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USACE / NAVFAC / AFCEC **UFGS-26 13 32 (November 2023)**

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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

SECTION 26 13 32

MEDIUM-VOLTAGE SWITCHGEAR, GAS-INSULATED

11/23

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SECTION 26 13 32

MEDIUM-VOLTAGE SWITCHGEAR, GAS-INSULATED
11/23

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NOTE: This guide specification covers the requirements for gas-insulated switchgear up to 38 kV with vacuum circuit breakers. Reference IEEE C37.20.9.

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

1. Location, space available, arrangement, and elevations of switchgear.

2. Grounding plan.

3. Special conditions, such as altitude, temperature and humidity, exposure to fumes, vapors, dust, and gasses; and seismic requirements.
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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 zonez 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.

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PART 1 GENERAL

1.1 REFERENCES

****

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

Use the Reference Wizard's Check Reference feature when you add a 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.

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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

ASHRAE 90.1 - SI (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	(2024) 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 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
ASTM D2472	(2000; R 2014) Standard Specification for Sulphur Hexafluoride

EUROPEAN COMMITTEE FOR STANDARDIZATION (CEN/CENELEC)

EN 50181	(2010) Plug-in Type Bushings Above 1 kV Up to 52 kV and From 250 A to 2,50 kA for Equipment Other Than Liquid Filled Transformers

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 C37.20.9	(2019) Standard for Metal-Enclosed Switchgear Rated 1 kV to 52 kV Incorporating Gas Insulating Systems
IEEE C37.60	(2019) High-Voltage Switchgear and Controlgear - Part 111: Automatic Circuit Reclosers for Alternating Current Systems Up to 38 kV
IEEE C37.74	(2014) Standard Requirements for Subsurface, Vault, and Pad-Mounted Load-Interrupter Switchgear and Fused Load-Interrupter Switchgear for Alternating Current Systems Up to 38 kV
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	(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 ELECTROTECHNICAL COMMISSION (IEC)

IEC 60068-3-3 (2019) Environmental Testing - Part 3-3: Supporting Documentation and Guidance - Seismic Test Methods for Equipment

IEC 62271-100 (2021) High-Voltage Switchgear and Controlgear - Part 100: Alternating-Current Circuit-Breakers

IEC 62271-103 (2021) High-Voltage Switchgear and Controlgear – Part 103: Switches for Rated Voltages Above 1 Kv up to and Including 52 Kv

IEC 62271-111 (2019) High Voltage Switchgear And Controlgear - Part 111: Automatic Circuit Reclosers for Alternating Current Systems up to and including 38 kV

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

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

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2023) National Electrical Code

NFPA 70B (2023) Recommended Practice for Electrical Equipment Maintenance

UNDERWRITERS LABORATORIES (UL)

UL 467 (2022) UL Standard for Safety Grounding and Bonding Equipment

1.2 SYSTEM DESCRIPTION

****

NOTE: 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. Pertinent portions of Section 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. Equipment must conform to Section 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT.

a. Fungus Control [_____]

b. Altitude [_____] m [_____] feet

c. Minimum Ambient Temperature [_____] degrees C [_____] degrees F

d. Maximum Ambient Temperature [_____] degrees C [_____] degrees F

e. Frequency [_____]

f. Ventilation [_____]

g. Humidity Control [_____]

h. Corrosive Areas [_____]

1.3 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING, applies to this section, with the additions and modifications specified herein. Cybersecurity requirements are specified in Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS.

1.4 DEFINTIONS

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 ADMINISTRATIVE REQUIREMENTS

1.5.1 Pre-Installation Meetings

Pre-installation meeting with Purchasing Agent, Engineer, and Contractor held one month prior to equipment arriving on site. Proper storage shelters installed with electricity and space heaters for electrical equipment.

1.5.2 Sequencing

Scheduling equipment involves continuous contact with suppliers for manufacturing, testing, factory acceptance and shipping.

1.6 SUBMITTALS

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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

Electronic Overcurrent Control Curves; G, [_____]

SF6 Insulated Mv Switchgear; G, [_____]

Surge Arresters; G, [_____]

SD-06 Test Reports

Switchgear Conformity to Design Tests; G, [_____]

SD-07 Certificates

Paint Coating System; G

SD-09 Manufacturer's Field Reports

Switchgear Design And Production Tests; G, [_____]

SD-11 Closeout Submittals

Assembled Operation And Maintenance Manuals; G, [_____]

Equipment Test Schedules; G, [_____]

Required Settings; G, [_____]

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

1.7 MAINTENANCE MATERIAL SUBMITTALS

a. Provide accessories for test, inspection, maintenance, and operation.

b. Tool for manually charging breaker closing spring.

c. Include data on switches and associated accessories with each submittal. Include manufacturer's information for each component, device, and accessory provided with the equipment with each submittal.

1.7.1 Spare Parts

Manufacturer to provide List of recommended "start-up" and "running" spare parts with prices.

1.8 QUALITY CONTROL

1.8.1 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.

c. Complete instruction manuals and software for protective relays, metering equipment, and instrumentation.

1.8.2 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.

1.8.3 Switchgear Drawings

Furnish drawings that include, but are not limited to, the following:

Include wiring diagrams or wiring lists and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, conduit, ductwork, and other items that must be shown to ensure a coordinated installation. Identify circuit terminals on wiring diagrams or wiring lists 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. Also 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 protection devices.

b. Provide weights, arrangements, plan view, section views, footprint, rigging plan, and front view.

c. Bus configuration including ampere ratings of bus bars.

d. Single-line diagram including breakers[, fuses][, current transformers, and meters]. Showing buses and interrupting devices with interrupting capacities; current transformers with ratings; instruments and meters required; and description of instruments and meters.

e. Manufacturer's instruction manuals to provide breaker information that ensures protection and coordination can be achieved.

f. Markings and NEMA nameplate data[including fuse information (manufacturer's name, catalog number, and ratings)].

g. Provisions for future expansion by adding switchgear sections.

h. Grounding plan.

i. Conductors point of entry (top or bottom).

[j. Provide warning label for switchgear. Locate this self-adhesive warning label on the outside of the enclosure warning of potential electrical.]

****

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. 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.

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[k. Locate this self-adhesive warning label on the outside of the switchboard. Provide label format as indicated.]

l. Arc resistant ducting and duct supports if required for arc resistant rating.

m. Locations with arc energy reduction methods specified.

o. Wiring diagrams or wiring lists and elementary diagrams with terminals identified and indicating prewired interconnections between items of equipment and the interconnection between the items.

p. Spare parts list.

q. Master Drawing Index including switchgear front view, side view, top view, bottom view, floor plan dimensions, and one-line digram.

1.8.4 Paint Coating System

Ferrous steel components of the equipment must be protected with zinc phosphate. Test paint finish in accordance with IEEE C37.20.3 or [IEEE C57.12.28][IEEE C57.12.29] paint coating system performance requirement tests.

1.8.5 Electronic Overcurrent Control Curves

Provide time-current characteristic curves available in PDF format.

1.8.6 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 not less than two 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 two-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.

1.8.6.1 Alternative Qualifications

Products having less than a two-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.

1.8.6.2 Material and Equipment Manufacturing Date

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

1.9 MAINTENANCE

1.9.1 SF6 Insulated Switchgear Operation and Maintenance Data

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

1.9.2 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 operation and maintenance (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. Routine test reports.

1.10 DELIVERY, STORAGE, AND HANDLING

a. Store switchgear in a weather protected area until installation.

b. Handle and store equipment in accordance with manufacturer's instructions. Provide one copy of these instructions outside the switchgear packing with the equipment at time of shipment

1.11 PROJECT/SITE CONDITIONS

1.11.1 Environmental Requirements

Where venting is intended to penetrate an external wall or roof, cover vent such that it meets all specified environmental requirements (e.g., rain-tight, dust-tight, vermin-proof).

1.11.2 Existing Conditions

Install switchgear capable of being structurally supported on structure. Switchgear may require future expansion without modification to existing switchgear structural members or bus work.

1.11.3 Cybersecurity

Control systems (including systems separate from an energy management control system) must be planned, designed, acquired, executed and maintained in accordance with Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS, required by individual Service Implementation Policy.

Submit certification that equipment complies with the above DoD instructions.

1.12 SPARE PARTS

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 two - Fuses of each type and size.]

1.13 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 SF6 INSULATED MV SWITCHGEAR

2.2.1 Ratings and Test Requirements

a. The voltage rating of the switchgear must be [4.76 kV][7.2 kV][15.5 kV][27 kV][38 kV] 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.] Provide the corresponding ratings associated with the required switchgear voltage rating as follows:

b. Short Circuit Rating: [[16][20][25][31.5][40][_____] rms kA symmetrical amperes] [as indicated].

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

d. Impulse Withstand (Basic Impulse Level): [60][95][125][150][170][200] KV.

e. Power Frequency Withstand: [19][28][36][60][70][80] KV, one 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: [[630][1200][2000][2500][2800][3000 or 2750 at 27KV] amperes][as indicated].

2.2.2 MV Gas Insulated Switchgear Construction

Provide switchgear with dead-front, switchgear assembly of vertical sections, cable entrance terminations contained in a non-SF6 compartment. This vertical section contains the circuit breaker, three position (open/close/grounded) switch and the voltage transformer (VT) when required. Ship switchgear from factory, filled with appropriate levels of SF6 gas conforming to ASTM D2472 or less-flammable, high-firepoint gas whenever possible. Provide switchgear with accessible terminations suitable for cables entering from below with manual operating provisions. Provide front vertical section covers with full length hinges. Provide additional vertical sections to house accessories related to the switchgear functions per IEEE C37.74. Gas compartments are to be equipped with a gas pressure monitoring system. Pressure relief devices are to be included. A visual indicator located on the front of the section must display the status of each compartment. Auxiliary contacts are to be provided for remote indication of the warning levels. The device must be self-monitoring.

2.2.2.1 Enclosure

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.

(2) The sections are divided into compartments: circuit breaker, instrumentation, main bus, auxiliary device, and cable may be contained in one compartment. Each feeder section will have one circuit breaker compartment.

(3) Provide the structure with a front accessible low voltage compartments. The low voltage compartments contain the gas pressure gauge, circuit breaker operating mechanism, three position switch\operating mechanism and a front or rear [view port][camera] used for visual confirmation of the three position switch (closed/opened/earthed) status. The low voltage compartment also contains any meters, relays or other low voltage control devices required for the equipment.

(4) Additional control equipment that exceeds the available space on the low voltage compartment door is installed in an additional vertical section designated for low voltage devices.

(5) Each single gas vessel is provided with an SF6 gas density gauge. Contacts are provided to monitor the pressure of the gas adjusted for changes in temperature. Density gauge comes with warning and alarm output contacts.

(6) The switchgear is classified as internal arc resistant classification with the rear of the switchgear enclosure placed near a wall. The arc duct, if required, can be directed out either side of the switchgear lineup or to the rear of the switchgear, IEEE C37.20.7 Type 2B.

(7) Arc containment device housing, if required, are to be designed

to contain the arcing within the device and vent gases through ducted plenums located on the back of the switchgear.

b. Indoor Enclosure.

c. Outdoor Enclosure: [As indicated] [3RX fabricated entirely of 12 gauge ASTM A240/A240M type 304 or 304L stainless steel] [GIS should be provided in standard construction installed in an e-house with the corrosion resistance requirement that the DOD requires].

d. Switchgear Outdoor Enclosure: Welded or bolted together with removable bolt-on side and[hinged] rear covers[, and sloping roof downward toward rear].

e. Outdoor Front Doors: Provided with[stainless steel] pad-lockable vault handles with a three point catch.

f. Bases, Frames, and Channels of Outdoor 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 top 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 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.]

****
NOTE: Continuous thermal monitoring system is not required for connections using inside cone cable termination plugs.
****

[l. Cable connections are to be provided with a continuous thermal monitoring (CTM) system for 24/7 monitoring of cable connections. The cable monitoring system must consist of self-powered wireless sensors mounted at the cable connection and be capable of wireless communication for local or remote monitoring.]

****
NOTE: Voltage detection system is not required for connections using inside cone cable termination plugs.
****

[m. The check of voltage presence is to be done with an electronic and integrated voltage detecting system.

(1) The indication must be tapped from a capacitive voltage divider in the cable connection compartment.

(2) The maintenance free voltage detection system must work without any external energy and must monitor its connected test circuits continuously.

(3) For phase comparison, suitable connections must be provided, which must be covered during general use.]

2.2.2.2 Bus Bars

Provide the following:

a. Bus bars: Copper with silver-plated contact surfaces.

(1) GIS phase bus bar systems: [Isolated phase design which is copper in an aluminum tank] [Shielded Solid Insulated Switchgear] [Uninsulated][Insulated with an epoxy finish coating powder or insulating sleeve providing a minimum breakdown voltage per ASTM D149.][Insulated with SF6 with bus compartment SF6 gas pressure monitoring system][Insulated with shielded Solid Insulation].

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 bus throughout the switchgear. Typical bus ratings range from 1000 to 3000 amperes. Conductors and busbar connectors must be copper, must carry rated continuous current at 40 degrees C 104 degrees F ambient temperature and must withstand the rated short-circuit current for 2 seconds unless limited to a shorter duration by the protective device.

d. Minimum 30 x 6 mm 1.2 x 0.25 inches (25kA and below) 40 x 10 mm 1.6 x 0.40 inches (31.5kA and above) copper ground bus secured to each vertical section along the entire length of the switchgear. The bus rating is based on the switchgear bus ampacity.

2.2.2.3 Circuit Breaker Compartments

a. Each circuit breaker must be a fixed mounted vacuum circuit breaker.

b. The maintenance requirement would be for the lubrication of the breaker mechanism.

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].

[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

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, ethylene propylene rubber, or ethylene propylene diene monomer. Terminations 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. The design of the complete cable termination must be suitable for the switchgear short-circuit current and BIL as specified. Cable termination system are to be plug-in type as per DIN 47637 and EN 50181 standards.

Option 1 - Plug on type T-Body connector - outer cone type connection and the following paragraph to allow for terminations that are compatible with GIS switchgear. Recommend that these cable terminations be provided by the installing Contractor because they must be matched to the specific cable and insulation dimensions for the cable being provided by the contractor.

Option 2 - Inner cone style cable connectors can also be used. Type of connector is based on type of equipment construction.

Cable connections are to be made using fully insulated plug-on cable terminations according to EN 50181, Type C by Euromold, Nexans, Tyco, etc. or acceptable equal.

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 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.

d. Cable terminations must meet the requirements of gas insulated switchgear in accordance with manufacturer recommendations or approved equal, suitable for the switchgear short circuit and BIL ratings.

2.2.2.6 Circuit Breakers

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 fixed mounted and have a open/closed position indicator, operation counter, primary and secondary disconnect devices, and auxiliary switches. Circuit breakers must have one 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: Fixed-mounted, silver-plated.

b. Each breaker must be provided with open/closed position indication. The connected and disconnect positions must be clearly identified by an indicator on the circuit breaker front panel. A three position switch must have mechanical lockout mechanism that inserts a block into the switch mechanism.

The circuit breakers must be rated in accordance with IEEE C37.06 and IEC 62271-100. Overcurrent protection for the transformer must consider the base rating of the transformer, the through fault protection, transformer in-rush, and transformer impedance.

a. The Duty Cycle must be 0-15 sec-CO or 0-0.3 sec-CO-3 min-CO per IEEE C37.04 and related IEC standards. The circuit breaker short-time rating must be 3 seconds per IEEE C37.04, IEEE C37.06, and related IEC standards. The circuit breakers must be designed to withstand the Transient Recovery Voltage peaks which occur during the breaking of small inductive currents normally encountered in a high voltage system. The vacuum circuit breakers must not produce excessive overvoltage as a result of current chopping. The design must incorporate means to reduce the current chopping value to less than SA.

b. The circuit breaker operating mechanism must be designed for high speed operation and must be located in a separate cabinet at the front of the circuit breaker sections. Access must be from the front of the switchgear and permitted while the primary equipment is in service. The maximum difference in opening time between the three poles must not be more than 2 milliseconds.

c. The switchgear is designed according to the earthquake qualification category 1 of IABG TA13-TM-002/98. Earthquake qualification testing is carried out in accordance with IEC 60068-3-3. The associated test certificate is enclosed from the manufacturer.

d. Closing must be by motor-charged-, spring-operated-, stored-energy-type mechanism with electrical release. The circuit breaker must not close unless the closing spring is fully charged. Provide a visual mechanical indicating device to indicate closing spring status. Provide provisions for manually charging the closing spring. The closing spring must automatically recharge after the completion of a closing operation.

e. Tripping must be by means of a spring that is automatically charged when the circuit breaker is closed. The mechanism must be provided with a shunt release and the necessary auxiliary switches. An operations counter must be fitted to the mechanism and designed to indicate the total number of opening operations. Provide local manual close and trip shrouded pushbuttons, control power cutoff switch, local electrical close and trip at the circuit breaker, and local/remote selector switch at the circuit breaker for connection to SCADA system.

f. Maximum symmetrical interrupting current of 25, 31.5, or 40 kA Amp RMS.

g. Short-time (3 seconds) current carrying capability 25, 31.5, or 40 kA Amp RMS.

h. Minimum closing and latching peak current capability of 65, 82, or 104 kA Amp RMS.

i. 5-cycle maximum interrupting time.

j. 75, 95, 125, 150, 170, or 200kV minimum basic impulse insulation level (BIL).

2.2.2.7 Control Power Supply

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

b. System Requirements: External battery must have number of cells and ampere-hour capacity based on an initial specific gravity of 1.210 at 25 degrees C 77 degrees F with electrolyte at normal level and minimum ambient temperature of 13 degrees C 55 degrees F. Cycle battery before shipment to guarantee rated capacity on installation. Arrange to operate ungrounded. Battery system capacity is recommended by switchgear manufacturer to operate the circuit breakers for a one-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 closes contacts that provide a battery-charger malfunction indication at system control and monitoring panel.

d. DC ammeter: Maximum error of five percent at full-load current, with toggle switch to select between battery and charger current.

e. DC Voltmeter: Maximum error of five 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 normally open (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.

2.2.2.8 SCADA Operation

The circuit breaker control system must execute remote commands received from a SCADA master station and transmit switchgear operation information to a SCADA master station. Include transfer of circuit breaker to "Close" and "Open" positions[and enabling of the Source-Transfer operation] for execution of remote commands. Include circuit breaker position status, voltage and current readings, and DC supply system status with communication of switchgear information.

2.2.2.8.1 Source-Transfer Operation

Provide an automatic switch control system that opens an incoming circuit breaker when voltage is lost and closes the alternate incoming circuit breaker if voltage is present. Include with the Source-Transfer controls an overcurrent-lockout feature that prevents automatic closing of a circuit breaker into a system fault. Include provisions for returning the system to the normal configuration via manual, SCADA, or automatic operations when voltage is restored.

2.2.2.8.2 Fault Detection Isolation and Restoration Operation

The automatic control system must execute circuit fault detection isolation operation for closed and open loop distribution systems. Provide communication via a peer-to-peer fiber optic network for the control systems. Provide an optical fiber cable approved by the control system manufacturer.

2.2.2.8.3 Key Interlock

Provide key interlock system as indicated on the drawings.

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 Amps.

(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 two 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.

****

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 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 radians 250 degree scale. Provide single-phase indicating instruments with flush-mounted transfer switches for reading three phases.

a. AC ammeters: Transformer rated, five-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 five-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   Electronic Watthour Meter

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. 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 three current transformers. Include 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.

IEEE C57.13. Provide single ratio transformers, 60 hertz, [_____] to five-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.]

2.2.3.3 Instrument Transformers

IEEE C57.13.

a. Current transformers: Each breaker compartment must have provision for front-accessible mounting of current transformers (ANSI standard relay accuracy), on bus side and cable side of circuit breaker. Standard mounting location of current transformers are to be on the cable side of the circuit breaker. The current transformers wiring must be Type SIS No. 10 AWG copper.

b. Potential transformers: Transformers must be fixed mounted with fuses and disconnect switch, 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.

2.2.3.4 Heaters

Provide 120-volt heaters in each switchgear control 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 430 degrees F insulation system with a temperature rise not exceeding 115 degrees C 240 degrees F and must conform to NEMA ST 20. Provide panelboard and circuit breakers in each switchgear assembly[or outdoor enclosure in case of outdoor switchgear] 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.

2.2.3.5 Pilot and Indicating Lights

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

2.2.3.6 Metering

2.2.3.6.1 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 one 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 two cycles of voltage or current exceeding programmable set points. Store waveforms for all six channels of voltage and current for a minimum of 10 cycles prior to the event and 50 cycles past the event.

[2.2.3.7 Submetering

ASHRAE 90.1 - SIASHRAE 90.1 - IP. Provide submetering for [_____].

]2.2.3.8 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.

2.2.3.9 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 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.

2.2.3.10 Surge Arresters

Provide plug-in type surge arrestors, rated [[3][6][9][10][12][15][_____] kV] as indicated on the drawings, fully shielded, dead-front, metal-oxide-varistor type.

2.2.3.11 Control Wiring

The switchgear control wiring must be type SIS No. 2.1 mm squared 14 AWG copper minimum, except where larger size wire is required.

2.2.3.12 Grounding Resistor

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

a. The resistor element must be [stainless steel][cast-iron] and rated [_____] amperes for a [10-second][one-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 is provided with 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 are 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. [_____] mm squared [_____] 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 are 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. 107 mm squared 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 ratio is shown.

2.2.4 Design Requirements

a. Design equipment enclosure in accordance with seismic requirements.

b. Design switchgear to accommodate entrance of cables where indicated.

2.2.5 Performance Requirements

a. Factory testing in accordance with the latest ANSI standards.

b. Factory test results documentation.

2.3 [ASSEMBLY][FABRICATION]

2.3.1 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.

2.3.2 Field Fabricated Nameplates

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 off 25 mm by 65 mm 1 by 2.5 inches. Provide lettering that is a minimum of 6.35 mm 0.25 inch high normal block style.

2.3.3 Factory Assembly

Instruction manual and drawings for field assembly.

2.3.4 Shop Fabrication

Install switchgear fully tested at factory.

2.3.5 Finishes

Fully assembled switchgear is paint coated, and protected from environment for shipping to site.

2.4 EQUIPMENT

a. Provide a list of proposed equipment including model numbers, description of breakers, current transformers, voltage transformers, fuses, relays, control switches, and other devices.

b. Provide a list of special equipment required for operation and maintenance of switchgear.

2.5 COMPONENTS

a. Provide complete wiring diagrams or wiring lists showing connections of component devices and equipment.

b. Attach Data Sheets that specify major components and accessories to be provided with clear identification marking.

2.6 ACCESSORIES

Provide a list of instruments and accessories supplied, listing manufacturer, model number, operating ranges, and equipment tag numbers.

2.7 TESTS, INSPECTIONS, AND VERIFICATIONS

2.7.1 Switchgear Design and Production Tests

Furnish reports which include results of routine and production tests performed according to IEEE C37.74[, IEC 62271-103][and IEEE C37.60[, IEC 62271-111]]. Perform manufacturer certified production test reports on each switchgear assembly to ensure that design performance is maintained in production.

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 operating mechanism, mechanical interlocks.

    (2) 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.

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

    (4) 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 circuit breaker.

    (2) 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.

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

2.7.2 Switchgear Conformity to Design Tests

IEEE C37.20.2A, IEEE C37.20.3, or IEEE C37.20.9 as applicable. Furnish documentation showing the results of routine tests on a product of the same series and rating as that provided by this specification. Required tests are as follows:

a. Design Tests:

    (1) Dielectric test.

    (2) Resistance test of the main bus.

    (3) Pressure check of gas-filled compartments.

    (4) Auxiliary devices test.

(5) Wiring verification.

(6) Rated continuous current test.

(7) Short-circuit current withstand tests.

(8) Mechanical endurance tests.

(9) Rain test for outdoor MV switchgear.

2.8 COORDINATED POWER SYSTEM PROTECTION

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

2.9 SERVICE ENTRANCE AVAILABLE FAULT CURRENT LABEL

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.

2.10 MIMIC BUS LABELING

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 EXAMINATION

a. Verify Site conditions are acceptable for switchgear installation.

b. Inspect all surfaces of switchgear for dents or defects in manufacturing or shipping.

c. Manufacturer to provide detailed storage, installation and handling instructions.

c. Provide manufacturer's field service representative to perform wiring interconnections between shipping splits.

d. Provide manufacturer's field service representative for technical direction and field commissioning services. Relays are programmed in the factory using settings furnished by Engineer or Owner.

3.2 PREPARATION

a. Ship switchgear for installation as completely assembled as practicable.

b. Where switchgear is installed in separate building ship enclosure as complete as practicable with switchgear and components installed inside for ease of installation in field.

c. If shipping splits are required, clearly identify connections between splits for enclosure circuits and switchgear splits.

d. Provide junction and terminal boxes at each connection point.

3.2.1 Protection

a. Cover equipment and accessories and protect from damage during shipment.

b. Acceptable shipping materials used for protecting equipment when manufacturer's recommended storage procedures are maintained.

3.2.2 Surface Preparation

Clean shot blasted factory coated switchgear enclosure as specified.

3.3 INSTALLATION

Conform to IEEE C2, NFPA 70, storage, anchor provisions, O&M manuals, and to the requirements specified herein.

3.4 APPLICATION

3.4.1 Grounding

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

3.4.1.1 Grounding Electrodes

Provide driven ground rods as specified[in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION][at each corner of switchgear pad][as indicated].

3.4.1.2 Switchgear Grounding

Connect 107 mm squared 4/0 AWG bare copper conductor ground ring, not less than 600 mm 24 inches below grade, to the upper end of the ground rods by exothermic welds or compression connectors. Provide 107 mm squared 4/0 AWG bare copper conductors connecting the switchgear grounding provisions to two different ground rods.

3.4.1.3 Connections

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

3.4.1.4 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.4.2 Special Technique

When applicable.

3.4.3 Interface with Other Products

3.4.3.1 Foundation for Equipment and Assemblies

****
NOTE: Provide details for mounting equipment on foundation.
****

Provide foundation for supporting equipment and assemblies.

[3.4.3.2 Exterior Location

Mount switchgear on concrete foundation slab. Provide slab of adequate size to project at least 200 mm 8 inches beyond equipment.[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.] 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 install bushings on conduits 75 mm 3 inches above slab surface. Concrete work must be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

][3.4.3.3 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. Concrete work must be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

]3.4.4 Tolerances

Perform in accordance with the manufacturer's recommendations, NFPA 70B, NETA ATS, and referenced ANSI standards.

Include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.5 FIELD QUALITY CONTROL

3.5.1 Tests

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

Perform in accordance with the manufacturer's recommendations, NFPA 70B, NETA ATS and referenced ANSI standards. The [_____] Division, Naval Facilities Engineering Sytems 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.

Include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

a. Perform contact-resistance tests.

b. Trip fault interrupters by operation of overcurrent control and remote trip.

c. Perform insulation-resistance tests.

d. Perform an over-potential test on each switched way pole with the switched way in the open position in accordance with the manufacturer's instructions.

e. Set fault interrupter overcurrent control in accordance with Government provided settings. Request settings from Government, in writing, a minimum of 30 days prior to scheduling electrical tests.

3.5.2 Inspection - Medium-Voltage Vacuum Circuit Breakers

a. Visual and Mechanical Inspection

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

(2) Inspect physical and mechanical condition.

(3) Check for proper anchorage, alignment, required area clearances, and grounding.

(4) Perform mechanical operational tests in accordance with manufacturer's instructions.

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

(6) Verify that insulating SF6 gas pressure or dielectric fluid level is correct.

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

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

(9) Verify that current and potential transformer ratios correspond to approved shop drawings.

(10) Verify tightness of accessible bolted connections by calibrated torque-wrench method. Thermographic survey is required.

(11) Inspect all indicating devices for proper operation.

(12) Confirm correct operation and sequencing of electrical and mechanical interlock systems for proper operation and sequencing.

(13) Clean switchgear.

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

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

(16) Exercise all active components.

(17) Inspect all mechanical indicating devices operational tests in accordance with manufacturer's instructions for correct operation.

(18) Verify that vents are clear.

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

(20) Inspect control power transformers.

(21) Record as-found and as-left operation 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 overpotential tests.

(3) Perform control wiring performance test.

(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 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.

(7) Verify operation of heaters.

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

(5) CAUTION: Changes of connection, insertion, and removal of instruments, relays, and meters must be performed systematically 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 applicale.

3.5.2.2 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 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.

3.5.2.3 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, 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 electrically operated to verify that the proper breakers and alarms initiate.

3.5.3 Manufacturer Field Service

Schedule training with Owner with at least three weeks advance notice.

Upon completion of acceptance checks, settings, and tests, the Manufacturer 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 --