****
USACE / NAVFAC / AFCEC **UFGS-26 22 00.00 10 (November 2023)**

Preparing Activity: USACE **Superseding**
UFGS-26 22 00.00 10 (October 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2024
****

SECTION TABLE OF CONTENTS

DIVISION 26 - ELECTRICAL

SECTION 26 22 00.00 10

480-VOLT STATION SERVICE SWITCHGEAR AND TRANSFORMERS

11/23

2.7.3.7 Foundations
2.7.3.8 Cable Compartment Barriers
2.7.3.9 Infra-red (IR) Viewing Windows
2.7.3.10 Switchgear Arc Rating
2.7.3.11 Switchgear Ventilation
2.7.4 Buses and Connections
2.7.5 Power Circuit Breakers
2.7.5.1 General
2.7.5.2 Main and Bus Tie[s] Circuit Breakers
2.7.5.3 Feeder Air Circuit Breakers
2.7.5.4 Digital Trip Units
2.7.5.5 Remote Control Device
2.7.6 Wiring
2.7.6.1 Control Panel and Power Wiring
2.7.6.2 Terminals and Installation
2.7.6.3 Terminal Blocks
2.7.6.4 Wire Markers
2.7.7 Grounding
2.7.8 Molded Case Circuit Breakers
2.7.8.1 General
2.7.8.2 Trip Units
2.7.8.3 480-Volt AC Circuits
2.7.8.4 120-Volt and 208-Volt AC Circuits
2.7.8.5 125 Volt DC Circuits
2.7.9 Instrument Transformers
2.7.9.1 General
2.7.9.2 Voltage Transformers
2.7.9.3 Current Transformers
2.7.9.3.1 General
2.7.9.3.2 Window or Bushing Type Current Transformers
2.7.9.3.3 Rating
2.7.9.3.4 Burden Analysis
2.7.10 Ground Detection Equipment
2.7.11 Relays
2.7.11.1 General
2.7.11.2 AC Voltage Relays
2.7.11.3 Auxiliary relays
2.7.12 Automatic Bus Transfer
2.7.13 Protective Relays
2.7.14 Test Switches
2.7.15 Fiber Optic Arc Flash Sensors
2.7.16 Panelboards
2.7.17 Control Switches
2.7.17.1 General
2.7.17.2 Switch Features
2.7.18 Indicating Lamp Assemblies
2.7.19 Indicating Instruments
2.7.19.1 General
2.7.19.2 Ammeters
2.7.19.3 Voltmeters
2.7.19.4 Wattmeters
2.8 STATION SERVICE TRANSFORMER
2.8.1 Type and Rating
2.8.1.1 Core and Coils
2.8.1.2 Enclosure
2.8.2 Incoming Sections
2.8.3 Outgoing Sections
2.8.4 Temperature Relay
2.8.5 Foundation

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC | **UFGS-26 22 00.00 10 (November 2023)**

Preparing Activity: USACE | **Superseding UFGS-26 22 00.00 10 (October 2007)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2024

****

SECTION 26 22 00.00 10

480-VOLT STATION SERVICE SWITCHGEAR AND TRANSFORMERS
11/23

****

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., compact disks, DVD, or approved web based data transferring site, 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.

This section should be modified as required to clearly indicate the specific requirements for the contract. References to other sections which must be incorporated into the equipment design should be added. If general electrical requirements, high resistance ground, transformers, wire and cable, protective systems are specified in other sections, these should be added at the end of this section.

Remove information and requirements not required whether or not brackets are present.

****

1.1 REFERENCES

****

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

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(2014; Errata 2016) Electric Meters - Code for Electricity Metering
ANSI C39.1	(1981; R 1992) Requirements for Electrical Analog Indicating Instruments

AMERICAN SOCIETY OF 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; R 2023) 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	(2023) 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 1248	(2020) Guide for the Commissioning of Electrical Systems in Hydroelectric Power Plants
IEEE C2	(2023) National Electrical Safety Code
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 C37.20.7	(2017; Corr 2021) Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults
IEEE C37.23	(2015) Metal-Enclosed Bus
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
IEEE C57.13.3	(2014) Guide for Grounding of Instrument Transformer Secondary Circuits and Cases
IEEE C57.32	(2015) Requirements, Terminology, and Test Procedure for Neutral Grounding Devices
IEEE C62.11	(2020) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

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

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

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; R 2023) 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 PB 2	(2011) Deadfront Distribution Switchboards
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; ERTA 7 2023; TIA 23-15) 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

1.2 SUMMARY

****

NOTE: NOTE:To ensure an installation in the desired location and orientation, it is critical for the designer to include layout drawings showing the maximum sizes allowable and any/all clearances required. The designer must base these drawings off of actual equipment capable of being produced as part of a normal product line to avoid custom solutions and dramatically increased costs.

****

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

****

NOTE: Dimension of equipment must be smaller than the associated dimensions of doorways, hatches, hallways, galleries, or any other restrictions in the movement of the equipment to its final location for assembly.

****

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.

1.3 SUBMITTALS

****

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

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

The "S" classification indicates submittals required

as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Work Plan; G[, [_____]]

Temporary Power Plan; G[, [_____]]

Qualifications Of Field Engineering Service Personnel; G[, [_____]]

Contractor Furnished Training Of Government Personnel; G[, [_____]]

Course Outline And Course Material; G[, [_____]]

SD-02 Shop Drawings

Shop Drawings; G[, [_____]]

Installation; G[, [_____]]

Terminal Blocks; G[, [_____]]

Assembly And Detail Drawings; G[, [_____]]

Outline Drawings; G[, [_____]]

Schematic Diagrams, Connection Diagrams And One Line Diagrams; G[, [_____]]

Foundation Detail Drawings; G[, [_____]]

SD-03 Product Data

Transformers

Power Circuit Breakers

Spare Parts

Metal-Enclosed Bus

480-Volt Station Service Switchgear

Infra-Red (Ir) Viewing Windows; G[, [_____]]

Digital Trip Units; G[, [_____]]

Remote Control Device; G[, [_____]]

Instrument Transformers; G[, [_____]]

Protective Relays

Test Switches

Fiber Optic Arc Flash Sensors

Control Switches

Station Service Transformer; G[, [_____]]

Temperature Relay

Surge Protection

Capture Key Interlocks

Annunciation Equipment

Time Current Curves

SD-04 Samples

Nameplates; G[, [_____]]

SD-06 Test Reports

Factory Inspection and Tests

Design Test Reports; G[, [_____]]

Factory Test Procedure; G[, [_____]]

Factory Inspection And Test Reports

Field Test Procedure; G[, [_____]]

Field Test Reports

Manufacturer's Test Reports

480-Volt Switchgear Factory Inspection And Tests; G[, [_____]]

SD-07 Certificates

Notification Of Testing; G[, [_____]]

Certifications Of Switchgear And Breakers Design Tests; G[, [_____]]

Certifications Of Seismic Requirements; G[, [_____]]

Qualifications Of Instructor; G[, [_____]]

SD-10 Operation and Maintenance Data

Operation And Maintenance Manual; G[, [_____]]

SD-11 Closeout Submittals

As-Built Drawings; G[, [_____]]

1.4 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 cell (housing) switch.

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

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

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

m. Ten Indicating lamp color caps of each color.

n. One spring for stored-energy closing mechanism.

o. Four spare blank nameplates for operating unit doors.

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

[q. One ground detection relay of each type and size used.]

[r. One protective relay of each type and size used.]

[s. One temperature relay of each type and size used.]

[t. Three voltage transformer of each type and size used.]

[u. Three current transformers of each type and ratings used.]

[v. Three surge arresters of each type and size used.]

[w. Three surge capacitors of each type and size used.]

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

a. Ensure the equipment furnished and the work performed under this Contract is in conformance with the applicable provisions of ANSI & IEEE standards. Furnish documentation substantiating that the circuit breakers and switchgear[and metal enclosed bus] have previously satisfied the requirements for design testing in accordance with IEEE and ANSI standards.

b. All materials, components, and equipment must conform to the requirements of these specifications, be free from defects and imperfections, of recent manufacture, and have mechanical and electrical properties suitable for the intended use. All materials, components, and equipment not manufactured by the Contractor must be products of other recognized reputable manufacturers meeting the requirements of subparagraph Qualifications. Insofar as practicable, devices and equipment used for the same or similar services must be of the same make and type, and be interchangeable when of the same rating.

c. The switchgear[,][and] power circuit breakers,[metal enclosed bus][, and][transformers] must essentially duplicate the standard published catalog item from the manufacturer and such equipment has been in satisfactory service for at least five years.

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

e. The switchgear will be located[indoors] within ambient temperature extremes of[0 degrees C to +40 degrees C][_____][at 0 to 95 percent relative humidity, non-condensing]. The switchgear will be installed at an altitude [below 1000 m/3280 ft][_____].

2.2 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.

2.3 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.

[2.4 CONDUIT AND ELECTRICAL METALLIC TUBING

****
NOTE: THE SECTIONS FOR "CONDUIT AND ELECTRICAL METALLIC CONDUIT ARE TYPICALLY INCLUDED IN THE 26 05 00.00 COMMON WORK RESULTS FOR ELECTRICAL FOR BOTH PRODUCT INFORMATION AND INSTALLATION.
****

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 (EMT) conforming to ANSI C80.3.] Ensure fittings for rigid metal conduit[and electrical metallic tubing] conform to NEMA FB 1.

]2.5 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.

2.6 SECONDARY UNIT SUBSTATION

2.6.1 General

The secondary unit substation is to be indoor metal-enclosed secondary selective [double-ended][single-ended] type rated [13,800-480] [[_____]-480] volts, [_____]kVA, [3-phase, 3-wire,][_____]3-phase, 4-wire, with incoming, transforming, and outgoing sections arranged as indicated. The unit substation must conform to the applicable requirements of NEMA TR 1.

2.6.2 Incoming Sections

Incoming sections for terminating the medium voltage [power cables][bus] are to be in accordance with paragraph STATION SERVICE TRANSFORMERS.

2.6.3 Transforming Sections

The transforming section are to be metal enclosed containing ventilated dry type (Class AA) transformers in accordance with paragraph STATION SERVICE TRANSFORMERS.

2.6.4 Transformer Bus Connections

The transformer low-voltage terminals are to 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's medium-voltage and low-voltage bus connections are to 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 are to be provided.

2.6.5 Outgoing Section

The outgoing section must 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.

2.7 480-VOLT STATION SERVICE SWITCHGEAR

****

NOTE: To ensure a product with the layout and configuration of the controls, indication, and options desired, the designer must show them on drawings.

****

2.7.1 General

The 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].[The annunciator window group will be furnished by the Government for mounting and wiring by the Contractor.]

2.7.2 Switchgear Drawings And Data

2.7.2.1 Assembly and Detail Drawings

Prepare and submit assembly, detail drawings, and data to demonstrate that all parts of the equipment conform to the requirements and intent of the specifications. Include drawings and data , sectional views of switchgear units; including bus and bracing, description of removable elements, all

relays and other devices, equipment lists,[high resistance ground equipment] and nameplate schedules. On the drawings, show all coordination with other connected equipment including the transformer and metal enclosed bus indicating full electrical details of the connection.

2.7.2.2 Outline Drawings

Prepare and submit outline drawings for coordination of equipment and physical location. Include in the drawings, the overall dimensions and weights of the equipment; the size and location of conduit and cable entrances; details of provisions for bolting equipment to the floor, walls, and ceilings; the equipment crate sizes and proposed routing to the installation site within the facility.

2.7.2.3 Schematic Diagrams, Connection Diagrams and One Line Diagrams

Submit Schematic Diagrams, Connection Diagrams and One Line Diagrams indicating the switchgear assembly, complete assembly full line connection diagram, and control logic to demonstrate that the equipment will satisfy the requirements and intent of the specifications. Account for all the controls and external connections indicated by the Contract drawings. Show all point to point connection wireless wiring diagrams to terminal blocks and connections as seen by the observer. Provide a space at least three inches below and adjacent to the terminal blocks in which external circuits, conduits or connections may be shown. Make wiring diagrams as seen by an observer of the actual wiring, and show all the wiring and devices in the cubicle/sections. Solely using ladder logic or control diagrams to indicate wiring connections is not acceptable. Include in the drawings, space for the addition of devices where mounting space exists on the structure.[Additional information on outgoing circuits will be provided by the Government when the drawings are received for approval, and be added to the drawings by the Contractor.]

2.7.3 Enclosure and Framework

2.7.3.1 General

Provide a totally-enclosed, free-standing, dead-front type switchgear 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.

2.7.3.2 Enclosure

Make the enclosure from 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.

2.7.3.3 Access Doors and Panels

Provide hinged doors that have bent angle or channel edges, invisible hinges and are suitable latches or fastenings. Access to bus compartments can only be through removable bolted panels, cover plates or hinged doors. Access to circuit breakers, instrument transformers, instrument, relay wiring and fuses[, and high resistance ground equipment], must also be through hinged doors.

2.7.3.4 Drawout Circuit Breaker Compartment

Provide drawout type circuit breakers that are completely enclosed in a metal compartment. Provide access to the circuit breakers through hinged steel doors. Separate each individual circuit breaker compartment from adjacent compartments and sections by means of steel barriers. Equip with drawout rails and primary and secondary disconnecting contacts. Provide each breaker cubicle with positive acting safety shutters that isolate the breaker connections to the main bus when the breaker is withdrawn from the cell[, if this is an option from the manufacturer].

[2.7.3.5 Remote Racking Device

[OPTION 1: Furnish a remote racking device that is a portable unit that may be positioned in front of the breakers in the switchgear to rack the breaker in or out remotely. The device must include a wheeled assembly with brakes, a power module capable of exerting a minimum of 10 pounds of positive pressure and 100 foot-pounds of torque in the braked position to rack the breakers in and out with 15 inches of horizontal traverse, status indicator lights on the assembly visible from all directions, vertical height adjustment, and a control pendant with a minimum 25-foot cord. Power supply for the racking device is 120 volts AC, 15 amps. The remote racking device must be the switchgear manufacturer's standard system designed for racking the breakers provided. If the switchgear manufacturer does not offer such a remote racking device, a different manufactured system may be provided if certified to rack the breakers provided with the switchgear.]

[OPTION 2: Provide a portable remote racking device which can be placed on the breaker door enclosure to allow remote racking of all the breakers within the switchgear. The remote racking device must be the standard product used by the switchgear manufacture and be provided with all the adapters required to remotely rack out the breakers. If battery powered, provide it with a battery charger and minimum of two batteries. The device must have adjustable torque setting to prevent damage during racking the breaker and be equipped with a minimum 25 foot cord. The device must be designed to automatically stop on fully racked in and out position.]

]2.7.3.6 Ventilating Opening

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

2.7.3.7 Foundations

Provide 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. The foundation must satisfy the requirements of Section 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT. Submit Foundation Detail Drawings of the foundation and its installation requirements along with the drawing submittals.

[2.7.3.8 Cable Compartment Barriers

[Provide a metal barrier full height and depth between adjacent vertical structures in the cable compartment.][Provide a vented barrier between the cable compartment and the main bus to protect against inadvertent contact with main or vertical bus bars.]

][2.7.3.9 Infra-red (IR) Viewing Windows

Provide Infra-red (IR) viewing windows on the rear of the switchgear enclosures, minimum one window for each vertical breaker section. Provide the number of windows required to view each circuit breaker cable lug to allow IR sensing of each breaker in the closed position under load conditions without having to open the enclosure. Windows must feature a removable steel or aluminum security cover over a 4-inch crystal sight glass. The IR windows must be the switchgear manufacturer's standard product, or a third-party product that is UL certified and arc-flash tested to the fault withstand rating of the breakers or higher, and installed with the coordination and approval of the switchgear manufacturer.

][2.7.3.10 Switchgear Arc Rating

****
NOTE: Include the sections below for arc resistant switchgear. The arc resistant switchgear cost is approximately an additional 50% material cost over general metal-enclosed switchgear and require additional height and space for directional venting of any arc produced gasses.
****

Provide Type 2B certified switchgear as defined by IEEE C37.20.7 such that the operator is protected around entire perimeter of equipment with the low voltage control, instrumentation, and breaker secondary customer termination compartment doors open.

][2.7.3.11 Switchgear Ventilation

Provide a ventilation system that allows exhaust of arc gasses regardless of the origination location of the arc event to exhaust arc events originating in the breaker cell, bus compartment, and rear cable compartment.[Provide switchgear without an arc plenum for arc exhaust.][Provide switchgear with an arc plenum included.][Provide external connections to arc duct.]

]2.7.4 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] [4,000] [_____] amperes without exceeding the temperature limits specified in [IEEE C37.20.1A][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.

2.7.5 Power Circuit Breakers

2.7.5.1 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.

****

NOTE: Tie and Tie isolation breakers are located in a separate vertical sections, with barriers between, to provide an electrical isolation point for access to the opposite breaker

Diesel Generator, Station Service Units, or "House Units" are recommended to be interlocked with the corresponding Main and Tie breakers if synchronizing capability is not installed.

****

****

NOTE: Interrupting rating is based on fault current available at that location. Fault current is based on the configuration and components of the system. Perform a fault study on the system to determine maximum available fault current to select the appropriate interrupting rating required. Cost and physical size my increase with a higher rated circuit breakers.

****

****

NOTE: To ensure an interlocking scheme operates as intended, the designer must include drawings showing the configuration or give a narrative on required behavior.

****

2.7.5.2 Main and Bus Tie[s] Circuit Breakers

Provide two power supply circuit breakers and the bus tie circuit breaker[and bust tie isolation breaker] must be electrically-operated drawout type with the closing mechanism designed for operation on [125 volts DC] [120 VAC]. Provide circuit breakers rated 600 volts AC, [600] [1,600] [3,000][4,000][_____] 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[s] with a solid-state direct-acting over-current tripping device consisting of long-time-delay and short-time-delay elements.[Furnish the bus tie [isolation]circuit breaker [without an overcurrent trip device] but with a 125-volt DC shunt trip device.] Coordinate 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. The two power supply circuit breakers and the bus tie circuit breaker are to be electrically interlocked such that only two of the three breakers can be in the closed position at the same time. Provide a local test control switch for each electrically-operated circuit breaker which will 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 are to be provided to accomplish the required breaker control and interlocking system[as shown]. Provide at least four auxiliary switch contacts on each breaker and at least two spare auxiliary switch contacts, one normally-open and one normally-closed on each electrically-operated breaker.

2.7.5.3 Feeder Air Circuit Breakers

****

NOTE: Feeder breakers can have manual or electrical and manual spring charging capabilities if control power is available. Control Power is recommended, if available, to provide indication and power for

trip units on open breakers or breakers that have too little current flow to self power to prevent a dead battery.

Feeder breakers can be configured with shunt trips to allow for load shedding of nonessential loads for reduced power demand while on emergency diesel generator source.

****

Provide feeder breakers that are independent [manually-operated][remote operated] type with [electrically][manually]charged stored energy closing mechanism, with frame sizes as indicated, and rated 600 volts AC. Circuit breakers will have a short-circuit interrupting capacity of not less than [22,000][_____] RMS symmetrical amperes at 600 volts AC. Each feeder breaker must have 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 must be adjustable over an approximate range of 600 to 100 percent of the trip ampere rating. The short-time-delay trip elements, for the direct-acting overcurrent tripping devices must be adjustable over a range of approximately four to ten times the ampere rating.[Manually-operated drawout type circuit breakers are to 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 are to be designed for tripping [by a rotary motion in the opposite direction or][by pressing a readily accessible trip button].[Make the operating handles easily removable when it is necessary to open the compartment door and easily replaceable for operating the breaker in the withdrawn or test position.][Capture key interlock duplicate feeder breakers.] Equip each breaker with a conspicuous mechanical target[and light] visible with the breaker in the normal operating position to indicate whether the breaker is open or closed and 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 must be[manually-operated type] electrically operated type equipped with a 125-volt DC shunt trip attachment for emergency stop operation from remote stations.]

[2.7.5.4 Digital Trip Units

Provide digital trip units for each breaker . Loss of control power to the trip unit must not affect the operation of the unit to trip the associated breaker.

a. The digital trip units must have been used successfully on low voltage power circuit breakers of the type and rating to be furnished under these specifications. The minimum requirements to be defined as successful is a minimum of 500 units installed and in operation for five years. Provide a trip unit that is the manufacture's standard type and compatible with the breaker to be provided.

b. Provide a microprocessor-controller based trip unit for use on three-phase, 600 volts AC circuit breakers with a liquid crystal display (LCD) to provide programming and setting capability for the user.

c. The trip units must have three different power supplies:

i. Primary power supply is to be derived from the phase current transformers (CT). The trip unit must be powered with less than 20% of the rated CT tap current.

ii. Provide a battery to power the unit when the CT power is lost. The status of the battery (good/bad) must be displayed and loss of the battery results in an alarm output. The battery can be charged when not in use through the power derived by the CT.

iii. 125 VDC Power for auxiliary power to the trip unit. Provide 125VDC Control power from the existing 125 VDC control power of the corresponding switchgear bus. Limit the uses of control power to recharging the trip unit's internal battery and to change or review the trip unit's settings when the battery charge is low.

d. The trip unit must measure the true RMS current through each of the breakers' three poles. The trip unit must be capable of determining the vector sum of the three phase currents, and calculate the 60 Hz component of the ground fault current. Provide trip units with the following trip settings:

i. long time.
ii. short time delay.
iii. instantaneous pickup.
[iv. ground fault.]

e. The trip unit must store the trip settings and the last trip data in a non-volatile memory for later recall. Include a security means with the trip unit to reduce the risk of unauthorized tampering with the trip unit's settings.

f. Equip each Main and Tie breaker's trip unit with arc flash reduction settings to put the trip unit automatically in instantaneous trip mode by means of a contractor installed control switch mounted on the cubicle door. Provide switch and wiring to connect this function to the trip unit. The switch must have a provision for installing a padlock.

g. The Government reserves the right to change the indicated trip ratings, within the limits of the frame, of the trip devices at the time the shop drawings are submitted for approval.

][2.7.5.5 Remote Control Device

Provide a remote control device that is a portable unit that connects to the exterior of the breaker enclosure to allow remote operation of the breaker (open/close). The remote control device must be a pendant with a minimum 25-foot cord. The cord must be equipped with a plug with threaded or locking coupling and strain relief

]2.7.6 Wiring

2.7.6.1 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. Provide current transformer secondary leads No. 10 AWG and

larger. 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.

2.7.6.2 Terminals and Installation

****

NOTE: If incorporating new switchgear into existing installations where terminations are required to interface with existing equipment or systems, the designer may include drawings showing these connections via new contract drawings or as referenced drawings.

****

a. Provide control wiring within the assembly housingse[as shown]. All control wiring entering and leaving equipmentt must be terminated on terminal blocks. 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 applicable to the equipment involved. Each individual potential transformer lead must be brought out to a terminal block. Ground the potential transformers at the equipment.[Potential transformers for metering circuits will be remotely grounded][by the Government]. No splices will be allowed in the wiring and all connections are to be made at terminal studs or blocks. Add terminal blocks for wiring to devices having leads instead of using the device's terminals.[Indented terminals are to be used on all wires terminated on screw or stud terminals.] Provide screw terminals with toothed lock washers and all stud 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 enters the switchgear from [above] [below][through floor slots]. Provide matched 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. The terminals must be of the heavy-duty, full clamp type. Make provisions for supporting the Government's cables between the conductor terminating points and where they enter or leave the switchgear.

2.7.6.3 Terminal Blocks

****

NOTE: DIN rain rail mounted terminal blocks are acceptable for most input/output of PLC. For other terminal block ring type terminals are preferred in most applications.

****

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. 10 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 DIN rail type terminal blocks, they must be modular and rated no less than 600 Volts and 20 Amperes. The terminal connections must be pressure type with length and space for connection of at least two No. 14 AWG stranded conductors on each end of the feed-through. The terminal contacts must be built to prevent the terminated wires from being loosened by vibration or by normal pulling forces. Mounting rails and end covers must be provided for the terminal block assemblies.]

d. 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.

e. 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.

f. 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.

2.7.6.4 Wire Markers

Tube-type heat shrink or self laminating markers must be used at each

terminating end of the conductor and must be suitable for contact with the type of insulation material used. Tubing must have permanent black marking on a light-colored background.

2.7.7 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.

2.7.8 Molded Case Circuit Breakers

****

NOTE: If included with other systems where molded case breakers are provided, it may be better to reference Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL.

Interrupting rating is based on fault current available at that location. Fault current is based on the configuration and components of the system. Perform a fault study on the system to determine maximum available fault current to select the appropriate interrupting rating required. Cost and physical size my increase with a higher rated circuit breakers.

****

2.7.8.1 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.

2.7.8.2 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.

2.7.8.3 480-Volt AC Circuits

Provide circuit breakers for 480-volt AC circuits that are rated 600 volts AC with a minimum NEMA interrupting capacity of [10,000] [14,000] [20,000] [_____] symmetrical amperes at 600 volts AC.

2.7.8.4 120-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] [14,000] [_____] symmetrical amperes.

2.7.8.5 125 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.

2.7.9 Instrument Transformers

[2.7.9.1 General

[Bring all leads from each individual instrument transformer out to switchgear terminal blocks. All instrument transformers must conform to the applicable grounding requirements of IEEE C57.13.]

[Provide relay curves for instrument transformers. Submit typical ratio and phase angle curves for each type and rating of all voltage and current transformers supplied with the equipment.]

][2.7.9.2 Voltage Transformers

[Voltage (Potential) Transformers must conform to the applicable requirements of IEEE C57.13, and be of the indoor dry or compound-filled type with a minimum full-wave impulse level of 10 kV. Provide transformers with a voltage rating and indicate on the drawings, and with a thermal rating for a 55 degrees C ambient and be no less than 150 volt-amperes. Voltage transformers must have a relay and metering accuracy of 0.3W, 0.3X, 0.3Y. Configure the voltage transformer as indicated on the Contract drawings.]

[Mount the voltage transformer in separate switchgear compartments. Use current limiting fuses for each phase connection on the primary side and type J fuses on the secondary. Locate fuses so as to be readily accessible from the front of the switchgear using doors per PARAGRAPH: ACCESS DOORS AND PANELS. Fuses must be able to withstand maximum possible energizing current, but capable of interrupting the circuit in case of a short-circuit on the secondary winding. Install fuses in [finger safe] fuse cartridge holders [with blown fuse indicator] allowing their removal without a fuse puller. Connect each voltage transformer low voltage connection to a terminal block in the switchgear low voltage compartment.]

][2.7.9.3 Current Transformers

[2.7.9.3.1 General

[Provide the quantity, ratios, and functions of the current transformers [as needed][as shown on the drawings].]Current transformers must conform to the applicable requirements of IEEE C37.20.1A, IEEE C57.13, and IEEE C57.13.3. Provide current transformers of the dry or compound-insulated type [relay][metering] accuracy, and with a suitable means of mounting and for grounding the frame. Connect each current transformer secondary lead to a terminal block of the short-circuiting type and be conveniently located to permit short-circuiting the secondary windings without requiring access to the primary bus compartments. Plainly mark the polarity of the current transformers. Short the current transformers at the terminals of each of the current transformers for shipping. All current transformers must be suitable for continuous operation at the full-rated voltage and current at a frequency of 60 Hz. All current transformers are to be designed and built to withstand, without damage, the thermal and mechanical stresses resulting from short-circuit currents corresponding to ratings of the breakers in the circuits to which they are connected. Current transformers must have a continuous thermal current rating factor based on 30 deg C average ambient air temperature of a minimum of 1.33. Current transformer secondary leads cannot be smaller than No. 10 AWG.

][2.7.9.3.2 Window or Bushing Type Current Transformers

Provide window or bushing type current transformers in the 480 volt switchgear unless otherwise noted. Window or bushing type current transformers must have a minimum full-wave insulation level of 10 kV when installed and meet the requirements for a 10-kV BIL rating as listed in Table 2 of IEEE C57.13 for test voltage applied between the bus and transformer secondary terminals.

][2.7.9.3.3 Rating

Current transformers with ratios between 75:5 and 300:5 must have a combination metering/relaying rating of 0.6 B-0.1 / C50. Current transformers with ratios between 400:5 and 500:5 must have a combination metering/relaying rating of 0.3 B-0.1 / C100.

][2.7.9.3.4 Burden Analysis

Calculate the burden of the new relays, conductors and associated equipment to demonstrate that the burden does not exceed the current transformer rating. Notify the Contracting Officer if there is a problem with excessive burdens that could result in current transformers inaccuracies or going into saturation under fault conditions. Submit analysis as part of the Factory Inspection and Test Report.

]][2.7.10 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 C37.20.3]. Provide two ground detector relays, one for each bus section of the switchgear.

]2.7.11 Relays

2.7.11.1 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. 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, chatter-proof and non-bouncing relay contacts suitable for use on 125-volt ungrounded DC circuits. 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.

2.7.11.2 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 [_____].

2.7.11.3 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 [_____].

[2.7.12 Automatic Bus Transfer

****

NOTE: Electromechanical relay operation using undervoltage relays is a simple and inexpensive means of automatically transferring to active power sources.

Some power plants have one main and one tie closed or use a station service unit feed as their normal operation. If this is the configuration, need to update the following scheme appropriately. Coordinate with Protection and Control Engineer on the programming of the relay for the auto transfer scheme.

****

****

NOTE: To ensure an auto transfer scheme operates as intended, the designer must include drawings showing the configuration or give a narrative on required behavior.

****

Provide the switchgear with automatic bus transfer[,as shown by the schematic diagrams,] incorporating the following (normal operation will be with both supply breakers closed and the bus tie breaker open):

a. Loss of voltage on one bus causes 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 one of the two normal sources will (after a time delay) open the bus tie breaker and close the associated supply breaker.

d. Recovery of voltage from both normal sources will (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 must be accomplished within approximately one second.

][2.7.13 Protective Relays

Provide a microprocessor based protective relay to perform the required functions. The relay must provide overcurrent protection of the main breakers.[The relay must also provide ground detection alarm and tripping in conjunction with three 3-phase voltage transformers connected to each bus section.][The relay must be SEL type 751 or approved equal.][The protective relay must have arc-flash light sensing with high speed detection and be used in conjunction of the fiber optic sensors. The relay must be provided with adequate fiber sensor inputs to implement the required number of protective zones.][The relay must have a minimum 10 year warranty in addition to those requirements in Section 01 78 23 OPERATION AND MAINTENANCE DATA. Provide Protective Relays with programmable button on the front of the relay labeled to "MAINT" for an Arc Flash maintenance mode. Additionally, a front indicating LED must be labeled "ENABLED" to indicate when maintenance mode is active.][The relay will be used to perform the automatic bus transfer function[and be compatible with [SEL] [District's Protective relaying network currently in use] networking equipment.]][Wire the relay to the transformer temperature relay alarm and trip contacts to provide protection of the transformer and provide alarm on over-temperature. The alarm functions must be connected into the existing annunciation system.] Power to operate the Protection relays will be 125 VDC from the Station Battery, with a range of 105 VDC to 140 VDC with a power consumption of less than 25 Watts.

][2.7.14 Test Switches

****
NOTE: To ensure existing testing equipment connections can be used on the new equipment, the designer must include drawings showing the orientation and layout of the test switches.
****

Provide switches[as shown] for all voltage, current, power and trip signals into the protective relay to alarm for testing and maintenance. Provide test switches with covers and combination test switches not to exceed 14 poles. Current test switches must be the short-circuiting type. Provide test devices for insertion into the associated test switches to permit application of the proper current or potential source for testing and calibration. Test switches must be rated not less than 20 amperes and 125 volts DC and be equivalent to ABB FT-1 and FT-14 test switches.

][2.7.15 Fiber Optic Arc Flash Sensors

Provide the switchgear with arc flash fiber optic [loop][and][point]sensors [two loops run parallel throughout the entire switchgear, one for each relay input][as indicated on the drawings][as recommended by the Protective Relay manufacturer]. The loop sensors must be compatible with the protective relay provided. For double-ended switchgear, run two loops in parallel throughout the entire switchgear, one for each relay input. Provide documentation of their compatibility . The sensors must be designed and built specifically for the use in arc flash sensing and be

connected to the relay in accordance with the manufactures recommendations

][2.7.16 Panelboards

Install panelboards in the switchgear[as indicated on the drawings] to supply the control power to the electrically operated breakers and protective relays. Panelboards must be dead front, complete with doors, frames and hardware, rated 125/250 VDC [120/208 VAC] [_____] with breakers and spaces as indicated, be NEMA type 1 and satisfy the requirements of NEMA PB 2 and be painted to match switchgear. Panelboards must bear Underwriters Laboratories label or other reliably recognized testing laboratory. All panelboards must have copper bus and have an internal ground bus which is to be wired to switchgear ground bus. Install the panelboards in switchgear cubicles to allow access to the breakers. Provide a transparent directory holder inside door and a neatly typed directory placed within the holder.

]2.7.17 Control Switches

2.7.17.1 General

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

2.7.17.2 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 the switches with a black[pistol grip,][oval,][round notched][or][knurled] handles or as approved.

b. Control switches for electrically-operated circuit breakers must be 3-position momentary-contact type with spring return to neutral position, and have 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.

c. Control switches for instrument and meter transfer switches and for selector switches must be the maintained contact type with the required number of positions, and ammeters with round notched type handles and be connected to read all three phases. Connect ammeter switches to not open the secondary circuits of the current transformer at any time.

d. Provide each control switch with an escutcheon clearly marked to show each operating position. The switch identifications be engraved on the escutcheon plates or on separate nameplates. The escutcheon and

nameplate markings are subject to approval.

2.7.18 Indicating Lamp Assemblies

Provide indicating lamp assemblies of the switchboard light emitting diode (LED) type, insulated for either 125-volt and 120-volt AC depending on its service and have colored lens cap with integrally mounted resistors. Provided caps must not be softened during operation. Lamps must be long-life LED with a minimum normal life span of not less than 100,000 hours, visible from at least 20 feet away and replaceable from the front of the panels. Furnish special tools required for lamp replacement. Insofar as practicable, all color caps must be similar and interchangeable, and all lamps be the same type and rating.

2.7.19 Indicating Instruments

****
NOTE: If remote indication or input into plant SCADA, or equivalent, is desired, insert analog communication or network protocol in accordance with any and all relevant USACE cyber security requirements.
****

2.7.19.1 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, dust proof, direct-reading, of the switchboard type, and approximately 4-1/4 inches square instruments. Provide instruments with white dials, circular scales, black scale markings, and black tapered antiparallax pointers. Ensure instrument cases are dust tight with shadow proof 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 secondary windings of voltage transformers and 5-ampere secondary windings 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.

2.7.19.2 Ammeters

Full-load current must be indicated by the pointer at approximately 75 percent of the full-scale range.

2.7.19.3 Voltmeters

Provide voltmeters with expanded scales and calibrated to indicate the nominal phase-to-phase voltages at approximately mid-scale.

[2.7.19.4 Wattmeters

Watthour meters must be digital, with RS-485 communications capability

having a 15-minute, cumulative form, demand register. Watthour meters must conform to ANSI C12.1. Watthour meters must be accurately calibrated for use with the associated instrument transformers. The Contractor may submit for approval a digital multimeter combining any or all of the functions for indicating meters and watthour meters.

]2.8 STATION SERVICE TRANSFORMER

****

NOTE: If the transformer is not close-coupled to the switchgear, the connection between the transformer and the switchgear should generally be made by metal enclosed bus to ensure reliability. Cabling can be used where impractical, where physical limitations prevent bus, or cost prohibitive for bus.

Reference UFGS Specification for Metal enclosed bus to complete or edit this as needed.

****

****

NOTE: When procuring a 480 volt substation it is preferable that the switchgear and transformer be contained in the same specification to ensure that the equipment is properly coordinated and designed as a system. If it is separated into two sections, care should be taken to ensure all the necessary requirements are moved with the transformer section and requirements for coordination of equipment connections is included. Enclosure, ground bus, terminal blocks and wiring are some of the critical items that must be clearly identified in the transformer section. Also it must be required that the Contractor fully coordinate the bus connections and enclosure requirements for the bus penetrations to connect the equipment. Those details should be clearly indicated on the Contractor's shop drawings.

****

****

NOTE:

1. Consideration should be given for the transformer winding configuration. Existing transformer configurations are most likely delta-delta windings. This configuration allow continuity of service with one ground on the system. Modern configurations are Delta-WYE with a high resistance applied to the neutral of the transformer. This configuration is HDC standard configuration, but not mandatory if project requests otherwise.

2. The impedance of the transformer should be coordinated with fault study to limit fault current to within the equipment rating. Standard impedance should be used where possible. Higher impedances and BIL rating may affect the physical size of the

transformer.

3. Lower temperature rise transformers are normally specified to reduce the heat load into the power plant. At times it may be necessary to specify higher temperature rise transformers due to powerhouse space requirements.

4. Use of fans for cooling should be avoided and are not included as an option in these specifications. It complicates the controls. Fans can result increased maintenance by allowing dirt of the power floor to be blown into the transformer. Also increases loading on 125 VDC system.

5. Where it is necessary to place transformer with one side up against the wall, that design requirement should be clearly stated in the specification and the temperature rise test should be made to simulate that side being blocked. Manufacturers can design transformer to allow more air to enter the bottom of the transformer to compensate for the blocked side, however it may increase the enclosure height. Special configurations should be discussed with the transformer manufacture's while developing the specifications to ensure the requirements can be met within the powerhouse limitations.

6. Evaluation of the room to access the final location should be looked at. Equipment designs have changed and plant may have added equipment that restrict access ways for moving equipment. If the transformer must be disassemble to move into the final location, that requirement should be clearly articulated in the specifications. It should not be assumed that the offerors will determine this prior to bid. Transformers can be designed to be easily disassemble to very narrow widths if that information is known by the factory. All limiting dimensions and size criteria should be clearly indicated in the specifications or on drawings. Disassembly of a transformer in the field which is not designed for that purpose can subject the transformer to potential damage or require modifications in the field.

7. Minimum BIL rating for 13.8 kV winding is 95 kV; for 4.16 kV is 60 kV. An analysis should be performed to determine whether surge capacitors are required. Care should be taken to ensure that capacitors are only installed where required as these devices can have other detrimental affects.

****

Connect the transformer low-voltage terminals to the switchgear main breakers in the adjacent 480-volt switchgear section by means of [flexible leads connected to the switchgear bus] [metal enclosed bus] [low voltage cables] with thermal and mechanical capacities coordinated with the

ratings of the 480-volt power supply circuit breakers. The transformer medium-voltage and low-voltage bus connections must be arranged so that the front of the transformer enclosures will line up with the front of adjoining incoming sections and the 480-volt switchgear section. Ensure coordination of the housing penetrations and bus connections between equipment. Field cutting or drilling of the enclosure or bus will not be allowed.

2.8.1 Type and Rating

The station service transformers must be indoor ventilated dry-type, self-cooled, Class AA with [155] [220] degrees C insulation and conform to the applicable requirements of IEEE C57.12.01, [IEEE C57.12.50] [IEEE C57.12.51] and IEEE C57.12.91. The transformers are rated [_____]kVA, 3-phase, 60-Hz, [13,800-480 volts],[[4160]-480 volts], [[_____]-480/277] with a primary winding BIL rating of [95] [60] [_____] kV and secondary winding BIL of 10 kV. The windings must be copper and connected [delta-delta] [delta-wye]. The transformer impedance must be [standard] [[_____] percent] subject to ANSI standard tolerance. The transformer must be rated to carry rated load continuously without exceeding 80 degrees C (Class 155 degrees C) or 150 degrees C (Class 220 degrees C) temperature rise above 40 degrees C ambient temperature when installed in its ventilated sheet metal enclosure and cooled by natural air circulation.

2.8.1.1 Core and Coils

The core, coils and metal enclosure of the transformer must be rigidly attached 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. The core laminations must be free from burrs which may puncture the insulation between laminations and be securely fastened 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 medium-voltage windings, and suitable means provided for changing the taps while the transformer is de-energized. The terminal board must be accessible through a door or removable panel in the enclosure. Securely brace all transformer leads and taps to prevent displacement or injury during transit or installation and under short-circuit condition.

2.8.1.2 Enclosure

Provide the transformer with a ventilated sheet steel enclosure per paragraph 480-volt Station Service Switchgear, except that a formed enclosure of no less than No.12 MSG may be used. Provide doors or removable panels in the enclosure to permit access to the transformer, and suitable removable lifting eyes or other approved means to permit lifting both the enclosure and the complete transformer by the use of a crane. The enclosure must be adequately braced and stiffened on the inside, and be coated with sound-deadening material if necessary, so that the audible sound level of the enclosed transformer when operating at rated load does not exceed the value permitted in Table 6 of IEEE C57.12.01. Install Corrosion resistant insect proof screens in ventilation grills.[There are powerhouse limitations that will not allow the transformer to be moved into its final position fully assembled. The transformer must be designed and built to be disassembled on site and reassembled at its final position. Connection which are to be disassembled must be bolted and not

crimped to allow for complete removal of the bus or cable to prevent damage during movement. The transformer must be designed and built to accomplish this disassembly without damage or loss of warranty. Include full set of drawings and instructions with the transformer submittals to accomplish this work.]

2.8.2 Incoming Sections

Provide a metal-enclosed medium voltage transition compartment for terminating the incoming medium voltage shielded cables. Include ground bus and support for cable bracing in this section. Access to the interior of the compartment must be through removable bolted panels or bolted hinged doors. Connections between the terminals of the incoming cables and the medium-voltage winding terminals of the adjacent transformer by means of copper bus with not less than [600][_____] amps continuous current-carrying capacity and [_____] kA asymmetrical amperes momentary current rating. Provide heavy-duty clamp type terminal lugs for connecting the medium-voltage cables to the transformer medium-voltage bus. The design must allow adequate space for bending and bracing of medium voltage shielded cable. The termination point for the medium voltage cable must be no less than 3 feet from where the cable enters the enclosure.[Install grounding studs on all three phases for use by maintenance personnel to install safety grounds.]

[2.8.3 Outgoing Sections

Provide a metal-enclosed low voltage transition compartment for connecting the transformer bus to the low voltage metal enclosed bus. Access to the interior of the compartment must be through removable bolted panels or bolted hinged doors. The connections must be made of copper bus with no less than [1200][1600][3200][_____]amps continuous current-carrying capacity and [25][42][65][_____] kA symmetrical amperes momentary current rating.

][2.8.4 Temperature Relay

****

NOTE: The transformer temperature relay must be coordinated with the specific requirements of the project. If the relay is to be used for tripping rather than alarm functions, the contact ratings must be investigated to ensure it will be adequate. If it is used as an input to a protective relay or annunciation the electrical contact requirements are not as stringent. Coordinate with control and protection section within HDC to verify adequate contact ratings.

****

Provide the transformers with a temperature monitor relay. The transformer temperature monitor must utilize four inputs: winding 1, winding 2, winding 3, and ambient temperature. Place input RTDs in the anticipated hottest spot of each winding assembly. The monitor equipped operate off of a 125VDC supply. Provide RTDs of the type recommended for the selected monitor. At a minimum, two programmable Form C contacts, rated for operation on a 125VDC system, be available for over-temperature alarm and trip functions. The temperature monitor must include communications provisions for utilizing MODBUS RTU protocol.

][2.8.5 Foundation

The transformer foundations must satisfy the requirements of the foundation for the 480 Volt switchgear.

]2.8.6 Surge Protection

****

NOTE: Surge protection must be properly evaluated. The overvoltages as a result of the use of vacuum must be closely evaluated to determine the need for surge protection. Even if the project does not have medium voltage vacuum circuit breakers at the time of this equipment replacement, it will most likely get them within the life of this equipment. Standard HDC practice is to install surge arresters to protect the medium voltage winding. Care must be taken when installing surge capacitors however, as it can result in impacts to he electrical system if not properly evaluated.

****

[Mount surge arresters for each phase in the medium voltage terminal compartment. Surge arresters must be metal-oxide, station class, with a MCOV of 15.3 kV for 13.8 kV winding [MCOV of 5.1 kV for 4.16 kV winding]. Surge arresters must be constructed in accordance with the requirements of IEEE C62.11. Submit the surge arrester design test results for each type of arrester provided and the surge arrester conformance test results for each arrester provided. If surge arresters are not mounted near the base of the enclosure, a ground bus must be run to close proximity of the surge arrester so that cable is not run along the equipment housing to the enclosure ground bus. Perform all tests in accordance with IEEE C62.11]

[Surge Capacitors for each phase must be mounted in the transformer medium voltage terminal compartment. Provide surge capacitors rated 0.25 microfarad at 13.8 kV,[0.5 microfarad for 4.16 KV]. If capacitors are not mounted near the base of the enclosure, a ground bus must be run to close proximity of the capacitors so that cable is not run along the equipment housing to the enclosure ground bus.]

[2.8.7 Ground Bus

Provide a continuous ground bus inside the transformer enclosure including the transition and termination compartments. It must be copper not less than 2 inch by 1/4 inch. The ground bus must be mechanically connected to the core, frame and enclosure. The use of ground cables in lieu of bus is not allowed. Bond the ground bus to the bus within the switchgear.[Ground connections to surge protection equipment, except for final connection must be by adequately sized bus. The final connection to the surge equipment must be by cable to allow disconnection for maintenance and testing.] In the medium voltage compartment, install the bus up the wall to allow the connection of the medium voltage cable shields. Provide a burndy type YA lug to connect a 1/0 AWG copper cable to the powerhouse ground bus.

][2.8.8 High Resistance Ground Equipment

Install the High Resistance Ground (HRG) equipment at the main breaker sections for each bus of the switchgear. The HRG must be a regular

catalog off-the-shelf packaged unit of a manufacturer regularly engaged in the design, manufacture, and testing of neutral grounding systems and for use on this type of equipment with no less than five years of successful operation. A device assembled of discrete parts is not acceptable. The HRG must be fully installed during switchgear tests.

2.8.8.1 Grounding Equipment

a. Each set of grounding equipment must include a grounding resistor and all associated controls and wiring. All connections and leads must be insulated for 600 volts AC.

b. Size the grounding resistors to provide 1 to 5 amperes of ground current in the event a single-line-to-ground fault. Tap the resistors with taps wired out to a convenient accessible terminal block. Provide taps for 1-5 amperes of ground current in 1 ampere increments. The resistors must be rated for continuous duty and of the heavy duty industrial stamped steel design. The resistors must conform to IEEE C57.32 except that they are insulated for not less than 600 volts AC and the rated maximum temperature of the resistors can not exceed 415 degrees C when mounted inside the switchgear with natural air cooling. Provide mounting brackets for the resistors for mounting in the switchgear. All steel support materials must be corrosion-resistant steel or hot-dipped galvanized.

c. Current transformers must be window or bushing type rated 600 volts, ratio 10:10 with full wave insulation of 10-kV BIL when installed, 1.33 continuous thermal current rating factor based on 30 deg C and conform to the applicable requirements of IEEE C37.20.1A, IEEE C57.13, and IEEE C57.13.3. Plainly mark the polarity and provide with a suitable means of mounting and for grounding the frame. Each current transformer secondary lead must be connected to short-circuiting type terminal block with no less than No. 10 AWG and be conveniently located to permit short-circuiting the secondary windings without requiring access to the primary bus compartments. Short the current transformers at the terminals of each of the current transformers for shipping.

d. Each unit must be enclosed in the 480V switchgear, completely wired in the factory, in a location that will not interfere with the installation, operation, repair and maintenance of the switchgear. Manufacturer's standard ventilating openings must be provided for proper ventilation. Intake vents must be filtered, and both intake and exhaust vents be provided with corrosion-resistant insect-proof screens on the inside.

e. Provide engraved nameplates for all devices mounted within the assembly corresponding to appropriate designation on manufacturer's drawings.

f. Submit with the switchgear drawings: outline drawings, connection and assembly drawings, and schematic diagram of high resistance grounding system. Drawings to include overall dimensions, size and location of cable entrances, details for bolting equipment to the switchgear, data for all equipment, nameplate schedule, wiring diagrams. Provide wiring diagrams of the wire-less type and as viewed from the front, as seen by the observer facing the equipment.

][2.8.9 Ground Detection Equipment

Provide the ground detection equipment for each bus section of the switchgear, to be used for indication and annunciation of grounds on the 480-volt system. The equipment must 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. Provide two ground detector relays, one for each bus section of the switchgear. Mount the ground detection relay on the auxiliary compartment doors.

][2.8.10 Heaters

****

NOTE: Heaters should be specified when required for the environment or by user request. Normally the station service transformers are always energized from the medium voltage side so heaters are not required for normal operation. In high humid environments, it may be difficult to get proper insulation resistance reading when the transformer has been out of service for maintenance. The need for heaters should be coordinated with the specific application.

****

Provide heaters with the transformer rated for 240VAC, but the number of heaters to be provided must be rated for operation at 120VAC. Provide a thermostat to operate the heaters and the thermostat must have user defined setting range of no less than [60 to 105][[_____] to [_____]] degrees F.

]2.9 METAL-ENCLOSED BUS

Submit the proposed methods for grounding bus housing.

2.9.1 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 C37.20.3. Ensure bus is rated 600 volts AC [800][1,600][2,000] [_____] amperes continuous current carrying capacity, and the momentary current rating is no less than [25,000][42,000][50,000][65,000] 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][monolith] joint in the [building][powerhouse]. 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.

2.9.2 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.

2.9.3 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.

[2.9.4 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.

][2.10 CAPTURE KEY INTERLOCKS

****
NOTE: Capture Key Interlocks (Kirk Key) are not commonly used in most installation where automatic operation of breakers is required and electrical interlocks prevent inadvertent operation. Where manual breakers capable of feeding from multiple sources exist, capture key interlocks may a viable solution.
****

Where required, provide capture key interlocks that are switchgear mounted. Capture key interlocks must be factory installed and included as part of the breaker design. The key interlocks must hold the breaker mechanically trip-free to prevent electrical or manual closing while key is released. The key interlocks must only release the key with the breaker in the mechanically trip-free status.

][2.11 ANNUNCIATION EQUIPMENT

****
NOTE: Annunciation panels can be installed at the switchgear to display faults and alarms to supplement or duplicate SCADA system alarms from the switchgear. Add specific requirements for operator interface (HMI or light box) and alarms or indications chosen to be displayed.
****

Mount and wire one annunciator on each switchgear assembly as indicated on the drawings. The annunciator must satisfy the requirements of Section [_____].

]2.12 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).

2.13 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.

2.13.1 General

Give each item of equipment supplied under this contract the manufacturer's routine factory tests and also other tests, as specified below, to ensure 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.

2.13.2 Switchgear Assembly Tests

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

2.13.2.1 Assembled Equipment

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

2.13.2.2 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.

2.13.2.3 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.

2.13.2.4 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.

2.13.3 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.

2.13.4 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 C37.20.3].

2.13.5 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

****

NOTE: An evaluation of the equipment installation requirements should be made. Requirements should be written to clearly articulate to the bidder the specific site requirements.

Hatch dimensions and doorway restrictions should be clearly indicated to ensure equipment is designed to be disassembled where required. Switchgear should be design for shipping splits where required to prevent factory wiring having to be redone in the field.

Critical powerhouse and main dam loads should be evaluated and a determination should be made as to how these loads are to be supplied while equipment is being replaced. Clear guidance should be provided to the Contractor to eliminate increase costs due to unknown risks. Unwatering pumps and battery chargers should be evaluated based on the time period of the outage and the amount of leakage in the plant. Also head cover pumps can also be critical in some of the plants. Sometimes the projects have the capability to provide temporary power; however, in this case clear time restrictions should be placed on the contractor to limit the impact to the project. Where the loads must be provided by the Contractor, these loads and the allowed location for temporary generators should be identified. A reasonable time period should be specified for the time period that the temporary power will be allowed as it has some impact on powerhouse reliability.

****

****

NOTE: The drawings to be used in the contract set should be carefully considered to present a clear biddable package to the prospective bidders. Excessive drawings can add confusion to the work and it should be understood that Government will have significantly more knowledge about the project than the Contractor can have during the short proposal process. It can not be expected that the Contractor can navigate drawing pages with an excessive number of drawings with significant note callouts. Internals of equipment to be removed is not required. When equipment is being retained from existing equipment, reference drawings are usually adequate. New equipment arrangements, site space limitations, means for personnel and equipment access to work area are critical contract drawings. Reference drawings should be used to the maximum extent possible to indicate the existing equipment to be removed. Where minor modifications to existing equipment are being performed, such as replacing the feeder cables to motor control centers, it is not required to put the detailed motor control drawings in the contract set. The appropriate existing drawings can be reference. Reference drawings should be laid out in a logical manner to assist in navigating the information. Bidders will use the reference drawings and the cable and conduit schedule to determine level of work.

Contract Drawings should include:
1. Site Map
2. Index
3. Plan view of all floors affected and required to gain access to work area. This is to include plan

view indicating all equipment being modified or replaced.
4. Transverse section of powerhouse indication location of equipment where available.
5. Longitudinal section of powerhouse indication location of equipment where available.
6. Elevation and plan views of new equipment indicating the desired layout, size limitations and conductor entry.
7. Plan view indicating general routing and restrictions of new raceways.
8. One-line diagrams of powerhouse and equipment indicating the equipment to be modified or replaced.
9. Control schematic of electrical operated breakers.
10. Annunciation drawings if modified. If not being modified, reference drawings can be used to indicate reconnection of alarm circuits.
11. Wiring diagrams of affected remaining panels if being modified if substantial work is being performed which cannot be referred to the reference drawings. It should be understood that prospective bidders are only bidding on the level of work during proposal process, so there are other alternatives than including detailed wiring diagrams in contract set to facilitate bidding process. If not modified, reference drawings can be used to indicate the location of the work.
12. Cable and conduit schedule. These drawings are critical as they indicate to the bidders the amount and routing cables and new raceways. Care should be taken to ensure these accurately represent the scope of the project.
****

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 C37.20.3], 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.

3.2 480-VOLT SWITCHGEAR FACTORY INSPECTION AND TESTS

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

3.2.1 General

****
NOTE: The switchgear assembly to be furnished should be a standard product of a manufacturer that has satisfied all the required design test requirements. Specifying switchgear assemblies that

has not been subjected to design testing prior to award should be avoided. If for some reason standard switchgear product can not be installed, the specifications should be carefully modified by knowledgeable individuals to reduce risk to the Government.

****

a. Give each item of equipment supplied under this contract the manufacturer's routine factory inspections and tests and also other tests, as specified below, to ensure successful operation of all parts of the assemblies. All equipment must be completely assembled and wired during testing.[Where controls connect to other equipment to be provided, such as transformer temperature relays, simulate these controls during testing.] All tests required must be witnessed by the Contracting Officer, unless waived in writing, and no equipment is to be shipped until it has been approved for shipment. Provide no less than [14][_____] calendar days advance notification of testing to the Government.

b. Design tests must have been previously performed prior to award on the circuit breakers and switchgear design to be furnished under this contract. Submit Certifications of Switchgear and Breakers Design Tests and Time Current Curves. Design tests require to be conducted are as described in IEEE C37.20.1A as applicable for the ratings of the circuit breakers and switchgear to be furnished under this Contract. Submit proof of adequacy of design by certified reports. Identify all design tests which were performed to certify the design and submit Design Test Reports to permit review of design test data, oscillograph tracings, and other information by the Contracting Officer's Representative (COR).

c. Submit Factory Test Procedure prior to factory testing. Test the equipment for the production tests required in IEEE C37.20.1A. The factory test equipment and test methods used must conform to the applicable requirements of ANSI, IEEE and NEMA standards. Submit Factory Inspection and Test Reports after completion of the tests.

3.2.2 Breaker Assembly Tests

Test each low-voltage air circuit breaker assembly to the Production Tests described in IEEE C37.20.1A, except as modified or supplemented below:

3.2.2.1 Assembled Equipment

Check the assembled equipment for mechanical adjustment, alignment of roll out assemblies and devices mounted thereon to ensure proper fit and insertion into cubicles in existing switchgear assembly. The combined assembly of breaker and switchgear will be checked for adequacy of fastenings and general good workmanship.

3.2.2.2 Wiring

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

3.2.2.3 Breaker Assembly

Perform a 1-minute power frequency withstand dielectric test of 2,200 volts AC as recommended in NEMA C37.50 on each breaker assembly. Perform a 1-minute, power frequency withstand dielectric test of 1,500 volts AC to ground unless the required test voltage is reduced per NEMA C37.50 on all control, instrument, and relaying wiring.

3.2.2.4 Circuit Breaker

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

3.2.2.5 Switchgear Assembly

Perform a 1-minute power frequency withstand dielectric test of 2,200 VAC on each switchgear assembly, with all circuit breakers in the fully racked in position and all breakers closed.

3.3 INSTALLATION

Install all equipment in accordance with the National Electrical Code, NFPA 70, and the National Electrical Safety Code, IEEE C2. Omission of details on the drawings or in the specifications will not be construed as permitting deviations from Code requirements. Plan work and coordinate all outages with the requirements of other contract technical sections to ensure continuity of service to powerhouse equipment and to limit impact to the operation of the powerhouse.

3.3.1 Work Plan

****

NOTE: Edit "WORK PLAN" section based on contract type as described in note under section 1 GENERAL. Reference appropriate specification sections if appropriate or use/edit bracketed text as needed.

****

Submit a work plan for approval per Section 01 33 00 SUBMITTAL PROCEDURES.[For coordination of electrical outages and equipment installation, to be updated as changes occur, but no less than weekly during site work. Include all activities which are hazardous, affect plant operation, or require participation by Government personnel, in the plan. Include an itemized listing of all work to be performed with detailed schedule of outages required for equipment replacements or for temporary power connections. Take into account the time for government switching and safety clearance procedures.]

[3.3.2 Temporary Power

****

NOTE: Temporary power is recommended for loads that are deemed critical for powerhouse operation and are not able to be powered from another normal power source. Examples may include: Battery chargers, head cover pumps, drainage or sump pumps, intake structure power source, lighting, etc.

Edit "TEMPORARY POWER" section based on contract type as described in note under section 1 GENERAL. Reference appropriate specification sections if appropriate or use/edit bracketed text as needed.

****

The existing 480 volt equipment is critical to operation of the [powerhouse][_____]. Provide temporary power to the [powerhouse][_____] per Section 01 11 00 SUMMARY OF WORK.[Only one bus of the existing 480 volt switchgear will be allowed to be taken out at a time. The Government will transfer all loads to the opposite bus prior to de-energization for removal.[Provide temporary power to the equipment listed below.][Provide standby diesel generator(s) to supply these loads. Locations for placing the temporary power supplies are to be indicated on the drawings.][Install temporary feeder cables from existing motor control centers to supply power to the critical loads listed.][Include the temporary power plan as part of the detailed work plan.]]

][3.3.3 Foundations and Seismic Requirements

Level and grout the equipment foundations into place prior to installing the equipment.[Place the foundation channels on top of the floor, leveled, anchored to floor and grouted in place.] The minimum embedment depth of anchors into solid concrete is 4 inches and the installation must comply with the requirements of Section 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT.[Install an equipment housekeeping pad under the equipment with the foundation channels level on the pad using leveling bolts prior to installing pad in accordance with Section 03 33 00 CAST-IN-PLACE ARCHITECTURAL CONCRETE.][The concrete pad must be extended at least 2 inches beyond all sides, front and back of the equipment except where equipment extends to walls.] Bolt the switchgear to the foundation. Welding of the switchgear to the foundation is prohibited. Provide all trim to completely enclose open ends in foundation. Coordinate the foundation construction and install as approved by the COR.

[Submit Certifications of Seismic Requirements with specific ground motion criteria per per Section 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT prior to installation.]

]3.4 FIELD INSPECTION, TESTING AND COMMISSIONING

3.4.1 General

****

NOTE: The NETA acceptance testing specifications lists the field testing to be performed. The General inspections and tests have been listed below, however, they are not all encompassing. This general listed is used for bidders to understand the general scope of work prior to award and to emphasize the required acceptance testing. If the NETA tests are to be modified, those modifications should be clearly identified in the list.

****

After completion of the installation of the equipment and accessories, perform routine and complete operational tests to insure proper installation and verify proper operation. Perform field testing of

switchgear and breakers [, and metal enclosed bus] per IEEE C37.20.1A, IEEE C57.13, NETA ATS,[IEEE C37.23] and applicable IEEE 1248 recommended procedures. Perform routine tests including inspections and tests for location and mechanical alignment, damage to equipment porcelain or painted surfaces, electrical continuity of external circuits, and voltage transformer phase rotation.

a. Following installation, inspect, adjust, test, and commission the equipment following applicable procedures listed in IEEE 1248. Perform all equipment commissioning required by the equipment manufacturers and as noted in Section 01 91 00.15 BUILDING COMMISSIONING of this contract.

b. Include all testing recommended in the referenced standards. All test equipment must have been calibrated within one year of testing. Include test equipment manufacturer, serial number, range and test equipment calibration certificate on all test reports. Record the exact test voltage, current, etc. Include the name of the test engineer and the date the tests were performed as part of the test data.

c. Submit a Field Test Procedure for approval, listing the routine and operational tests to be conducted. Include a detailed step by step process of what tests and inspections are to be performed and their acceptance criteria. Include on the test forms, a row for each activity with a column for pass/fail, testers initials and remarks. The tests must be witnessed by a COR. Furnish a certified copy of all Field Test Reports, including complete test data on all tests. Reports of all witnessed tests must be signed by the witnessing representatives of the Contractor and the COR. The costs of performing all tests is to be included in the prices bid for the items of equipment in the Schedules. Perform the routine and operational tests as outlined below and as recommended by the manufacturer and the Field Service Engineer.

3.4.2 Low Voltage Breakers and Switchgear

At a minimum, perform the following tests:

a. Breaker contact resistance. Provide data on maximum allowable contact resistance from the manufacturer.

b. Mechanical alignment of breaker assembly including the primary and secondary contacts, shutters; verifying operation of auxiliary breaker and cell switches. Rack the breaker out no less than 5 times to verify the proper operation of cell switches and to ensure that the shutters do not bind.

c. Breaker/racking mechanism interlocks to ensure it cannot be inserted or removed unless the breaker is in the open position. If there is a test position, verify operation of breaker in test position.

d. All local and remote breaker controls, auto transfer, interlocks, remote trips and alarms in both the test and the operate positions.

e. Electrical check operation of each low-voltage power circuit breaker.

f. All breaker trip settings at the final settings.

g. Check calibration and accuracy of meters.

h. Subject each switchgear to a 1-minute power frequency withstand dielectric test at 1,600 VAC with circuit breakers in the operate position and with breakers closed.

[i. Accuracy and polarity of all instrument transformers.]

[3.4.3 Metal Enclosed Bus

At a minimum, test each section of metal enclosed bus in accordance with the manufacturer recommendations. Perform a dielectric test with values in IEEE C37.23.

]3.4.4 Transformer

At a minimum, test each transformer after installation in accordance with the manufacturers recommendations and the following tests:

a. Insulation Resistance Test

b. Turns Ratio Test

[3.4.5 Protective Relays

Perform testing of the protective relays in the factory prior to shipment, and visually and mechanically inspected once received at the project. Submit Manufacturer's Test Reports no later than [7][_____] days after shipment.[Program and test the relays with the Government provided relay settings and procedures. Test the functionality of the relays and controls with Government provided test procedures.][Test the functionally of the relays and controls with Government provided program and test procedures.] Notify the Government prior to doing the relay and functional testing to allow a Government representative to be present during the testing. No testing of the relay settings or functionally test of the relay will be allowed without a qualified Government official present unless the Government waives their right to witness the specific test.

]3.5 QUALIFICATIONS OF FIELD ENGINEERING SERVICE PERSONNEL

Provide a qualified field engineering service personnel who is fluent in the English language to supervise, test, and install the new equipment. The personnel must have a minimum of five years experience in the installation and testing of new equipment made by the manufacturer used and is required to be onsite during equipment installation and testing. Submit qualifications for the field service engineer(s) for approval and must demonstrate compliance with the above requirements. The Field Engineering Service personnel must certify that the equipment has been installed in accordance with the manufacturers recommendations and all warranties are in effect. Submit documentation of all adjustments, tests and inspections made by field engineer. The field engineering service personnel is required to be present during both the Contractor's commissioning of equipment and for the Government's commissioning of the system, per Section 01 91 00.15 BUILDING COMMISSIONING. Provide the COR with a current resume for all field engineering service personnel.

3.6 CONTRACTOR FURNISHED TRAINING OF GOVERNMENT PERSONNEL

a. Provide a qualified training engineer(s) who is fluent in the English language to provide training on the breakers and the trip units. The personnel must have a minimum of two years experience in the operations, maintenance, installation and testing of switchgear and power circuit breakers for the manufacturer furnished. Submit Qualifications of Instructor for approvals no less than [60][_____] days prior to training.

b. Include in the training for Project personnel the theory, operation, and maintenance of the new switchgear, breakers and [transformers]. Provide [one][two] training course[s].[One for maintenance personnel and one for operating personnel.] The maintenance course must be a minimum of eight hours in duration with [one][_____] class.[In addition to the maintenance courses, provide [two][_____] courses for operational personnel that will be a minimum of two hours each.] The operational personnel training must occur on different days and be coordinated with Government to ensure shift operators can all attend. Time and date of training is subject to Government approval. Conduct the training with an expectation of approximately 10[_____] Government employees at the Project for each session. Training must occur no more than [30][_____] days after[first] equipment has been placed in service, but in no case prior to equipment installation.

c. Include the operation, maintenance, warranty requirements, inspection repair and adjustment for the power circuit breakers, digital trip units[, and transformer controls] in the maintenance course. Include the theory of operation, calibration, programming, repair, routine maintenance, disassembly, trouble analysis and safety precautions. The operations course must include equipment design, theory of operation, use of displays and explanation of trip and alarm messages. Perform all demonstrations on the actual equipment furnished, to the maximum extent possible.

d. Submit course outline and course material for approval no less than [60][_____] days prior to training. Include, to the maximum extent possible, the site-specific operation and maintenance data that is provided for the project, utilizing the actual on site provided equipment when possible. The Government may videotape the training sessions for future use. Submit for Government approval, a training outline detailing course topics, material, and subjects.

3.7 OPERATION AND MAINTENANCE MANUAL

Provide Operations and Maintenance (O&M) manuals for all the equipment contained in this section in compliance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

[Assemble the O&M manual specifically for this contract. Provide the O&M manual for all equipment provided and include all the requirements for the testing, inspection, maintenance, troubleshooting, and repair of the equipment. Provide an index for each section/sub section and include tabs which correlate to the index. Include final as-built drawings as part of the O&M manual. Submit three draft hard copies of the O&M manual for approval. Once approved, provide [five][_____] final copies of O&M manual along with a CD of the O&M manual with each final manual.]

3.8 AS-BUILT DRAWINGS

Provide a complete set of final As-built Drawings for the equipment furnished per Section 01 78 00 CLOSEOUT SUBMITTALS. Prior to the field training course, all as-built drawings must be approved.[Include at a minimum:

a. Switchgear Manufacturer's Installation Drawings and Details.

b. Switchgear Manufacturer's One-Lines and Three-Lines

c. Circuit Breaker Controls and Schematic Diagrams

d. Switchgear Manufacturer's Wiring Diagrams]

3.9 FINAL ACCEPTANCE

****
NOTE: Reference appropriate specification section in summary of work, Quality Control or other section covering the requirements associated with final acceptance by the government. Varies based on contract type.
****

Final acceptance of the switchgear[and installation] [per Section 01 45 00 QUALITY CONTROL][_____][will not be given until the Contractor has successfully completed all testing, test reports have been submitted and approved, and after all defects in installation, material or operation have been corrected.]

-- End of Section --