Preparing Activity: USACE Superseding
UFGS-26 22 00.00 10 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
****

SECTION TABLE OF CONTENTS

DIVISION 26 - ELECTRICAL

SECTION 26 22 00.00 10

480-VOLT STATION SERVICE SWITCHGEAR AND TRANSFORMERS

10/07

PART 1 GENERAL

1.1 PAYMENT PROCEDURES
1.2 REFERENCES
1.3 SUMMARY
1.4 SUBMITTALS
1.5 EXTRA MATERIALS

PART 2 PRODUCTS

2.1 NAMEPLATES
2.2 COPPER AND ALUMINUM BARS AND RODS
2.3 CONDUIT AND ELECTRICAL METALLIC TUBING
2.4 CONNECTIONS
2.5 480-VOLT STATION SERVICE SWITCHGEAR
2.5.1 General
2.5.2 Enclosure and Framework
2.5.2.1 Switchgear
2.5.2.2 Enclosure
2.5.2.3 Drawout Circuit Breaker
2.5.2.4 Ventilating Opening
2.5.2.5 Foundations
2.5.3 Buses and Connections
2.5.4 Power Circuit Breakers
2.5.4.1 General
2.5.4.2 Power Supply and Bus Tie Circuit Breakers
2.5.4.3 Feeder Air Circuit Breakers
2.5.4.4 Automatic Bus Transfer
2.5.5 Wiring
2.5.5.1 Control Panel and Power Wiring
2.5.5.2 Terminals and Installation
2.5.5.3 Terminal Blocks
2.5.6 Grounding
2.5.7 Molded Case Circuit Breakers

2.5.7.1 General
2.5.7.2 Trip Units
2.5.7.3 480-Volt AC Circuits
2.5.7.4 120-Volt and 208-Volt AC Circuits
2.5.7.5 125 Volt DC Circuits
2.5.8 Instrument Transformers
2.5.8.1 Voltage Transformers
2.5.8.2 Current Transformers
2.5.9 Ground Detection Equipment
2.5.10 Relays
2.5.10.1 General
2.5.10.2 AC Voltage Relays
2.5.10.3 Auxiliary relays
2.5.11 Control and Instrument Switches
2.5.11.1 General
2.5.11.2 Switch Features
2.5.12 Indicating Lamp Assemblies
2.5.13 Indicating Instruments
2.5.13.1 General
2.5.13.2 Rectangular Switchboard Instruments
2.5.13.3 AC Voltmeters
2.6 METAL-ENCLOSED BUS
2.6.1 General
2.6.2 Conductors
2.6.3 Enclosure
2.6.4 Grounding
2.7 SECONDARY UNIT SUBSTATION
2.7.1 General
2.7.2 Incoming Sections
2.7.3 Transforming Sections
2.7.4 Transformer Bus Connections
2.7.5 Outgoing Section
2.8 STATION SERVICE TRANSFORMER
2.8.1 Type and Rating
2.8.2 Core and Coils
2.8.3 Enclosure
2.8.4 Incoming Sections
2.9 ACCESSORIES
2.10 FACTORY INSPECTION AND TESTS
2.10.1 General
2.10.2 Switchgear Assembly Tests
2.10.2.1 Assembled Equipment
2.10.2.2 Wiring
2.10.2.3 Switchgear Assembly
2.10.2.4 Circuit Breaker
2.10.3 Instrument Transformer Test
2.10.4 Metal-enclosed Bus Test
2.10.5 Station Service Transformer Test

PART 3 EXECUTION

3.1 PAINTING
3.2 INSTALLATION

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC / NASA **UFGS-26 22 00.00 10 (October 2007)**

Preparing Activity: USACE **Superseding**
UFGS-26 22 00.00 10 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
****

SECTION 26 22 00.00 10

480-VOLT STATION SERVICE SWITCHGEAR AND TRANSFORMERS
10/07

****

NOTE: This guide specification covers the requirements for 480-volt station service switchgear and transformers normally used for hydroelectric power plant facilities, navigation locks and pumping plants. This section was originally developed for USACE Civil Works projects.

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).
****

PART 1 GENERAL

****

NOTE: If this guide specification is used for procurement of items to be installed by the Government or to be furnished to the Contractor as Government furnished equipment, or is used to obtain services which are not part of a construction contract, the following guidance applies:

a. Applicable parts of this guide specification should be adapted to the procurement and included in Section C of the Uniform Contract Format contracts for products or the scope of work portion of

contracts for services.

b. The following provides information and requirements to be included in a contract for procurement of the specified supplies or services.

PART I -- THE SCHEDULE

Section B Supplies or Services and Prices

Select the appropriate schedule applicable to the procurement.

ITEM NO.	SUPPLIES/SERVICES	UNIT QUANTITY	UNIT	PRICE	AMOUNT
SCHEDULE (ALTERNATE 1)					
0001	480-Volt AC Indoor Metal-Enclosed Power Circuit Breaker Switchgear Assembly	[_____]	Each	[_____]	[_____]
0002	Switchgear Accessories and Spare Parts	[_____]	Lot	[_____]	[_____]
0003	600-Volt, AC, [_____]-Amps 3-Phase, Metal-Enclosed Bus	[_____]	Lot	[_____]	[_____]
0004	[[_____]-480] [13,800-480]-Volt. [_____]-kVA, 3-Phase, Indoor, Ventilated, Dry Type (Class AA), Transformer	[_____]	Each	[_____]	[_____]
0005	Bid Data (See DD Form 1423, Exhibit A)	[_____]	[_____]	Not separately priced	[_____]
0006	Contract Data (See DD Form 1423, Exhibit B)	[_____]	[_____]	Not separately priced	[_____]
				TOTAL	[_____]

ITEM NO.	SUPPLIES/SERVICES	UNIT QUANTITY	UNIT	PRICE	AMOUNT
SCHEDULE (ALTERNATE 2)					
0001	[[_____]-480] [13,800-480] Volt, [_____]-kVA, 3-Phase, Indoor, Metal-Enclosed Secondary Unit Substation	[_____]	Each	[_____]	[_____]
0002	Substation Accessories and Spare Parts	[_____]	Lot	[_____]	[_____]
0005	Bid Data (See DD Form 1423, Exhibit A)	[_____]	[_____]	Not separately priced	[_____]
0006	Contract Data (See DD Form 1423, Exhibit B)	[_____]	[_____]	Not separately priced	[_____]
				TOTAL	[_____]

SCHEDULE (ALTERNATE 2)

NOTE: Bid items above should be copied on Standard Form 36, continuation sheet, when submitting specifications for approval.

Section C Description/Specifications

All materials, components, and equipment not manufactured by the Contractor must be products of manufacturers other than those specified herein will be accepted when it is proved to the satisfaction of the Contracting Officer that such products are adequate and suitable for the intended use. Upon request, furnish to the Contracting Officer for approval the names of all such other manufacturers, together with complete pertinent information regarding all such products which he proposes to incorporate into the work. Submit samples of materials and equipment for approval when so directed. Insofar as practicable, devices and equipment used for the same or similar services must be of the same make and type, and inter-changeable when of the same rating.

Section D Inspection and Acceptance

Include the following:

Test of Materials.

Test all materials, supplies, and parts and assemblies thereof entering into the work to be done under these specifications in accordance with the

requirements of the referenced standard specifications specified herein, except as otherwise indicated or where such tests are waived in writing by the Contracting Officer. In case the Contractor desires to use stock material not manufactured specifically for the work covered by these specifications, submit evidence satisfactory to the Contracting Officer that such material conforms to the requirements of these specifications, in which case detailed tests on these materials may be waived.

Unless waived in writing, make all tests or trials in the presence of a Quality Assurance Representative (QAR) and furnish copies of all test reports by the Contractor as soon as practicable after the tests are made and submitt in such form as to provide means of determining compliance with the applicable specifications for the material tested. Where the presence of a QAR is waived, furnish certified copies of the test reports to the Contracting Officer.

Plainly mark test specimens and samples for analysis to indicate the materials they represent and, if required, properly box and prepare them for shipment.

Except as provided elsewhere, all costs of all test and trials, excepting the pay and expense of the QAR, are borne by the Contractor and no separate payment will be made therefor.

Section E Special Contract Requirements

Include the following:

Contractor's Drawings and Data.

1. Within [_____] calendar days after [date of award] [date of receipt of notice of award], submit for approval outline drawings of all equipment to be furnished under this contract, together with weights and overall dimensions to enable the Contracting Officer to proceed with the final design of the [powerhouse] [pumping plant] [navigation lock]. These drawings must show space requirements, details of any floor supports to be embedded in concrete, location of terminal blocks, and top and bottom conduit entrance areas.

2. Within [_____] calendar days after [date of award] [date of receipt of notice of award], submit for approval such assembly and detailed drawings and data as required to demonstrate fully that all parts of the equipment will conform to the requirements and intent of the specifications. Include applicable schematic diagrams with wire designations, equipment lists, accessories and spare parts lists, nameplate schedules, all necessary descriptive data, and wiring diagrams showing panel

connections, panel interconnections, terminal block and conductor designations, and external cables.

3. All drawings and data submitted and approved will form a part of the contract. The sequence of submission of drawings must be such that all information is available for checking each drawing when it is received.

4. Furnish [_____] reproducible, of a quality that will make legible prints,] [and] black and white copies or blueprints of each drawing for approval. Each submission of drawings by the Contractor must be accompanied by a letter of transmittal containing a list of drawings giving titles and numbers. Address transmittals to [_____]. Decisions on these drawings, either approval or disapproval, will be given by the Contracting Officer by letter or telegram. Within [15] [_____] calendar days after receipt, the Contracting Officer will return one copy to the Contractor marked "Approved", "Approved Except as Noted", or "Returned for Correction". The notations "Approved" and "Approved Except as Noted" authorize the Contractor to proceed with the fabrication of the equipment covered by such drawings, subject to the correction, if any, indicated thereon or described in the letter of transmittal. When prints of drawings have been "Returned for Correction", make the necessary revisions on the drawings and submit [reproducibles] [and] [_____] prints for approval in the same routine as before. Show every revision made during the life of the contract by number, date, and subject in a revision block and make a notation in the drawing margin to permit rapid location of the revision. Include the time consumed by the Contractor in submitting and obtaining approval of assembly and shop drawings in the time allowed for completion of the contract.

5. Upon receipt of prints which have been marked "Approved Except as Noted" or "Returned for Correction", within 30 calendar days after receipt, submit correct [reproducibles] [and] [_____] prints of each drawing. If revisions are made after a drawing has been "Approved", furnish [reproducibles] [and] [corrected prints] subsequent to each revision.

6. All of the applicable requirements of this paragraph with reference to drawing submittals apply equally to catalog cuts, illustrations, printed specifications, weld qualifications, mill tests, factory tests, field tests, or other required data, except submit two additional copes in lieu of any reproducibles. All correspondence, drawings, literature, instruction books, data, and nameplates must be in the English language, with Metric (English) units as currently used in the United States.

7. Any manufacturing work performed prior to the approval of the drawings will be at the Contractor's risk. Make any changes in the design which are necessary to make the equipment conform to the provisions and intent of these specifications without additional cost to the Government. Do not construe approval of the drawings as a complete check but will indicate only that the general method of construction and detailing is satisfactory. Do not hold Contracting Officer's approval of the Contractor's drawing to relieve the Contractor of any part of the Contractor's' obligation to meet all of the requirements of these specifications or of the responsibility for the correctness of the Contractor's drawings.

8. Upon completion of the work under this contract, furnish a complete set of [CADD files] [process tracings together with complete sets of black and white prints or blue-prints] of added drawings as finally approved. [Furnish the CADD files in Microstation format on electronic media; i.e., $3^1/_2$ inch floppy disks, compact disks, etc.] [The process tracings must be full size reproducibles made on cloth, Mylar, or equal, from the original tracings by photographic-type reproduction, and of such quality and clarity as to permit sharp and thoroughly legible microfilm copying.] These [CADD files] [tracings] [tracings and prints] must show all changes and revisions, including any field changes made up to the time that the equipment is completed and accepted and the contract number must be shown thereon. Locate the number immediately above the title block if possible.

9. Assemble parts catalogs, where applicable, the operating instructions especially prepared covering all equipment furnished under this contract which may be needed or useful in operation, maintenance, repair, dismantling, or assembling, and for repair and identification of parts for ordering replacements under a suitable common cover and [_____] furnish copies of the assembled material. Include complete identification of the spare parts furnished in compliance with the requirements of these specifications.

Part III -- LIST OF DOCUMENTS, EXHIBITS, AND OTHER ATTACHMENTS

Section F List of Documents, Exhibits, and Other Attachments

Suitable drawings showing the location and general arrangements of the equipment, a single-line diagram of the main power connections, and tabulations of feeder circuit data should be included with the procurement specifications. The drawings should

include all features not adequately covered in the specifications which will affect the design of related equipment or the structure.
****

1.1 PAYMENT PROCEDURES

The 480-Volt Station Service Switchgear and Transformers will be paid by the lump sum job basis for costs associated with [furnishing] [and] [installing] the 480-Volt Station Service Switchgear and Transformers and other completed work, as specified.

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

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2003; R 2018) Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)

ASTM INTERNATIONAL (ASTM)

ASTM B187/B187M	(2020) Standard Specification for Copper, Bus Bar, Rod and Shapes and General

	Purpose Rod, Bar and Shapes
ASTM B188	(2015; E 2016) Standard Specification for Seamless Copper Bus Pipe and Tube
ASTM B236	(2007) Standard Specification for Aluminum Bars for Electrical Purposes (Bus Bars)
ASTM B236M	(2007) Standard Specification for Aluminum Bars for Electrical Purposes (Bus Bars) (Metric)
ASTM B317/B317M	(2007; R 2015; E 2016) Standard Specification for Aluminum-Alloy Extruded Bar, Rod, Tube, Pipe, Structural Profiles, and Profiles for Electrical Purposes (Bus Conductor)

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.13	(2015) Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures
IEEE C37.16	(2009) Standard for Preferred Ratings, Related Requirements, and Application Recommendations for Low-Voltage AC (635 V and below) and DC 3200 V and below) Power Circuit Breakers
IEEE C37.17	(2022) Standard for Trip Devices for AC and General-Purpose DC Low-Voltage Power Circuit Breakers
IEEE C37.20.1A	(2020) Metal-Enclosed Low-Voltage (1000 Vac and below, 3200 Vdc and below) Power Circuit-Breaker Switchgear Amendment 1: Control and Secondary Circuits and Devices, and All Wiring
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 C37.90	(2005; R 2011) Standard for Relays and Relay Systems Associated With Electric Power Apparatus
IEEE C57.12.01	(2020) General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid-Cast and/or Resin-Encapsulated Windings
IEEE C57.12.50	(1981; R 1998) Ventilated Dry-Type Distribution Transformers, 1 to 500 kVA, Single-Phase, and 15 to 500 kVA, Three-Phase, with High-Volt 601 to 34,500

	Volts
IEEE C57.12.51	(2019) IEEE Guide for Mechanical Interchangeability of Ventilated Dry-Type Transformers
IEEE C57.12.91	(2011) Standard Test Code for Dry-Type Distribution and Power Transformers
IEEE C57.13	(2016) Standard Requirements for Instrument Transformers

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C80.1	(2020) American National Standard for Electrical Rigid Steel Conduit (ERSC)
ANSI C80.3	(2020) American National Standard for Electrical Metallic Tubing (EMT)
NEMA AB 3	(2013) Molded Case Circuit Breakers and Their Application
NEMA C37.50	(2018) Switchgear--Low-Voltage AC Power Circuit Breakers Used in Enclosures - Test Procedures
NEMA C37.51	(2018) Switchgear--Metal Enclosed Low-Voltage AC Power, Circuit-Breaker Switchgear Assemblies-Conformance Test Procedures
NEMA FB 1	(2014) Standard for Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable
NEMA TR 1	(2013) Transformers, Regulators, and Reactors
NEMA WC 70	(2021) Power Cable Rated 2000 Volts or Less for the Distribution of Electrical Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures

1.3 SUMMARY

a. The location and general arrangement of the low-voltage metal-enclosed switchgear assembly, [metal-enclosed bus structures] [and station service transformers] are shown. Modifications of the equipment arrangement or the equipment device requirements shown are subject to

approval. Assemble and wire the switchgear assembly completely at the factory. Assemble at the factory the metal-enclosed bus structures in sections of sufficient length for convenience of tests, shipment, and installation. After complete assembly, disassemble the switchgear group into sections, for convenience of handling, shipment, and installation.

b. Matchmark each shipping section of the switchgear properly to facilitate reassembly, and provide with removable lifting channels with eye bolts for attachment of crane slings to facilitate lifting and handling. Ship equipment as completely assembled and wired as feasible so as to require a minimum of installation work. Provide switchgear groups and metal-enclosed buses which are disassembled into sections for shipment with the associated parts properly matchmarked to facilitate installation by the Government. Carefully pack and ship separately any relay (, indicating instrument) or other device which cannot withstand the hazards of shipment when mounted in place on the switchgear. Mark these pieces with the number of the panel on which they are to be mounted and fully identified so they can be readily mounted and connected.

c. Wrap all finished painted surfaces and metal work suitably or otherwise protect from damage during shipment. Prepare all parts for shipment so that slings for handling may be attached readily while the parts are in a railway car or transport truck. Ensure switchgear sections crated for shipment are of such size, including crates, that they will pass through a [_____]-meter by [_____]-meter [_____]-foot by [_____]-foot hatch opening, and a [_____]-meter by [_____]-meter [_____]-foot by [_____]-foot wall opening.

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA 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, Air Force and NASA 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

Shop Drawings; G[, [_____]]

Installation; G[, [_____]]

Terminal Blocks; G[, [_____]]

SD-03 Product Data

Switchgear

Power Circuit Breakers

Transformers

Spare Parts

Metal-Enclosed Bus

SD-04 Samples

Nameplates; G[, [_____]]

SD-06 Test Reports

Factory Inspection and Tests

1.5 EXTRA MATERIALS

Submit a list of spare parts as specified herin. Provide spare parts that are duplicates of the original parts furnished, and interchangeable therewith. Furnish the following spare parts for each type and frame size of drawout circuit breaker, except that only one spare is required where parts are applicable to all types and frame sizes of the circuit breakers:

a. One complete set of main, intermediate and arcing contacts and associated springs for one three pole breaker.

b. One complete set of arc chute assemblies for one three pole breaker.

c. One set of primary disconnecting devices for one three pole breaker.

d. One set of secondary disconnecting devices for one three pole breaker.

e. One shunt trip coil.

f. One Spring-charging motor or solenoid for electrically-operated breakers.

g. One Control relay of each type and rating for electrically-operated breakers.

h. One Auxiliary switch complete for electrically-operated breakers.

i. One manual operating mechanism handle for drawout feeder air circuit breakers.

j. Twelve fuses of each type and size for voltage transformers.

k. Six Indicating lamp assemblies (three red lens and three green lens.)

l. Ten Indicating lamp color caps of each color.

m. One spring for stored-energy closing mechanism.

n. Four spare blank nameplates for operating unit doors.

o. One lot spare bulbs for indicating lamp assemblies, package to contain not less than 20.

PART 2 PRODUCTS

2.1 NAMEPLATES

Submit samples of engraved nameplates with a schedule of nameplate sizes and lettering. The Contractor will be permitted to supply and attach to the switchgear assembly a nameplate or trademark. Include a drawing or illustration showing the proposed nameplate, its size and location. Provide each item of equipment mounted on the switchgear, which does not have a suitable designation included as an integral part of the device, with an engraved nameplate or with other approved suitable means of identification. Make nameplates of laminated sheet plastic or of anodized aluminum approximately 3 mm 1/8 inch thick, engraved to provide white letters on a black background. Provide equipment of the withdrawal type with nameplates mounted on the removable equipment in locations visible when the equipment is in place. Fasten nameplates to the panels in proper positions with black finished roundhead screws. Provide each control switch with an escutcheon clearly marked to show each operating position. Engrave switch identifications on the escutcheon plates or on separate nameplates. The escutcheon and nameplate markings are subject to approval.

2.2 COPPER AND ALUMINUM BARS AND RODS

Provide copper or aluminum bars and shapes for main bus and ground bus conductors conforming to the requirements of ASTM B187/B187M, ASTM B188, ASTM B236M ASTM B236, and ASTM B317/B317M.

2.3 CONDUIT AND ELECTRICAL METALLIC TUBING

Provide rigid conduit conforming to ANSI C80.1 that is zinc-coated

(galvanized) both inside and outside by the hot-dip method. Provide electrical metallic tubing conforming to ANSI C80.3. Ensure fittings for rigid metal conduit and electrical metallic tubing conform to NEMA FB 1.

2.4 CONNECTIONS

Provide all bolts, studs, machine screws, nuts, and tapped holes in accordance with ASME B1.1. Ensure threads for sizes 6 to 25 mm 1/4 to 1 inch, inclusive, NC or UNC series. Ensure sizes and threads of all valves, pipe and fittings, conduit and fittings, tubing and fittings, and connecting equipment are in accordance with ASME B1.20.2MASME B1.20.1. Manufacturer's standard thread and construction may be used on small items which, in the opinion of the Contracting Officer, are integrally replaceable, except that threads for external connections to these items must meet the above requirements.

2.5 480-VOLT STATION SERVICE SWITCHGEAR

2.5.1 General

Except as otherwise specified or indicated, provide design, construction and tests of the switchgear conforming to the applicable requirements of IEEE C37.13, and [IEEE C37.20.1A][IEEE C37.20.2A][IEEE C37.20.3]. The switchgear will be used to distribute power from two [[_____]-kVA, [_____]-480 volt] [13,800-480 volt], 3-phase, 60-Hz, station service transformers to 480-volt power distribution centers and to other station service loads. Provide switchgear assembly that contains two main bus sections connected by a bus tie circuit breaker. Each main bus section will be connected to a supply transformer through a main supply circuit breaker. Provide two main supply circuit breakers and bus tie circuit breaker that are electrically operated and normally remotely controlled. Provide automatic bus transfer as specified in paragraph Automatic Bus Transfer. Provide switchgear with instruments, control accessories, and other equipment mounted on the front panels and inside the switchgear as shown and as specified. The annunciator window group will be furnished by the Government for mounting and wiring by the Contractor.

2.5.2 Enclosure and Framework

2.5.2.1 Switchgear

Provide switchgear of the totally-enclosed, free-standing, dead-front type built on a suitable framework of structural steel, or by an equivalent approved method, to provide a self-supporting and stable structure. Metal-enclosed switchgear construction consisting of ribbed side sheets and fabricated framework which is functionally equivalent to the structural steel framework specified will be acceptable. Ensure framework and structure is sufficiently rigid to withstand operation of the equipment or any stresses due to short circuits. Ensure each shipping assembly is also sufficiently rigid, with the addition of temporary members if required, to withstand handling during shipment and installation.

2.5.2.2 Enclosure

Make enclosure of selected smooth sheet steel panels, suitably supported. Use doors and panels to support instruments and other devices and barriers between compartments that are no less than No. 11 MSG. Use exposed panels on the front and ends of the enclosure consisting of bent angle or channel

edges with all corner seams welded and ground smooth, or use the manufacturer's equivalent construction as approved. Do not drill or weld front outside surfaces for the purpose of attaching wires or mounting devices if such holes or fastenings will be visible from the front.

2.5.2.3 Drawout Circuit Breaker

Completely enclose each drawout type circuit breaker in a metal compartment. Provide access to the circuit breakers through hinged steel doors. Also provide access to instrument and relay wiring, instrument transformers and fuses, through hinged doors. Provide all hinged doors with bent angle or channel edges, invisible hinges and suitable latches or fastenings. Provide access to bus compartments through removable bolted panels, cover plates or hinged doors.

2.5.2.4 Ventilating Opening

Provide grille type ventilating openings as required. Provide all ventilating openings with corrosion-resistant insect-proof screens on the inside.

2.5.2.5 Foundations

Furnish continuous channel iron foundations, complete with bolts and drilled holes for grouting and anchoring to the floor, for the complete length (front and rear) of each [substation] [switchgear assembly]. Construct channel and drill as required for mounting the equipment. Design channels for flat mounting and use a maximum channel depth of 63 mm 2-1/2 inches. Place foundation channels on top of the floor, fasten in place, and then fill with grout. Provide additional channel or substantial metal trim flush with the end panels to completely enclose the bases across the ends of the equipment assemblies where exposed to view.

2.5.3 Buses and Connections

a. Provide buses in each main bus section with a continuous current-carrying capacity of no less than [1,200] [1,600] [2,000] [3,000] amperes without exceeding the temperature limits specified in [IEEE C37.20.1A][IEEE C37.20.2A][IEEE C37.20.3]. Provide buses with mechanical and thermal capacities coordinated with the interrupting rating of the power supply circuit breakers. Provide bus bars consisting of hard-drawn copper, aluminum, or aluminum-alloy. Braze, pressure-weld or bolt shop splices and tap connections. Bolt all splices for field assembly. Where bolted connections are used, use silver-plated contact surfaces except use tin-plated contact surfaces for aluminum-alloy and equip with provisions for adequate clamping. Mount buses on insulating supports of wet process porcelain, glass polyester, or suitable molded material. Make all primary connections including the power connections to the line side of the circuit breakers by bus bar.

b. Ensure standard phasing within equipment housing for AC power circuits is A-B-C from left to right when facing the front of the equipment, A-B-C from top to bottom, and A-B-C from front to back. Nonstandard phasing in any compartment will be permitted only upon approval and providing each phase is identified and a warning sign, "Nonstandard Phasing," is incorporated within such a compartment.

c. Provide blank compartments without buses and small spare compartments

with buses and complete provisions for installing future feeder circuit breakers where shown.

2.5.4 Power Circuit Breakers

2.5.4.1 General

Provide power supply, bus tie, and feeder air circuit breakers that are the 3-pole, dead-front, drawout type rated 600 volts AC, conforming to the requirements of IEEE C37.13; IEEE C37.16; and IEEE C37.17. Ensure all circuit breakers of the same frame size and type of operation (electrical or manual) are interchangeable. Provide suitable means for removing and handling the drawout circuit breakers. These means may include support from the top of the switchgear enclosure without interference with incoming or outgoing wiring. The Government reserves the right to change the indicated current ratings, within frame limits, of the tripping devices at the time the shop drawings are submitted for approval. Furnish overcurrent trip alarm contacts, with means for manual reset, as indicated. Provide covers over readily accessible energized portions to prevent hazards to personnel when withdrawing or inserting the breakers.

2.5.4.2 Power Supply and Bus Tie Circuit Breakers

Provide 2 power supply circuit breakers and the bus tie circuit breaker which are the electrically-operated drawout type with the closing mechanism designed for operation on 125 volts DC. Use circuit breakers rated 600 volts AC, [600] [1,600] [3,000] ampere frame size, [22,000] [42,000] [65,000] amperes symmetrical interrupting capacity at 600 volts AC, with continuous current ratings as indicated. Provide each circuit breaker with functional components in accordance with Table 1 of IEEE C37.13, including means for manual emergency tripping and manual closing for maintenance operation. Provide each power supply breaker and the bus tie circuit breaker with a solid-state direct-acting over-current tripping device consisting of long-time-delay and short-time-delay elements. Furnish bus tie circuit breaker without an overcurrent trip device but provide with a 125-volt DC shunt trip device. Select long-time and short-time-delay operation bands to provide maximum selectivity between the primary supply protective relays, power supply breakers, bus tie breaker, feeder breakers and motor control center molded case breakers for a fault on a feeder circuit. Information on primary relays and molded case breakers will be supplied to the Contractor. Electrically interlock 2 power supply circuit breakers and the bus tie circuit breaker so that only 2 of the 3 breakers can be in the closed position at the same time. Provide a local test control switch for each electrically-operated circuit breaker which is electrically interlocked through cell switches or secondary disconnects to prevent breaker operation except when the breaker is in the test position. Provide sufficient breaker auxiliary switch contacts and cell switches to accomplish the required breaker control and interlocking system as shown. Provide at least 4 auxiliary switch contacts on each breaker. Also provide at least 2 spare auxiliary switch contacts, one normally-open and one normally-closed, on each electrically-operated breaker.

2.5.4.3 Feeder Air Circuit Breakers

Provide independent manually-operated type feeder breakers, rated 600 volts AC, with manually-charged stored energy closing mechanism and with frame sizes as indicated Provide circuit breakers with 600-ampere frames with a short-circuit interrupting capacity of no less than 22,000 rms

symmetrical amperes at 600 volts AC. Provide each feeder breaker, except as specified otherwise, with a solid-state direct-acting overcurrent tripping device consisting of a long-time-delay element and a short-time-delay element. Use long-time-delay trip elements for direct-acting overcurrent tripping devices that are adjustable over an approximate range of 80 to 110 percent of the trip ampere rating. Use short-time-delay trip elements, for the direct-acting overcurrent tripping devices yhat are adjustable over a range of approximately 4 to 10 times the ampere rating. Fit manually-operated drawout type circuit breakers with suitable operating handles, preferably of the pistol grip type, or vertical lever type, designed to close the breaker with a rotary motion of less than 180 degrees. Design all breakers for tripping by a rotary motion in the opposite direction or by pressing a readily accessible trip button. Ensure operating handles are easily removable when it is necessary to open the compartment door and easily replaceable for operating the breaker in the withdrawn or test position. Ensure duplicate feeder breakers are key interlocked. Equip each breaker with a conspicuous mechanical target visible with the breaker in the normal operating position to indicate whether the breaker is open or closed and provide with a manually-reset bell alarm contact to energize the annunciator circuit only when the breaker is automatically tripped on a fault or overload. Provide manually-operated type circuit breaker for the powerhouse crane feeder equipped with a 125-volt DC shunt trip attachment for emergency operation from remote stations.

2.5.4.4 Automatic Bus Transfer

Provide stations with automatic bus transfer. Make automatic transfer arrangement as shown by the schematic diagrams and incorporate the following (normal operation will be with both supply breakers closed and the bus tie breaker open):

a. Loss of voltage on one bus must cause the associated supply breaker to trip and the bus tie breaker to close.

b. Automatic transfer control will cease to function if either of the supply breakers or the bus tie breaker trip on overcurrent.

c. Recovery of voltage from 1 of the 2 normal sources must (after a time delay) open the bus tie breaker and close the associated supply breaker.

d. Recovery of voltage from both normal sources must (after a time delay) open the bus tie breaker and close the supply breakers.

e. After pickup by the voltage relays, accomplish the bus transfer operation within approximately 1 second.

2.5.5 Wiring

2.5.5.1 Control Panel and Power Wiring

Provide control panel wiring consisting of stranded copper switchboard wire with 600-volt insulation. Provide Type SIS wire as listed in NFPA 70 and meeting the requirements of NEMA WC 70. Provide hinge wire with class K stranding. Use current transformer secondary leads no smaller than No. 10 AWG. Ensure minimum size of wire for all other control wiring is No. 14 AWG. Use power wiring for 480-volt circuits and below that is the same type as control panel wiring and a minimum size of No. 12 AWG.

2.5.5.2 Terminals and Installation

a. Furnish and install control wiring within the assembly housings as specified. Run all control wiring leaving equipment to terminal blocks and terminate. Provide terminal blocks and internal wiring for connection of remote circuits to all spare auxiliary and alarm contacts, remote annunciators, remote control switches, and pilot devices and remote indicating lights where such devices are specified and applicable to the equipment involved. Bring each individual potential transformer lead out to a terminal block. Ground potential transformers for ground detecting circuits at the equipment. Potential transformers for metering circuits will be remotely grounded by the Government. Do not splice wiring and make all connections at terminal studs or blocks. Add terminal blocks for wiring to devices having leads instead of terminals. Use indented terminals, Burndy Type YAV10 or an approved equal, on all wires terminated on screw or stud terminals. Provide all screw terminals with toothed lock washers and all stud terminals with contact nuts and either locking nuts or lock washers.

b. All external control cables and power cables will enter the switchgear in [conduit] [cable trays] [from above] [from below]. Provide space for cables as shown. The 600-volt metal-enclosed buses must enter the switchgear from [above] [below through floor slots]. Provide matching openings in the switchgear to permit the entrance of the bus into the switchgear through the concrete openings. Provide clam-style terminals of sizes indicated for all main power cable leaving the switchgear. Provide terminals of the heavy-duty, full clamp type, Burndy "Qiklug", or approved equal. Include adequate provisions for supporting the Government's cables between the conductor terminating points and where they enter or leave the switchgear.

2.5.5.3 Terminal Blocks

Submit prints of wiring and terminal drawings in accordance with Contract Clause CONTRACTOR'S DRAWINGS AND DATA, which will be marked and returned to the Contractor for addition of the designations to the terminal strips and tracings, along with any rearrangement of points required.

a. Provide molded or fabricated type terminal blocks for control wiring with barriers, rated no less than 600 volts, type [_____]. Provide removable binding, fillister or washer head screw type, or stud type terminals with contact and locking nuts. Ensure terminals are no less than No. 10 in size and have sufficient length and space for connecting at least 2 indented terminal connectors for No. 19/22 AWG conductors to each terminal. The terminal arrangement is subject to approval. Provide no less than 10 percent, but in no case less than 2, spare terminals on each block or group of blocks.

b. Furnish short-circuiting type terminal blocks for all current transformer secondary leads and make provision for shorting together all leads from each current transformer without first opening any circuit. Ensure these terminal blocks are made by the same manufacturer as the terminal blocks for control wiring listed above, type [_____].

c. Provide white or other light-colored plastic marking strips, fastened by screws to each terminal block, for control wire designations. Show

the manufacturer's wire number and the Government's wire number for each connected terminal on the marking strips with permanent marking fluid. Use reversible marking strips to permit marking both sides, or furnish two marking strips with each block, to accommodate the two sets of wire numbers.

d. Provide load terminal blocks rated no less than 600 volts and of adequate capacity for the conductors of power circuits except those supplied from air circuit breakers. Provide either the stud type terminals with contact nuts and locking nuts or the removable screw type terminals, having length and space for at least two indented terminal connectors of the size required on the conductors to be terminated. For conductors rated more than 50 amperes, ensure all screws have hexagonal heads. For conductors rated 50 to 99 amperes, use a minimum screw size of 8 mm 5/16 inch. Use conducting parts between connected terminals with adequate contact surface and cross section to operate without overheating. Provide each connected terminal with the circuit designation or wire number marked on or near the terminal in permanent contrasting color.

e. Give special attention to wiring the terminal arrangement on the terminal blocks to permit the individual conductors of each external Government-furnished cable to be terminated on adjacent terminal points. The wire (terminal point) designations used on the Contractor's wiring diagrams and printed on terminal block marking strips may be according to the Contractor's standard practice; however, additional wire and cable designations for identification of remote (external) circuits may be required.

2.5.6 Grounding

Provide switchgear assembly that includes a full-length interior ground bus of copper or aluminum bar to which the housing, framework, cable supports, bus supports, and non-current carrying metallic parts of all equipment and conduits is grounded insofar as practicable. Do not use soldered connections in the ground leads. If the operating mechanism of drawout units is not permanently grounded, provide ground contacts to automatically connect the movable element to the ground buses. Make these connections before the main disconnecting devices upon insertion, and break after the main disconnecting devices upon withdrawal. Perform grounding in conformance to[IEEE C37.20.1A][IEEE C37.20.2A][IEEE C37.20.3] except that the ground bus must have a continuous current-carrying capacity no less than 25 percent of the continuous rating of the power supply circuit breakers.

2.5.7 Molded Case Circuit Breakers

2.5.7.1 General

Provide molded case circuit breakers conforming to the applicable requirements of UL 489 and NEMA AB 3, that are fully rated, and with voltage ratings and interrupting ratings stated. For circuit breakers of the same ampere frame size, ensure 3 pole and 2 pole circuit breakers are the same width as 3 single pole and 2 single pole circuit breakers respectively. Provide manually-operated circuit breakers with trip-free operating mechanisms of the quick-make, quick-break type. Operate all poles of each breaker simultaneously by means of a common handle, and enclose in a common molded plastic case. Ensure contacts of multi-pole breakers open simultaneously when the breaker is tripped manually or

automatically. Provide operating handles that clearly indicate whether the breakers are in "On", "Off", or "Tripped" position. Provide individually-mounted, stationary type, circuit breakers that are products of the same manufacturer, and are interchangeable when of the same frame size. Provide each circuit breaker with mechanical pressure type terminal lugs for single-conductor stranded copper cables of the size required by the specifications or shown.

2.5.7.2 Trip Units

Provide automatic type circuit breakers with combination thermal and instantaneous magnetic trip units. Set instantaneous magnetic trip units at approximately 10 times the continuous current ratings of the circuit breakers.

2.5.7.3 480-Volt AC Circuits

Provide circuit breakers for 480-volt AC circuits that are rated 600 volts AC with a minimum NEMA interrupting capacity of [14,000] [_____] symmetrical amperes at 600 volts AC.

2.5.7.4 120-Volt and 208-Volt AC Circuits

Provide circuit breakers for 120-volt and 208-volt AC circuits that are rated no less than 250 volts DC, and either 120/240 or 240 volts AC, and with a minimum NEMA interrupting capacity of 10,000 symmetrical amperes.

2.5.7.5 125 Volt DC Circuits

Provide 2-pole rated 125/250 or 250 volts DC circuit breakers for 125 volt DC circuits with a minimum NEMA interrupting capacity of 10,000 amperes DC.

2.5.8 Instrument Transformers

2.5.8.1 Voltage Transformers

Provide five 480-120 volt, 200 volt-ampere capacity, voltage transformers for each main 480-volt bus section. Use two of the transformers for metering and use three of the transformers with the ground detection equipment. Provide voltage transformers conforming to IEEE C57.13 with an ANSI accuracy classification of 0.3W, 0.3X, and 1.2Y or better. Ensure the full-wave impulse level is no less than 10 kV. Protech each voltage transformer with removable primary and secondary fuses. Install fuses in each ungrounded lead and locate adjacent to the transformers in an easily accessible place.

2.5.8.2 Current Transformers

Furnish, install and wire dry type current transformers as shown to the specified terminal blocks. Ensure these current transformers conform to IEEE C57.13, and have the ratios indicated. Provide current transformers rated no less than 600 volts AC, 10 kV BIL, with an ANSI accuracy classification in accordance with [IEEE C37.20.1A][IEEE C37.20.2A][IEEE C37.20.3], or better. If cable connections to the transformer primary are required, furnish terminals of an approved solderless type and proper size. If transformers are connected to buses, furnish proper connections, complete with bolts, nuts, washers and other accessories.

2.5.9 Ground Detection Equipment

Furnish ground detection equipment for each bus section of the switchgear, to be used for indication and annunciation of grounds of the 480-volt system. Provide equipment consisting of 3 instrument voltage transformers complete with primary and secondary fuses, connected wye-delta, with neutral of primary wye grounded and with the coil of a voltage ground detector relay connected in the broken delta corner of the secondary windings of the 3 voltage transformers in accordance with [IEEE C37.20.1A][IEEE C37.20.2A][IEEE C37.20.3]. Provide two ground detector relays, one for each bus section of the switchgear.

2.5.10 Relays

2.5.10.1 General

a. Provide relays conforming to the applicable requirements of IEEE C37.90. Provide back-connected, semi-flush-mounted, switchboard type relays with black, rectangular, dust-tight cases, removable covers with windows, and means of sealing against tampering. Ensure relays, except auxiliary relays, are drawout type with built-in test facilities arranged so that the relays can be tested in position or withdrawn from the fronts of the cases without opening current transformer secondary circuits, disturbing external circuits, or requiring disconnection of leads from the relay terminals. Use test devices that permit testing with energy from either the instrument transformers or an external power supply.

b. Submit descriptive data, including manufacturer types and catalog numbers for equipment. Curve sheets for power supply and bus tie circuit breakers combining characteristics of the trip elements to show the proposed selectivity. In addition, include [_____] sets of characteristic curves of the individual breaker trip elements to permit checking and for power supply and bus tie circuit breakers. Ensure breaker trip ampere ratings and lug sizes are as indicated.

c. Provide protective relays with all required auxiliaries, including auxiliary instrument transformers and reactors, to adjust currents, potentials and phase angles for proper operation. Mount external relay auxiliaries in compact assemblies back of the panels and adjacent to the relays. Provide AC relays suitable for use on 60-Hz circuits and for operation with the instrument transformer ratings and connections shown. Ensure relay current coils are able to withstand 35 times normal current for 1/2 second, and relay voltage coils are able to withstand 110 percent rated voltage continuously without damage. Ensure time delay features do not depend upon oil dashpots or other devices which are appreciably affected by temperature. Provide each relay with one or more operation indicators and/or indicating Contractor switches with targets and external target reset devices, and arrange the circuits for positive target operation. Provide seal-in Contractor and suitable loading resistors where required. Provide separate relay operating function, such as instantaneous trip attachments and different zones for distance relays, with separate targets and contacts.

d. Provide silver-to-silver, electrically independent, chatterproof and non-bouncing relay contacts suitable for use on 125-volt ungrounded DC circuits unless otherwise specified or shown. Where more than one electrically-independent relay contact is required, as indicated , and

it is not feasible to provide more than one such contact, or if two contacts are available but are not electrically independent, furnish auxiliary to provide the required additional contacts.

2.5.10.2 AC Voltage Relays

Provide voltage relays other than ground detector relays of the induction-disc inverse-time type with adjustable time and voltage settings and with semiflush mounting, drawout case type [_____]. Provide ground detector relays of the induction-disc inverse-time overvoltage type rated 199 volts AC with low pickup, semiflush mounting in drawout case with circuit closing contacts suitable for 125-volt DC ungrounded circuits. Ensure they are from the same manufacturer as the AC voltage relays, type [_____].

2.5.10.3 Auxiliary relays

Provide semiflush back-connected type auxiliary relays for bus transfer control for front-of-panel mounting. Provide black semiflush cases that match in appearance other relay cases on the switchgear. Provide auxiliary relays for interior mounting with covers. Provide relay coils and contacts suitable for continuous operation at 125 volts DC, furnish with resistors where required, and of a type that requires a minimum continuous current. Provide high-speed, multi-contact, self-reset type auxiliary relays from the same manufacturer as the AC voltage relays, type [_____].

2.5.11 Control and Instrument Switches

2.5.11.1 General

Ensure all control switches are the rotary switchboard type with handles on the front and the operating contact mechanisms on the rear of the panels, type [_____]. Provide each switch with ample contact stages to perform the functions of the control system. Provide self-aligning contact that operate with a wiping action. Provide a positive means of maintaining high pressure on closed contacts. Provide compression springs or pivotal joints that do not carry current. Use covers or plates on the switches which are readily removable for inspection of contacts. Ensure all control switches are suitable for operation on 600-volt AC or 250-volt DC circuits. Ensure all such switches are capable of satisfactorily withstanding a life test of at least 10,000 operations with rated current flowing in the switch contacts. Use switches capable of continuously carrying 20 amperes without exceeding a temperature rise of 30 degrees C. Ensure the single-break inductive load interrupting rating of switches is no less than 1.5 amperes for 125 volts DC or 10 amperes for 115 volts AC.

2.5.11.2 Switch Features

a. Provide control and instrument switches suitable for the intended use with the features shown on the schematic diagrams and switch development drawings. Provide switches with modern handles or keys of pistol grip, oval, round notched or knurled type, and black color unless otherwise specified.

b. Provide control switches for electrically-operated circuit breakers that are the 3 position momentary-contact type with spring return to neutral position and modern-black, heavy duty pistol grip handles. Provide circuit breaker control switches with mechanical operation

indicators to show the last manual operation of the switches, and slip contacts when so indicated or required.

c. Provide instrument and meter transfer switches and selector switches that are the maintained-contact type with the required number of positions and round notched or knurled handles. Ensure ammeter switches do not open the secondary circuits of current transformers at any time. Provide instrument switches for potential selection with oval handles.

2.5.12 Indicating Lamp Assemblies

Provide switchboard type indicating lamp assemblies, insulated for 125-volt DC service, with appropriately colored caps and integrally mounted resistors for nominal 125-volt DC service (140 volts maximum). Provide long-life low-wattage type lamps replaceable from the front of the panels and furnish any special tools required for lamp replacement. Provide color caps made of transparent or translucent material which will not be softened by the heat from the lamps. Insofar as practicable, ensure all color caps are similar and interchangeable, and all lamps are of the same type and rating.

2.5.13 Indicating Instruments

2.5.13.1 General

Provide electrical indicating instruments conforming to the applicable requirements of ANSI C39.1 and an accuracy rating within 1 percent of full-scale value. Provide back-connected semiflush mounting instruments. Provide instruments with white dials, circular scales, black scale markings, and black tapered antiparallax pointers. Ensure instrument cases are dust tight with shadowproof covers and anti-glare windows. Provide taut-band suspension where this design is available. Provide zero adjustments accessible from the front without removal of covers for instruments with spring control. Design and calibrate AC instruments for use on 60-Hz circuits and for operation from 120-volt secondaries of voltage transformers and 5-ampere secondaries of current transformers, as shown. Design AC instrument potential coils for continuous operation at 150-volts, and ensure AC instrument current coils are capable of withstanding 40 times rated current for two seconds. Print instrument identification legends neatly on the dials or on separate legend plates inside the cases. Provide instrument scales as specified, or as approved if scales are not specified, and appropriate for the application.

2.5.13.2 Rectangular Switchboard Instruments

Provide 108 mm 4-1/4 inch minimum rectangular type instruments with nominal 250-degree scale angle and zero-left scales

2.5.13.3 AC Voltmeters

Provide AC voltmeters with expanded type scales.

2.6 METAL-ENCLOSED BUS

Submit the proposed methods for grounding bus housing.

2.6.1 General

Make electrical connections between the 480-volt terminals of the station service transformers and the power supply air circuit breakers in the main 480-volt station service switchgear consisting of 3-phase, nonventilated, nonsegregated-phase, metal-enclosed bus conforming to the applicable requirements of [IEEE C37.20.1A][IEEE C37.20.2A][IEEE C37.20.3]. Ensure bus is rated 600 volts AC [1,600] [_____] amperes continuous current carrying capacity, and the momentary current rating is not less than [25,000][50,000] rms asymmetrical amperes. Fabricate metal-enclosed bus in sections to suit the arrangement shown. Provide necessary frames and flange sections required at the bus terminals at the transformers and switchgear, and all required structural supports for the bus structures. Provide expansion sections wherever the bus crosses a contraction joint in the building. Coordinate all electrical and mechanical connections at the station service transformers with the station service transformer manufacturer. Provide flexible connections at the switchgear and transformer connections. Coordinate connections at the switchgear with the design of the 480-volt station service switchgear.

2.6.2 Conductors

Provide bare copper, aluminum or aluminum-alloy bus phase conductors that when assembled, withstand the specified dielectric tests. Use silver-plated field joints in the conductors except that contact surfaces of aluminum-alloy conductors may be tin plated. Provide joints with sufficient bolts to provide adequate low-resistance contacts.

2.6.3 Enclosure

Mount three phase conductors with insulating supports and spacers inside a common nonventilated dust tight enclosure made of sheet metal no less than No. 14 MSG. Provide covers for enclosure openings that are no less than No. 14 MSG. Design enclosure to permit the installation and alignment of all bus sections and the completion of field joints in the conductors before the enclosure is completely closed.

2.6.4 Grounding

Connect all sections of the housing to the powerhouse ground system. Bond bus housing sections together or connect to a common ground bus to facilitate connection to the powerhouse ground system. The proposed method of metal-enclosed bus grounding is subject to approval.

2.7 SECONDARY UNIT SUBSTATION

2.7.1 General

Provide secondary unit substation that is indoor metal-enclosed secondary selective (double-ended) type rated [13,800-480] [[_____]-480] volts, [_____]kVA, 3-phase, 3-wire, with incoming, transforming, and outgoing sections arranged as indicated. Except as otherwise specified or indicated, provide unit substation conforming to the applicable requirements of NEMA TR 1.

2.7.2 Incoming Sections

Provide incoming sections for terminating the high-voltage power cables as specified for Station Service Transformers.

2.7.3 Transforming Sections

Provide metal enclosed transforming section containing ventilated dry type (Class AA) transformers as specified for Station Service Transformers.

2.7.4 Transformer Bus Connections

Connect transformer low-voltage terminals to the power supply breakers in the adjacent 480-volt, outgoing switchgear section by means of copper or aluminum bus with thermal and mechanical capacities coordinated with the ratings of the 480-volt power supply circuit breakers. Arrange transformer high-voltage and low-voltage bus connections so that the front of the transformer enclosures will line up with the front of adjoining incoming sections and the 480-volt outgoing switchgear section. Provide suitable bus transition compartments if required.

2.7.5 Outgoing Section

Provide outgoing section consisting of an indoor metal-enclosed 480-volt power circuit breaker switchgear assembly, with drawout type circuit breakers, as specified for 480-volt Station Service Switchgear.

2.8 STATION SERVICE TRANSFORMER

2.8.1 Type and Rating

Provide indoor ventilated dry-type, self-cooled, NEMA Class AA station service transformers with 150 or 220 degrees C 300 or 428 degrees F limiting temperature insulation and conforming to the applicable requirements of IEEE C57.12.01, [IEEE C57.12.50] [IEEE C57.12.51], IEEE C57.12.91, and NEMA TR 1. Ensure transformers are rated [_____]kVA, 3-phase, 60-Hz, [13,800-480 volts], [[_____]-480 volts] and connect the windings delta-delta. Use transformer impedance of [_____] percent subject to ANSI standard tolerance. Design transformer to carry rated load continuously without exceeding 80 degrees C (Class 150 degrees C) or 150 degrees C (Class 220 degrees C) 176 degrees F (Class 302 degrees F) or 302 degrees F (Class 428 degrees F) temperature rise above 40 degrees C 104 degrees F ambient temperature when installed in its ventilated sheet metal enclosure and cooled by natural air circulation.

2.8.2 Core and Coils

Attach core, coils and metal enclosure of the transformer rigidly to a structural steel base suitable for moving the complete transformer by the use of rollers. Provide jacking facilities and removable lifting eyes on the core and coil assembly. Ensure core laminations are free from burrs which may puncture the insulation between laminations and securely fasten to prevent excessive vibration in normal service or displacement under short-circuit conditions. Provide four 2-1/2 percent full-capacity taps, 2 above rated voltage and 2 below rated voltage, in the high-voltage windings, and provide suitable means for changing the taps while the transformer is de-energized. Access terminal board through a door or removable panel in the enclosure. Brace all transformer leads and taps securely to prevent displacement or injury during transit or installation and under short-circuit condition. Support wiring for transformer accessories adequately to prevent breaking of the conductors due to vibration of the transformer and connect to accessible terminal blocks.

2.8.3 Enclosure

Provide transformer with a ventilated sheet steel enclosure as specified for 480-volt Station Service Switchgear, except that a formed enclosure of no less than No.13 MSG may be used. Provide doors or removable panels in the enclosure to permit access to the transformer, and provide suitable removable lifting eyes or other approved means to permit lifting the enclosure alone and also the complete transformer by the use of a crane. Adequately brace and stiffen enclosure on the inside, and coat with sound-deadening material if necessary, so that the audible sound level of the enclosed transformer when operating at rated load will not exceed the value permitted in Table 0-3 of NEMA TR 1.

2.8.4 Incoming Sections

Provide metal-enclosed compartments for terminating the incoming high-voltage power cables with stress cones as indicated. Access the interior of the compartment through removable bolted panels or bolted hinged doors. Make connections between the terminals of the incoming cables and the high-voltage winding terminals of the adjacent transformers by means of copper or aluminum bus with no less than [600] [_____] amps continuous current-carrying capacity and [_____] asymmetrical amperes momentary current rating. Provide heavy-duty clamp type terminal lugs for connecting the high-voltage cables to the transformer high-voltage bus.

2.9 ACCESSORIES

Furnish handling and testing accessories needed to remove, replace, test and maintain the drawout type air circuit breakers. Include the following:

a. One Closing Lever for manually closing the electrically-operated circuit breakers.

b. One set of couplers (if required) for test operation of the electrically-operated breakers.

c. One set of test plugs for drawout relays.

d. Two sets of keys for key interlocks.

e. One Hoist, cart or other suitable means for breaker removal and handling.

f. One complete set of all special wrenches and tools required for the installation, maintenance and repair of the switchgear.

g. Four one-quart containers of paint for outside finish.

h. One portable test set by the same manufacturer as the static trip devices to check the operation of the static trip devices without the need for high primary circuit current.

i. One indicating lamp replacement tool (if required).

2.10 FACTORY INSPECTION AND TESTS

Submit five certified copies of the reports of all tests, including complete test data, and five sets of calibration curves for each trip.

2.10.1 General

Give each item of equipment supplied under this contract the manufacturer's routine factory tests and also other tests, as specified below, to insure successful operation of all parts of the assemblies. Ensure all tests required are witnessed by the Contracting Officer, unless waived in writing, and do not ship equipment until it has been approved for shipment. Notify the Contracting Officer sufficiently in advance of the test date, so that the Contracting Officer can make arrangements to be present. Ensure factory test equipment and test methods conform to the applicable requirements of ANSI, IEEE and NEMA standards, and are subject to approval. The witnessing representatives of the Contractor and the Contracting Officer must sign all test reports.

2.10.2 Switchgear Assembly Tests

Subject each low-voltage air circuit breaker switchgear assembly to the [_____] ["Production Tests"] described in [IEEE C37.20.1A][IEEE C37.20.2A][IEEE C37.20.3], except as modified or supplemented below:

2.10.2.1 Assembled Equipment

Check assembled equipment for mechanical adjustment, alignment of panels and devices mounted thereon, adequacy of fastenings and general good workmanship.

2.10.2.2 Wiring

Give control, instrument and relay wiring a point-to-point check, and verify the correctness of the control wiring by actual operation of the compartment devices.

2.10.2.3 Switchgear Assembly

Subject each switchgear assembly, with all circuit breakers in operating position and contacts closed, to a 1-minute power frequency withstand dielectric test of 2,200 volts AC. Subject control, instrument and relay wiring to a 1-minute, power frequency withstand dielectric test of 1,500 volts AC to ground.

2.10.2.4 Circuit Breaker

Give each low-voltage power circuit breaker the production tests described in [NEMA C37.50][NEMA C37.51]. Thoroughly check each circuit breaker for proper operation and make all necessary adjustments. Check shunt trip coils for proper operation.

2.10.3 Instrument Transformer Test

Subject voltage and current transformers to routine tests in accordance with paragraph 4.7.2 of IEEE C57.13.

Furnish five copies of typical ratio and phase angle tests for each type and rating of instrument transformer.

2.10.4 Metal-enclosed Bus Test

Subject each shop-assembled section of metal-enclosed bus to a low-frequency dielectric withstand test of 2,200 volts for 1 minute

between each conductor and the other conductors, and between all conductors connected together and the grounded metal housing in accordance with [IEEE C37.20.1A][IEEE C37.20.2A][IEEE C37.20.3].

2.10.5 Station Service Transformer Test

Subject station service transformers to the routine tests listed in paragraph 8.3 of IEEE C57.12.01, except that the temperature tests, if made, are made with the transformers in their enclosures in order to simulate actual operating conditions.

PART 3 EXECUTION

3.1 PAINTING

Finish and paint metal surfaces of the low-voltage metal-enclosed switchgear assembly and the enclosures for the metal-enclosed bus and station service transformers in accordance with [IEEE C37.20.1A][IEEE C37.20.2A][IEEE C37.20.3], except give all outside surfaces no less than 2 coats of quick air drying lacquer or synthetic enamel, [ANSI] Indoor Light Gray No. 61 in color, with semi-gloss finish. Finish accessories and interior surfaces in accordance with manufacturer's standard practices.

3.2 INSTALLATION

****
NOTE: Add appropriate requirements to specify installation by the Contractor.
****

[_____].

-- End of Section --