of each protective device. Reset trip logs and indicators.

(6) Perform power-factor or dissipation-factor tests on each pole with the breaker open and each phase with the breaker closed. Power-factor or dissipation-factor values must comply with manufacturer's published data.

(7) Perform vacuum bottle integrity (dielectric-withstand-voltage) test across each vacuum bottle, with the contacts in the "open" position according to manufacturer's published data. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the vacuum bottle integrity test, the test specimen is considered to have passed the test.

(8) Perform a dielectric-withstand-voltage test according to manufacturer's published data. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric-withstand-voltage test, the test specimen is considered to have passed the test.

Verify operation of heaters.

3.5.1.2 Switchgear 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 and potential transformer ratios correspond to approved shop drawings.

] (8) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method. Thermographic survey [is not]

[is] required.

(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 heaters.

3.5.1.3 Instrument 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) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method. Thermographic survey [is not] [is] required.

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

(7) Verify correct operation of transformer with drawout mechanism and grounding operation.

(8) Verify correct primary and secondary fuse sizes for potential transformers.

b. Electrical Tests - Current Transformers

(1) Perform insulation-resistance tests.

(2) Perform polarity tests.

(3) Perform ratio-verification tests.

(4) Perform excitation test on transformers used for relaying applications.

(5) Measure circuit burden at transformer terminals and determine the total burden.

(6) When applicable, perform insulation resistance and dielectric withstand tests on the primary winding with secondary grounded.

(7) CAUTION: Changes of connection, insertion, and removal of instruments, relays, and meters must be performed in such a manner that the secondary circuits of energized current transformers are not opened momentarily.

c. Electrical Tests - Voltage (Potential) Transformers

(1) Perform insulation-resistance tests.

(2) Perform a polarity test on each transformer to verify the polarity marks or H1 - X1 relationships as applicable

(3) Perform a turns ratio test on all tap positions, if applicable.

(4) Measure potential circuit burdens at transformer terminals and determine the total burden.

(5) Measure circuit burden at transformer terminals and determine the total burden.

3.5.1.4 Battery Systems

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 accessible bolted electrical connections by calibrated torque-wrench method. Thermographic survey [is not] [is] required.

(4) Measure electrolyte specific gravity and temperature and visually check fill level.

(5) Verify adequacy of battery support racks, mounting, anchorage, and clearances.

b. Electrical tests

(1) Set charger float and equalizing voltage levels.

(2) Verify all charger functions and alarms.

(3) Measure each cell voltage and total battery voltage with charger energized and in float mode of operation.

(4) Perform a capacity load test.

3.5.1.5 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.

3.5.1.6 Grounding System

a. Visual and Mechanical Inspection

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

b. Electrical Tests

(1) 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 must 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.

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.

3.5.1.7 Protective Relays

Protective relays must be visually and mechanically inspected, adjusted, tested, and calibrated in accordance with the manufacturer's published instructions. Tests must include pick-up, timing, contact action, restraint, and other aspects necessary to ensure proper calibration and operation. Relay settings must be implemented in accordance with the settings[provided by the government] [in accordance with the approved overcurrent protective device coordination study]. Relay contacts must be manually or electrically operated to verify that the proper breakers and alarms initiate.

[3.5.1.8 Cybersecurity Installation Certification

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NOTE: Coordinate equipment certification with Government's cybersecurity requirements and interpretations. Select this option if the switchgear includes remote control or remote access capability.
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Furnish a certification that control systems are installed in accordance with DOD 8500.01, DOD 8510.01, and as required by individual Service Implementation Policy.

]3.5.2 Follow-Up Verification

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NOTE: Use "10" working days and include last bracketed sentence in the paragraph for NAVFAC SE projects.
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Upon completion of acceptance checks, settings, and tests, the Contractor must show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. Circuit breakers must be tripped by operation of each protective device. Test must require each item to perform its function not less than three times. As an exception to requirements stated elsewhere in the contract, notify the Contracting Officer [5] [10] working days in advance of the dates and times for checks, settings, and tests[, to allow the Contracting Officer to notify NAVFAC SE Code 0742; Electrical Engineering Division and Code 162; Director, Utilities Engineering Division].

-- End of Section --