UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
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-- End of Section Table of Contents --

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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 January 2021

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SECTION 26 22 00.00 10

480-VOLT STATION SERVICE SWITCHGEAR AND TRANSFORMERS
10/07

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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).

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PART 1 GENERAL

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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 shall 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, the Contractor shall 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. Samples of materials and equipment shall be submitted for approval when so directed. Insofar as practicable, devices and equipment used for the same or similar services shall be of the same make and type, and shall be inter-changeable when of the same rating.

Section D Inspection and Acceptance

Include the following:

Test of Materials.

All materials, supplies, and parts and assemblies thereof entering into the work to be done under

these specifications shall be tested 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, he shall 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, all tests or trials shall be made in the presence of a Quality Assurance Representative (QAR) and copies of all test reports shall be furnished by the Contractor as soon as practicable after the tests are made an shall be submitted 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, certified copies of the test reports shall be furnished to the Contracting Officer.

Test specimens and samples for analysis shall be plainly marked to indicate the materials they represent and, if required, they shall be properly boxed and prepared for shipment.

Except as provided elsewhere, all costs of all test and trials, excepting the pay and expense of the QAR, shall be 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. The drawings and

data shall 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 shall be such that all information is available for checking each drawing when it is received.

4. [_____] reproducible, of a quality that will make legible prints,] [and] black and white copies or blueprints of each drawing for approval shall be furnished. Each submission of drawings by the Contractor must be accompanied by a letter of transmittal containing a list of drawings giving titles and numbers. Transmittals shall be addressed 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", the Contractor shall make the necessary revisions on the drawings and shall submit [reproducibles] [and] [_____] prints for approval in the same routine as before. Every revision made during the life of the contract shall be shown by number, date, and subject in a revision block and a notation shall be made in the drawing margin to permit rapid location of the revision. The time consumed by the Contractor in submitting and obtaining approval of assembly and shop drawings shall be included 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", the Contractor shall within 30 calendar days after receipt, submit correct [reproducibles] [and] [_____] prints of each drawing. If revisions are made after a drawing has been "Approved", the Contractor shall furnish [reproducibles] [and] [corrected prints] subsequent to each revision.

6. All of the applicable requirements of this paragraph with reference to drawing submittals shall apply equally to catalog cuts, illustrations, printed specifications, weld qualifications, mill

tests, factory tests, field tests, or other required data, except that two additional copes shall be submitted in lieu of any reproducibles. All correspondence, drawings, literature, instruction books, data, and nameplates shall 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. The Contractor shall 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. Approval of the drawings shall not be construed as a complete check but will indicate only that the general method of construction and detailing is satisfactory. Approval by the Contracting Officer of the Contractor's drawing shall not be held 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, the Contractor shall 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. [The CADD files shall be furnished in Microstation format on electronic media; i.e., $3^1/_2$ inch floppy disks, compact disks, etc.] [The process tracings shall be full size reproducibles made on cloth, Mylar, or equal, from the original tracings by photographic-type reproduction, and shall be of such quality and clarity as to permit sharp and thoroughly legible microfilm copying.] These [CADD files] [tracings] [tracings and prints] shall 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 shall be shown thereon. The number shall be located immediately above the title block if possible.

9. 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 shall be assembled under a suitable common cover and [_____] copies of the assembled material shall be furnished. The assembled material shall 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.

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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

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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 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	(2012) 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) Requirements for Instrument Transformers

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C80.1	(2005) American National Standard for Electrical Rigid Steel Conduit (ERSC)
ANSI C80.3	(2015) 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	(2009) Power Cable Rated 2000 V or Less for the Distribution of Electrical Energy--S95-658

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 489	(2016) 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 shall be subject to approval. The switchgear assembly shall be completely assembled and wired 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. Each shipping section of the switchgear shall be properly matchmarked to facilitate reassembly, and shall be provided with removable lifting channels with eye bolts for attachment of crane slings to facilitate lifting and handling. The equipment shall be shipped as completely assembled and wired as feasible so as to require a minimum of installation work. Switchgear groups and metal-enclosed buses which are disassembled into sections for shipment shall have the associated parts properly matchmarked to facilitate installation by the Government. Any relay (, indicating instrument) or other device which cannot withstand the hazards of shipment when mounted in place on the switchgear shall be carefully packed and shipped separately. These pieces shall be marked 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. All finished painted surfaces and metal work shall be wrapped suitably or otherwise protected from damage during shipment. All parts shall be prepared for shipment so that slings for handling may be attached readily while the parts are in a railway car or transport truck. Switchgear sections crated for shipment shall be 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

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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, 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. Spare parts shall be duplicates of the original parts furnished, and shall be 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. Nameplates shall be made 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. The nameplates shall be fastened to the panels in proper positions with black finished roundhead screws. Each control switch shall be provided with an escutcheon clearly marked to show each operating position. The switch identifications shall be engraved on the escutcheon plates or on separate nameplates. The escutcheon and nameplate markings shall be subject to approval.

2.2 COPPER AND ALUMINUM BARS AND RODS

Copper or aluminum bars and shapes for main bus and ground bus conductors may be provided at the option of the Contractor and shall conform to the requirements of ASTM B187/B187M, ASTM B188, ASTM B236M ASTM B236, and ASTM B317/B317M.

2.3 CONDUIT AND ELECTRICAL METALLIC TUBING

Rigid conduit shall conform to ANSI C80.1 and shall, be zinc-coated (galvanized) both inside and outside by the hot-dip method. Electrical metallic tubing shall conform to ANSI C80.3. Fittings for rigid metal conduit and electrical metallic tubing shall conform to NEMA FB 1.

2.4 CONNECTIONS

All bolts, studs, machine screws, nuts, and tapped holes shall be in accordance with ASME B1.1. Threads for sizes 6 to 25 mm 1/4 to 1 inch, inclusive, shall be NC or UNC series. The sizes and threads of all valves, pipe and fittings, conduit and fittings, tubing and fittings, and connecting equipment shall be 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 shall meet the above requirements.

2.5 480-VOLT STATION SERVICE SWITCHGEAR

2.5.1 General

Except as otherwise specified or indicated, the design, construction and tests of the switchgear shall conform 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. The switchgear assembly shall contain 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. The two main supply circuit breakers and the bus tie circuit breaker shall be electrically operated and will normally be remotely controlled. Automatic bus transfer shall be provided as specified in paragraph Automatic Bus Transfer. The switchgear shall have 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

The switchgear shall be of the totally-enclosed, free-standing, dead-front type built on a suitable framework of structural steel, or by an equivalent approved method, which shall 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. The framework and structure shall be sufficiently rigid to

withstand operation of the equipment or any stresses due to short circuits. Each shipping assembly shall also be sufficiently rigid, with the addition of temporary members if required, to withstand handling during shipment and installation.

2.5.2.2 Enclosure

The enclosure shall be made of selected smooth sheet steel panels, suitably supported. Doors and panels used to support instruments and other devices and barriers between compartments shall not be less than No. 11 MSG. Exposed panels on the front and ends of the enclosure shall be bent angle or channel edges with all corner seams welded and ground smooth, or shall be the manufacturer's equivalent construction as approved. The front outside surfaces shall not be drilled or welded for the purpose of attaching wires or mounting devices if such holes or fastenings will be visible from the front.

2.5.2.3 Drawout Circuit Breaker

Each drawout type circuit breaker shall be completely enclosed in a metal compartment. Access to the circuit breakers shall be provided through hinged steel doors. Access to instrument and relay wiring, instrument transformers and fuses, shall also be through hinged doors. All hinged doors shall have bent angle or channel edges, invisible hinges and suitable latches or fastenings. Access to bus compartments shall be through removable bolted panels, cover plates or hinged doors.

2.5.2.4 Ventilating Opening

Ventilating openings shall be provided as required and shall preferably be of the grille type. All ventilating openings shall be provided with corrosion-resistant insect-proof screens on the inside.

2.5.2.5 Foundations

Continuous channel iron foundations, complete with bolts and drilled holes for grouting and anchoring to the floor, shall be furnished by the Contractor for the complete length (front and rear) of each [substation] [switchgear assembly]. Channel construction and drilling shall be as required for mounting the equipment. The channels shall be designed for flat mounting and maximum channel depth shall be 63 mm 2-1/2 inches. The foundation channels shall be placed on top of the floor, fastened in place, and then filled with grout. Additional channel or substantial metal trim shall be provided 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. The buses in each main bus section shall have a continuous current-carrying capacity of not 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]. The buses shall have mechanical and thermal capacities coordinated with the interrupting rating of the power supply circuit breakers. Bus bars shall be of hard-drawn copper, aluminum, or aluminum-alloy. Shop splices and tap connections shall be brazed, pressure-welded or bolted. All splices for field assembly shall be bolted. Where bolted connections are used, contact surfaces shall be silver-plated except that contact

surfaces for aluminum-alloy may be tin-plated and shall be equipped with provisions for adequate clamping. The buses shall be mounted on insulating supports of wet process porcelain, glass polyester, or suitable molded material. All primary connections including the power connections to the line side of the circuit breakers shall be by bus bar.

b. The standard phasing within equipment housing for AC power circuits shall be 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. Blank compartments without buses and small spare compartments with buses and complete provisions for installing future feeder circuit breakers shall be provided where shown.

2.5.4 Power Circuit Breakers

2.5.4.1 General

The power supply, bus tie, and feeder air circuit breakers shall be 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. All circuit breakers of the same frame size and type of operation (electrical or manual) shall be interchangeable. Suitable means shall be provided 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. Overcurrent trip alarm contacts, with means for manual reset, shall be furnished as indicated. Covers shall be provided 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

The 2 power supply circuit breakers and the bus tie circuit breaker shall be electrically-operated drawout type with the closing mechanism designed for operation on 125 volts DC. The circuit breakers shall be 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. Each circuit breaker shall be provided with functional components in accordance with Table 1 of IEEE C37.13, including means for manual emergency tripping and manual closing for maintenance operation. Each power supply breaker and the bus tie circuit breaker shall be provided with a solid-state direct-acting over-current tripping device consisting of long-time-delay and short-time-delay elements. The bus tie circuit breaker shall be furnished without an overcurrent trip device but shall be provided with a 125-volt DC shunt trip device. Long-time and short-time-delay operation bands shall be selected 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. The 2 power supply circuit breakers and the bus tie circuit breaker shall be electrically interlocked so that

only 2 of the 3 breakers can be in the closed position at the same time. A local test control switch shall be provided for each electrically-operated circuit breaker which shall be electrically interlocked through cell switches or secondary disconnects to prevent breaker operation except when the breaker is in the test position. Sufficient breaker auxiliary switch contacts and cell switches shall be provided to accomplish the required breaker control and interlocking system as shown. At least 4 auxiliary switch contacts shall be provided on each breaker. At least 2 spare auxiliary switch contacts, one normally-open and one normally-closed, shall also be provided on each electrically-operated breaker.

2.5.4.3 Feeder Air Circuit Breakers

Feeder breakers shall be independent manually-operated type with manually-charged stored energy closing mechanism and with frame sizes as indicated, and shall be rated 600 volts AC. Circuit breakers with 600-ampere frames shall have a short-circuit interrupting capacity of not less than 22,000 rms symmetrical amperes at 600 volts AC. Each feeder breaker, except as specified otherwise, shall be provided with a solid-state direct-acting overcurrent tripping device consisting of a long-time-delay element and a short-time-delay element. The long-time-delay trip elements for direct-acting overcurrent tripping devices shall be adjustable over an approximate range of 80 to 110 percent of the trip ampere rating. The short-time-delay trip elements, for the direct-acting overcurrent tripping devices shall be adjustable over a range of approximately 4 to 10 times the ampere rating. Manually-operated drawout type circuit breakers shall be fitted 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. All breakers shall be designed for tripping by a rotary motion in the opposite direction or by pressing a readily accessible trip button. The operating handles shall be easily removable when it is necessary to open the compartment door and easily replaceable for operating the breaker in the withdrawn or test position. Duplicate feeder breakers shall be key interlocked. Each breaker shall be equipped with a conspicuous mechanical target visible with the breaker in the normal operating position to indicate whether the breaker is open or closed and shall be provided with a manually-reset bell alarm contact to energize the annunciator circuit only when the breaker is automatically tripped on a fault or overload. The circuit breaker for the powerhouse crane feeder shall be manually-operated type equipped with a 125-volt DC shunt trip attachment for emergency operation from remote stations.

2.5.4.4 Automatic Bus Transfer

The stations shall be provided with automatic bus transfer. The automatic transfer arrangement shall be as shown by the schematic diagrams and shall 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 shall 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 shall (after a time delay) open the bus tie breaker and close the associated supply

breaker.

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

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

2.5.5 Wiring

2.5.5.1 Control Panel and Power Wiring

Control panel wiring shall be stranded copper switchboard wire with 600-volt insulation. The wire shall be Type SIS as listed in NFPA 70 and shall meet the requirements of NEMA WC 70. Hinge wire shall have class K stranding. Current transformer secondary leads shall be not smaller than No. 10 AWG. The minimum size of wire for all other control wiring shall be No. 14 AWG. Power wiring for 480-volt circuits and below shall be of the same type as control panel wiring and the minimum size shall be No. 12 AWG.

2.5.5.2 Terminals and Installation

a. Control wiring within the assembly housings shall be furnished and installed by the Contractor as specified. All control wiring leaving equipment shall be run to and terminated on terminal blocks. Terminal blocks and internal wiring shall be provided 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. Each individual potential transformer lead shall be brought out to a terminal block. Potential transformers for ground detecting circuits shall be grounded at the equipment. Potential transformers for metering circuits will be remotely grounded by the Government. There shall be no splices in the wiring and all connections shall be made at terminal studs or blocks. Terminal blocks shall be added for wiring to devices having leads instead of terminals. Indented terminals, Burndy Type YAV10 or an approved equal, shall be used on all wires terminated on screw or stud terminals. All screw terminals shall have toothed lock washers and all stud terminals shall have 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]. Space for cables as shown shall be provided. The 600-volt metal-enclosed buses shall enter the switchgear from [above] [below through floor slots]. Matching openings shall be provided in the switchgear to permit the entrance of the bus into the switchgear through the concrete openings. Clam-style terminals of sizes indicated shall be provided for all main power cable leaving the switchgear. The terminals shall be of the heavy-duty, full clamp type, Burndy "Qiklug", or approved equal. Adequate provisions shall be included 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. Terminal blocks for control wiring shall be molded or fabricated type with barriers, rated not less than 600 volts, type [_____]. The terminals shall be removable binding, fillister or washer head screw type, or stud type with contact and locking nuts. The terminals shall be not less than No. 10 in size and shall 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 shall be subject to approval. Not less than 10 percent, but in no case less than 2, spare terminals shall be provided on each block or group of blocks.

b. Short-circuiting type terminal blocks shall be furnished for all current transformer secondary leads and shall have provision for shorting together all leads from each current transformer without first opening any circuit. These terminal blocks shall be made by the same manufacturer as the terminal blocks for control wiring listed above, type [_____].

c. White or other light-colored plastic marking strips, fastened by screws to each terminal block, shall be provided for control wire designations. The manufacturer's wire number and the Government's wire number shall both be shown for each connected terminal on the marking strips with permanent marking fluid. The marking strips shall be reversible to permit marking both sides, or two marking strips shall be furnished with each block, to accommodate the two sets of wire numbers.

d. Load terminal blocks rated not less than 600 volts and of adequate capacity shall be provided for the conductors of power circuits except those supplied from air circuit breakers. The terminals shall be of either the stud type with contact nuts and locking nuts or of the removable screw type, 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 all screws shall have hexagonal heads. For conductors rated 50 to 99 amperes the minimum screw size shall be 8 mm 5/16 inch. Conducting parts between connected terminals shall have adequate contact surface and cross section to operate without overheating. Each connected terminal shall have 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

The switchgear assembly shall include 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 shall be grounded insofar as practicable. No soldered connections shall be used in the ground leads. If the operating mechanism of drawout units is not permanently grounded, ground contacts shall be provided to automatically connect the movable element to the ground buses. These connections shall make before the main disconnecting devices upon insertion, and break after the main disconnecting devices upon withdrawal. Grounding shall conform to[IEEE C37.20.1A][IEEE C37.20.2A][IEEE C37.20.3] except that the ground bus shall have a continuous current-carrying capacity not 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

Molded case circuit breakers shall conform to the applicable requirements of UL 489 and NEMA AB 3, shall be fully rated, and shall have voltage ratings and interrupting ratings stated. For circuit breakers of the same ampere frame size, 3 pole and 2 pole circuit breakers shall be the same width as 3 single pole and 2 single pole circuit breakers respectively. The circuit breakers shall be manually-operated and shall have trip-free operating mechanisms of the quick-make, quick-break type. All poles of each breaker shall be operated simultaneously by means of a common handle, and shall be enclosed in a common molded plastic case. The contacts of multi-pole breakers shall open simultaneously when the breaker is tripped manually or automatically. The operating handles shall clearly indicate whether the breakers are in "On", "Off", or "Tripped" position. The circuit breakers shall be of the individually-mounted, stationary type, shall all be products of the same manufacturer, and shall be interchangeable when of the same frame size. Each circuit breaker shall be provided 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

The circuit breakers shall be of the automatic type provided with combination thermal and instantaneous magnetic trip units. Instantaneous magnetic trip units shall be set at approximately 10 times the continuous current ratings of the circuit breakers.

2.5.7.3 480-Volt AC Circuits

Circuit breakers for 480-volt AC circuits shall be rated 600 volts AC, and shall have 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

Circuit breakers for 120-volt and 208-volt AC circuits shall be rated not less than 250 volts DC, and either 120/240 or 240 volts AC, and shall have a minimum NEMA interrupting capacity of 10,000 symmetrical amperes.

2.5.7.5 125 Volt DC Circuits

Circuit breakers for 125 volt DC circuits shall be 2-pole rated 125/250 or 250 volts DC, and shall have a minimum NEMA interrupting capacity of 10,000 amperes DC.

2.5.8 Instrument Transformers

2.5.8.1 Voltage Transformers

Five 480-120 volt, 200 volt-ampere capacity, voltage transformers shall be provided for each main 480-volt bus section. Two of the transformers shall be used for metering and 3 of the transformers shall be used with the ground detection equipment. Voltage transformers shall conform to IEEE C57.13 and shall have an ANSI accuracy classification of 0.3W, 0.3X, and 1.2Y or better. The full-wave impulse level shall be not less than 10 kV. Each voltage transformer shall be protected with removable primary and secondary fuses. Fuses shall be installed in each ungrounded lead and located adjacent to the transformers in an easily accessible place.

2.5.8.2 Current Transformers

Dry type current transformers as shown shall be furnished, installed and wired to the specified terminal blocks. These current transformers shall conform to IEEE C57.13, and shall have the ratios indicated. The current transformers shall be rated not less than 600 volts AC, 10 kV BIL, and the ANSI accuracy classification shall be 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, terminals of an approved solderless type and proper size shall be furnished. If transformers are connected to buses, proper connections shall be furnished, complete with bolts, nuts, washers and other accessories.

2.5.9 Ground Detection Equipment

Ground detection equipment shall be furnished for each bus section of the switchgear, to be used for indication and annunciation of grounds of the 480-volt system. The equipment shall consist 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]. Two ground detector relays shall be provided, one for each bus section of the switchgear.

2.5.10 Relays

2.5.10.1 General

a. Relays shall conform to the applicable requirements of IEEE C37.90. The relays shall be back-connected, semi-flush-mounted, switchboard type with black, rectangular, dust-tight cases, removable covers with windows, and means of sealing against tampering. Relays, except auxiliary relays, shall be 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. The test devices shall 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, [_____] sets of

characteristic curves of the individual breaker trip elements shall be included to permit checking and for power supply and bus tie circuit breakers. The breaker trip ampere ratings and lug sizes shall be as indicated.

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

d. Relay contacts shall be silver-to-silver, electrically independent, chatterproof and non-bouncing, and 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 1 such contact, or if 2 contacts are available but are not electrically independent, auxiliary relays shall be furnished to provide the required additional contacts.

2.5.10.2 AC Voltage Relays

Voltage relays other than ground detector relays shall be induction-disc inverse-time type with adjustable time and voltage settings and with semiflush mounting, drawout case type [_____]. Ground detector relays shall be 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. They shall be from the same manufacturer as the AC voltage relays, type [_____].

2.5.10.3 Auxiliary relays

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

2.5.11 Control and Instrument Switches

2.5.11.1 General

All control switches shall be of the rotary switchboard type with handles on the front and the operating contact mechanisms on the rear of the panels, type [_____]. Each switch shall be provided with ample contact stages to perform the functions of the control system. Contacts shall be self-aligning and shall operate with a wiping action. A positive means of maintaining high pressure on closed contacts shall be provided. Compression springs or pivotal joints shall not carry current. The covers or plates on the switches shall be readily removable for inspection of contacts. All control switches shall be suitable for operation on 600-volt AC or 250-volt DC circuits. All such switches shall be capable of satisfactorily withstanding a life test of at least 10,000 operations with rated current flowing in the switch contacts. The switches shall be capable of continuously carrying 20 amperes without exceeding a temperature rise of 30 degrees C. The single-break inductive load interrupting rating of switches shall be not less than 1.5 amperes for 125 volts DC or 10 amperes for 115 volts AC.

2.5.11.2 Switch Features

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

b. Control switches for electrically-operated circuit breakers shall be 3 position momentary-contact type with spring return to neutral position, and shall have modern-black, heavy duty pistol grip handles. Circuit breaker control switches shall have mechanical operation indicators to show the last manual operation of the switches, and shall have slip contacts when so indicated or required.

c. Instrument and meter transfer switches and selector switches shall be the maintained-contact type with the required number of positions, and shall have round notched or knurled handles. Ammeter switches shall not open the secondary circuits of current transformers at any time. Instrument switches for potential selection shall have oval handles.

2.5.12 Indicating Lamp Assemblies

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

2.5.13 Indicating Instruments

2.5.13.1 General

Electrical indicating instruments shall conform to the applicable

requirements of ANSI C39.1 and the accuracy rating shall be within 1 percent of full-scale value. The instruments shall be back-connected semiflush mounting. Instruments shall have white dials, circular scales, black scale markings, and black tapered antiparallax pointers. Instrument cases shall be dust tight with shadowproof covers and anti-glare windows. Taut-band suspension shall be provided where this design is available. Zero adjustments accessible from the front without removal of covers shall be provided for instruments with spring control. AC instruments shall be designed and calibrated 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. AC instrument potential coils shall be designed for continuous operation at 150-volts, and AC instrument current coils shall be capable of withstanding 40 times rated current for two seconds. Instrument identification legends shall be neatly printed on the dials or on separate legend plates inside the cases. Instrument scales shall be as specified, or as approved if scales are not specified, and appropriate for the application.

2.5.13.2 Rectangular Switchboard Instruments

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

2.5.13.3 AC Voltmeters

AC voltmeters shall be provided with expanded type scales.

2.6 METAL-ENCLOSED BUS

Submit the proposed methods for grounding bus housing.

2.6.1 General

The 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 shall consist 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]. The bus shall be rated 600 volts AC [1,600] [_____] amperes continuous current carrying capacity, and the momentary current rating shall be not less than [25,000][50,000] rms asymmetrical amperes. The metal-enclosed bus shall be fabricated in sections to suit the arrangement shown. Necessary frames and flange sections required at the bus terminals at the transformers and switchgear, and all required structural supports for the bus structures shall be provided. Expansion sections shall be provided wherever the bus crosses a contraction joint in the building. All electrical and mechanical connections at the station service transformers shall be coordinated with the station service transformer manufacturer. Flexible connections shall be provided at the switchgear and transformer connections. Connections at the switchgear shall be coordinated with the design of the 480-volt station service switchgear.

2.6.2 Conductors

The bus phase conductors shall be of bare copper, aluminum or aluminum-alloy, and when assembled shall withstand the specified dielectric tests. Field joints in the conductors shall be silver-plated except that contact surfaces of aluminum-alloy conductors may be tin plated. The joints shall be provided with sufficient bolts to provide

adequate low-resistance contacts.

2.6.3 Enclosure

The three phase conductors with insulating supports and spacers shall be mounted inside a common nonventilated dust tight enclosure made of sheet metal not less than No. 14 MSG. Covers for enclosure openings shall be not less than No. 14 MSG. The design of the enclosure shall 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

All sections of the housing shall be connected to the powerhouse ground system. Bus housing sections shall be bonded together or connected to a common ground bus to facilitate connection to the powerhouse ground system. The proposed method of metal-enclosed bus grounding shall be subject to approval.

2.7 SECONDARY UNIT SUBSTATION

2.7.1 General

The secondary unit substation shall be 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, the unit substation shall conform to the applicable requirements of NEMA TR 1.

2.7.2 Incoming Sections

Incoming sections for terminating the high-voltage power cables shall be as specified for Station Service Transformers.

2.7.3 Transforming Sections

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

2.7.4 Transformer Bus Connections

The transformer low-voltage terminals shall be connected 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. The transformer high-voltage and low-voltage bus connections shall be arranged 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. Suitable bus transition compartments shall be provided if required.

2.7.5 Outgoing Section

The outgoing section shall be 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

The station service transformers shall be indoor ventilated dry-type, self-cooled, NEMA Class AA, with 150 or 220 degrees C 300 or 428 degrees F limiting temperature insulation and shall conform 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. The transformers shall be rated [_____]kVA, 3-phase, 60-Hz, [13,800-480 volts], [[_____]-480 volts] and the windings shall be connected delta-delta. The transformer impedance shall be [_____] percent subject to ANSI standard tolerance. The transformer shall be designed 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

The core, coils and metal enclosure of the transformer shall be rigidly attached to a structural steel base suitable for moving the complete transformer by the use of rollers. Jacking facilities and removable lifting eyes shall be provided on the core and coil assembly. The core laminations shall be free from burrs which may puncture the insulation between laminations and shall be securely fastened to prevent excessive vibration in normal service or displacement under short-circuit conditions. Four 2-1/2 percent full-capacity taps, 2 above rated voltage and 2 below rated voltage, shall be provided in the high-voltage windings, and suitable means shall be provided for changing the taps while the transformer is de-energized. The terminal board shall be accessible through a door or removable panel in the enclosure. All transformer leads and taps shall be securely braced to prevent displacement or injury during transit or installation and under short-circuit condition. Wiring for transformer accessories shall be adequately supported to prevent breaking of the conductors due to vibration of the transformer and shall be connected to accessible terminal blocks.

2.8.3 Enclosure

The transformer shall be provided with a ventilated sheet steel enclosure as specified for 480-volt Station Service Switchgear, except that a formed enclosure of not less than No.13 MSG may be used. Doors or removable panels shall be provided in the enclosure to permit access to the transformer, and suitable removable lifting eyes or other approved means shall be provided to permit lifting the enclosure alone and also the complete transformer by the use of a crane. The enclosure shall be adequately braced and stiffened on the inside, and shall be coated 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

Metal-enclosed compartments shall be provided for terminating the incoming high-voltage power cables with stress cones as indicated. Access to the interior of the compartment shall be through removable bolted panels or bolted hinged doors. Connections between the terminals

of the incoming cables and the high-voltage winding terminals of the adjacent transformers shall be by means of copper or aluminum bus with not less than [600] [_____] amps. continuous current-carrying capacity and [_____] asymmetrical amperes momentary current rating. Heavy-duty clamp type terminal lugs shall be provided 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. The accessories shall 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

Each item of equipment supplied under this contract shall be given the manufacturer's routine factory tests and also other tests, as specified below, to insure successful operation of all parts of the assemblies. All tests required shall be witnessed by the Contracting Officer, unless waived in writing, and no equipment shall be shipped 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. The factory test equipment and test methods used shall conform to the applicable requirements of ANSI, IEEE and NEMA standards, and shall be subject to approval. The witnessing representatives of the Contractor and the Contracting Officer shall sign all test reports.

2.10.2 Switchgear Assembly Tests

Each low-voltage air circuit breaker switchgear assembly shall be subjected 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

The assembled equipment shall be checked for mechanical adjustment, alignment of panels and devices mounted thereon, adequacy of fastenings and general good workmanship.

2.10.2.2 Wiring

Control, instrument and relay wiring shall be given a point-to-point check, and the correctness of the control wiring shall be verified by actual operation of the compartment devices.

2.10.2.3 Switchgear Assembly

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

2.10.2.4 Circuit Breaker

Each low-voltage power circuit breaker shall be given the production tests described in [NEMA C37.50][NEMA C37.51]. Each circuit breaker shall be thoroughly checked for proper operation and all necessary adjustments shall be made. Shunt trip coils shall be checked for proper operation.

2.10.3 Instrument Transformer Test

The voltage and current transformers shall be subjected to routine tests in accordance with paragraph 4.7.2 of IEEE C57.13.

Five copies of typical ratio and phase angle tests shall be furnished for each type and rating of instrument transformer.

2.10.4 Metal-enclosed Bus Test

Each shop-assembled section of metal-enclosed bus shall be subjected 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

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

PART 3 EXECUTION

3.1 PAINTING

Metal surfaces of the low-voltage metal-enclosed switchgear assembly and the enclosures for the metal-enclosed bus and station service transformers shall be finished and painted in accordance with [IEEE C37.20.1A][IEEE C37.20.2A][IEEE C37.20.3], except that all outside surfaces shall be given not less than 2 coats of quick air drying lacquer or synthetic enamel, [ANSI] Indoor Light Gray No. 61 in color, with semi-gloss finish. Accessories and interior surfaces shall be finished in accordance with manufacturer's standard practices.

3.2 INSTALLATION

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NOTE: Add appropriate requirements to specify installation by the Contractor.
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[_____].

-- End of Section --