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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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Superseding
NASA/KSC-26 23 00.00 98 (October 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023

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SECTION 26 23 00.00 98

LOW-VOLTAGE SWITCHGEAR
07/20

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NOTE: This specification covers the requirements for switchgear and switchboards of special design or configuration.

For primary-unit substations, use Section 26 11 13.00 20 PRIMARY UNIT SUBSTATION; for secondary-unit substations, use NASA Section 26 11 16 SECONDARY UNIT SUBSTATIONS; for motor-control centers, use Section 26 24 19.00 40 MOTOR-CONTROL CENTERS; for power panelboards, use Section 26 24 16.00 40 PANELBOARDS.

Drawings must show switchgear/switchboard elevation, dimensions, devices, instruments, and installation.

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 items(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Recommended changes to a NASAKSC Master Specification Section should be submitted as a Criteria Change Request (CCR) to the appropriate Technical Proponent (TP) through the SpecsIntact Help Desk.

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PART 1 GENERAL

1.1 REFERENCES

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

Use the Reference Wizard's Check Reference feature when you add a 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 are automatically deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A240/A240M	(2023) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A572/A572M	(2021; E 2021) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A1008/A1008M	(2021a) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 802.3	(2022) Ethernet
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 C37.20.1	(2015) Standard for Metal-Enclosed Low-Voltage Power Circuit-Breaker Switchgear
IEEE C37.17	(2022) Standard for Trip Devices for AC and General-Purpose DC Low-Voltage Power Circuit Breakers
IEEE C37.20.2	(2022) Metal-Clad Switchgear
IEEE C37.20.7	(2017; Corr 2021) Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults
IEEE C37.90	(2005; R 2011) Standard for Relays and Relay Systems Associated With Electric Power Apparatus
IEEE C57.12.28	(2014) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.12.29	(2014) Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments
IEEE C57.13	(2016) Standard Requirements for Instrument Transformers
IEEE C63.2	(2009) Standard for Electromagnetic Noise and Field Strength Instrumentation, 10 Hz to 40 GHz - Specifications
IEEE C63.4	(2014) American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

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

NETA MTS	(2015) Standard for Maintenance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA AB 3	(2013) Molded Case Circuit Breakers and Their Application
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA LI 1	(1998; R 2011) Industrial Laminating Thermosetting Products

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023) National Electrical Code
NFPA 70E	(2024) Standard for Electrical Safety in the Workplace

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS-STD-595A	(2017) Colors used in Government Procurement

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-568-C.3	(2008; Add 1 2011) Optical Fiber Cabling Components Standard

UNDERWRITERS LABORATORIES (UL)

UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 1558	(2016; Reprint Nov 2019) UL Standard for Safety Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear
UL 1666	(2007; Reprint Sep 2021) UL Standard for Safety Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts

1.2 SYSTEM DESCRIPTION AND GENERAL REQUIREMENTS

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NOTE: Provide NASA Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL and Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS along with this specification.
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NASA Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL and Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS apply to work specified in this section.

This specification details the requirements for electrical switchgear rated 600 volts and less.

1.3 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project.

A “G” following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a “G”. Only delete an existing “G” if the submittal item is not complex and can be reviewed through the Contractor’s Quality Control system. Only add a “G” if the submittal is sufficiently important or complex in context of the project.

An "S" following a submittal item indicates that the submittal is required for the Sustainability Notebook to fulfill federally mandated sustainable requirements in accordance with Section 01 33 29 SUSTAINABILITY REPORTING.

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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:

Provide all submittals in electronic format. Where multiple submittals are provided under single cover provide bookmarked PDF file. Bookmarks must be titled and configured to link to individual submittals, materials, or products as identified in this specification section. Multiple submittals provided under single cover that are not organized in such a fashion to be easily navigated and reviewed will be rejected for resubmittal.

SD-02 Shop Drawings

Submit connection diagrams and shop drawings for approval prior to switchgear fabrication indicating the relations and connections of the following items by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring, and other devices.

Sequence of Operation[; G] for all switchgear operational modes

Schematics and Wiring Diagrams[; G]

Switchgear Monitoring and Control System[; G] hardware, software, and interconnection drawings which include details of the power sources and communications pathways for devices accessed by KCCS

Switchgear Foundation Design Data[; G]

Fabrication Drawings[; G]

Weatherproof Pre-Fabricated Structure[; G]

KCCS Integration Design[; G]

Switchgear Drawings[; G]

As-Built Drawings[; G]

SD-03 Product Data

Submit manufacturer's catalog data for the following items:

Switchgear Components[; G] including all control switches and auxiliary relays

[Local/Remote Switches][; G]

[Control-Power Circuit Transfer Contactor][; G]

Space Heaters and Humidistat[; G]

Switchgear Monitoring and Control System[; G] including hardware as identified in this specification, software, and interconnection drawings which include details of the power sources and communications pathways for devices accessed by KCCS

[Uninterruptible Power Supply][; G]

Surge Protective Device[; G]

Switchgear Assembly[; G]

Electronic Trip Units[; G]

Unmanaged Ethernet Switch[; G]

Control Devices[; G]

Remote Racking System[; G]

SD-06 Test Reports

Submit Factory Test reports on switchgear assemblies in accordance with paragraphs, entitled "Factory Testing" of this section.

Submit Production test reports on switchgear assemblies for the following tests:

Switchgear Design Tests[; G]

Equipment Test Schedule[; G]

Switchgear Production Tests[; G]

Switchgear Paint Qualification Test[; G]

Integral Assembly Test[; G]

Auto-Transfer Sequence Factory Test Results[; G]

Monitoring And Control System Certification Test[; G]

SD-07 Certificates

Citect Scada Systems Integrator Qualifications[; G]

Testing Certificate Of Compliance[; G]

SD-08 Manufacturer's Instructions

Submit Manufacturer's Instructions for the Switchgear Assembly[; G] including special provisions required to install equipment components and system packages. Include special notices detailing impedances, hazards, safety precautions, and installation instructions.

SD-10 Operation and Maintenance Data

Switchgear Assembly[; G]Include manuals and materialson the following at a minimum:

Multi-function Relays

Circuit Breakers

Trip Units

Contactors

Metering

Programmable Logic Controller

HMI Touch Screen[

Uninterruptible Power Supply]

Switchgear Operation Procedures

All instruction leaflets and technical data

All software programs

Device address listing

Software data files

Function block program

All application software and screens

Detailed start-up report, including a list of customer trained individuals

List of programming and monitoring software and hardware

1.4 OPERATION AND MAINTENANCE DATA REQUIREMENTS

Include Operation and Maintenance Manuals for each Switchgear Assembly containing the following:

a. Instruction manuals for each device, including but not limited to multi-function relays, circuit breakers, trip units, contactors, metering, touch screens, [uninterruptible power supplies (UPS),]spare parts lists, and Programmable Logic Controllers(PLC), furnished in the switchgear.

b. Maintenance Manuals for each device, including but not limited to multi-function relays, circuit breakers, trip units, contactors, [control switches], metering, touch screens, [UPS units], recommended spare parts list, and PLCs, furnished in the switchgear.

c. Final as-built schematics, as-built one-lines, and as-built wiring diagrams (full point-to-point wiring tags) for the switchgear.

d. Integral switchgear operation procedures detailing all switching modes including, but not limited to loss of one source, loss of both sources, closed transition loss of PLC, loss of touch screen.

e. Sequence of Operation for all switchgear operational modes.

Provide Operation and Maintenance Manuals for the Switchgear Monitoring and Control System (SMCS) to include the following:

a. Instruction manuals for each device

b. Complete system description

c. All instruction leaflets and technical data

d. All software programs on CD ROM

e. Function block program and device address listing

f. Software data files and screens

g. Detailed start-up report including a list of customer trained individuals

h. List of programming and monitoring software and hardware

i. All application software and screens

Provide two (2) original licensed copies of all software with the final package.

1.5 QUALITY CONTROL

1.5.1 Manufacturer's Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal

material, design and workmanship, and:

a. Have been in satisfactory commercial or industrial use for 2 years prior to bid opening including applications of equipment and materials under similar circumstances and of similar size.

b. Have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

c. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

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

1.5.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" or "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Provide equipment, materials, installation, and workmanship in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.6 ENVIRONMENTAL REQUIREMENTS

1.6.1 General Requirements

Ensure items provided under this section are specifically suitable for the following service conditions:

a. Ambient Temperature: 50 degrees C120 degrees F

b. Frequency: 60 Hz

c. Humidity Control[

d. Hurricane Force Winds

e. Salt Fog Corrosive Atmosphere]

1.6.2 Humidity Control

Provide thermostatically and humidistatically controlled space heaters inside each section/cubicle of the substation as required to preclude the buildup of condensation within the substation.

[1.6.3 Hurricane Force Winds

Provide substation structure and associated substructure of sufficient construction to withstand a Basic Wind Speed of 150 mph (3 sec. gust) without physical damage due to wind loading or wind driven rain water infiltration.

]1.7 Citect SCADA SYSTEMS INTEGRATOR QUALIFICATIONS

The Kennedy Complex Control Systems (KCCS) is a combination of hardware and software components that are used to monitor and control power and other utilities across the Kennedy Space Center. Citect SCADA is an industrial control Supervisory Control and Data Acquisition (SCADA) software application that is used to monitor and control the I/O devices connected to the KCCS network. Information is transferred to and from the Citect SCADA server over a dedicated Ethernet controls network using Modbus TCP/IP as the preferred transportation protocol.

Submit documentation of Citect SCADA integrator systems qualifications demonstrating experience with Citect SCADA use in power systems. Provide information on a minimum of three projects completed within the last 5 years where the proposed Citect SCADA systems integrator has successfully completed. Ensure submittal includes sample Citect SCADA graphical process visualization and user interface screens with power systems related elements prepared by the proposed integrator.

PART 2 PRODUCTS

2.1 SWITCHGEAR ASSEMBLY

Provide switchgear assemblies conforming to IEEE C37.20.1 and UL 1558.

Provide switchgear conforming to IEEE C37.20.1 and UL 1558. Provide a new [double-ended][single-ended], [Main-Tie-Main (M-T-M)] switchgear consisting of main, distribution, [bus-tie,]and auxiliary sections listed and labeled by the manufacturer as suitable for use as service equipment. Switchgear must be of [NEMA 3R][NEMA 1] construction.[

Switchgear will be installed outdoors in a new weatherproof pre-fabricated structure. Refer to "WEATHERPROOF PRE-FABRICATED STRUCTURE" article of this section for structure requirements.]

2.1.1 Drawings

2.1.1.1 Switchgear Drawings

Include wiring diagrams and installation details of equipment indicating layout and arrangement, control panels, accessories, and other items that must be shown to ensure a coordinated installation. Identify circuit terminals on wiring diagrams and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Indicate on the drawings adequate clearance for operation, maintenance, and replacement of operating equipment devices. Include the nameplate data, size, and capacity on submittal. Also include applicable federal, military, industry, and technical society publication references on submittals. Include the following:

a. One-line diagram including breakers, fuses, instrument transformers, and meters.

b. Dimensioned plan drawings including front elevation, section views, footprint, and overall dimensions.

c. Bus configuration including dimensions and ampere ratings of bus bars.

d. Markings and NEMA nameplate data, including fuse information

(manufacturer's name, catalog number, and ratings).

e. Circuit breaker type, interrupting rating, and trip devices, including available settings.

f. Wiring diagrams and elementary diagrams with terminals identified, and indicating prewired interconnections between items of equipment and the interconnection between the items.

g. Switchgear monitoring and control system hardware with touch screen monitor, software, and interconnection drawings which include details of the power sources and communications pathways for devices accessed by KCCS.

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

Upon approval of initial switchgear drawings, provide manufacturer fabrication and assembly drawings detailing the work to be performed in the factory. Fabrication drawings must cover the following:

a. Switchgear Assemblies

b. Enclosures

c. Buses

d. Switchgear components including all control switches and auxiliary relays

e. Control-power system

f. Switchgear electrical interlocks

g. Space heaters

2.1.1.3 As-Built Drawings

Submit "As-Built" Configuration Drawings after installation, inspection, and testing is complete documenting the configuration of the final switchgear and its components. Ensure drawings show in sufficient detail all wiring, settings, adjustments, and field changes made during construction and installation of the switchgear.

2.1.2 Construction

Provide equipment with the following ratings:

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NOTE: Select "as indicated" if there are multiple switchgear with details of each shown on drawings. Most switchgear will be 4-wire, but might be a 3-wire design for delta-connected or ungrounded systems.

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a. Voltage rating: [480Y/277][480][208/120] volts AC, three-phase, [4][3]-wire.

b. Continuous current rating of the main bus: [ ] amperes.

c. Short-circuit current rating: [42,000][65,000][100,000][ ] rms symmetrical amperes.

d. UL listed and labeled[as service entrance equipment].

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NOTE: Edit the selection options below as needed for the intended project configuration.

Determine if an arc-resistant design will be specified for the installation. A selection of arc-resistant switchgear can affect the installation design. Arc-resistant switchgear is tested and certified to IEEE C37.20.7, and is intended to provide added protection for internal arcing faults. Select Type 1 if arc protection is only required for the freely accessible front of the enclosure. Select Type 2 if arc protection is required for freely accessible front, sides and rear of the enclosure. Select the 'B' suffix for additional protection applied to compartments designated as low voltage control or instrumentation compartments. Select the 'C' suffix where isolation from the effects of an internal arcing fault is desired between all adjacent compartments within a switchgear assembly. Most manufacturers produce Type 2B as a standard product, which could increase the switchgear cost by about 20 percent. Review IEEE C37.20.7 for additional information.

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Provide the following:

a. Switchgear: consisting of vertical sections bolted together to form a rigid assembly, [front][rear][front and rear] aligned[as indicated].

b. All circuit breakers: front accessible with rear load connections.

c. Compartmentalized switchgear: vertical insulating barriers between the front device section, the main bus section, and the cable compartment[with full front to rear vertical insulating barriers between adjacent sections].

d. Where indicated, "space for future" or "space" means to include all necessary components and hardware to be fully equipped for racking in a circuit breaker element.

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

[f. Moisture resistant coating: applied to all rough-cut edges of barriers.

][g. Switchgear: Arc-resistant[Type 1[B][C]][Type 2[B][C]], tested in accordance with IEEE C37.20.7.

]2.1.2.1 Compartment Details

Switchgear assemblies and auxiliary equipment must be stationary, mounted in self-supporting, self-contained, sheet metal enclosures with front and rear hinged full size doors. Secure switchgear front compartment doors and covers with knurled knob bolts or latches. Provide the capability to lock doors. Join sheet metal compartments together to form a continuous structure. Construct sheet metal barriers, enclosures, external covers and doors from cold-rolled carbon-steel sheets of commercial quality not less than 1.9 [_____] millimeter [12] [_____]-gage, with stretcher-level flatness in accordance with ASTM A1008/A1008M.

Unit sheet metal must enclose one or more vertically mounted power circuit breakers or auxiliary equipment in individual sheet metal compartments and a full height rear compartment. Provide housing of approximately 2300 millimeter 90 inches high with individual ventilated front and rear-hinged panels and bolted top covers. Rear compartment must contain the main bus, main bus-tap connections, cable connections, and instrument transformers. Completely wire compartments with cable terminals, cable clamps, control bus, control power switch, and terminal blocks. Generate Schematics and Wiring Diagrams for each compartment. Make terminal blocks readily accessible for the external connections of metal-enclosed switchgear.

Run low-voltage wiring for controls and accessories to terminal blocks having numbered points, as indicated, to identify circuits. Run low-voltage wiring in conduit or wiring raceways to isolate the wiring from high-voltage circuits. Clearly identify all wiring connections.

Clearly identify and designate, by cubicle, all switchgear components, including but not limited to fuse blocks, push buttons, selector switches, indicating lights, and terminal blocks (i.e.: 1A, 1B, 2A, 2B, this being cubicle 1 device A, cubicle 1 device B, etc.) Identify device designation with a label, with a minimum 1/4 inch high lettering. Wiring between sections/cubicles must identify the end devices by section/cubicle number and device designation. All controls equipment must be accessible from the front of the switchgear and face the front.

Provide terminal blocks with engraved plastic terminal strips with screw type terminals having letter designations and numbered terminal points. Terminal blocks in each section/cubicle used for the same wiring as the adjacent sections/cubicles must have the same letter designation preceded by the section/cubicle number. Terminal blocks associated with current transformers must be short circuiting type. Terminal blocks with sliding links are not allowed. Terminal blocks for multi-ratio current transformers must be wired with all taps and ground, one terminal block per current transformer. Wiring must be SIS Class insulation, sized No. 12 AWG at 120/240 panel with 20 amp breakers, No. 14 AWG for control, No. 12 AWG for potential leads, and No. 10 AWG for current leads. Terminate all current conductors with compression ring terminal lugs and control and potential conductors with compression forked (with tabs) terminal lugs. Do not use male/female spade connectors. Final conductor leads for terminations on the switchgear heaters must be a minimum of 150 degrees high temperature wiring.

Locate at each end, wire marking for controls, metering, relaying, and

accessory conductors. Wire markers must be white plastic tubing heat stamped with black block type letters. On all wire markers, indicate the device or equipment, including specific terminal numbers to which the other end of the wire is attached, and the terminal number to which the wire is directly attached (near end/far end marking).

Identify each compartment of the switchgear assembly by an identification plate engraved with circuit and function designations. Plate must be a minimum of 24 mm 1 inch high and 48 mm 2 inches long.

Removable elements of the same type and rating in the switchgear assembly must be physically and electrically interchangeable in corresponding compartments. Provide front-hinged panel suitable for mounting instruments, relays, control switches, and indicating lamps.

Barriers between a sectionalized bus with bus sectionalizing breakers in a compartment must be sheet steel not less than[3.1] [_____] millimeter [11] [_____] gage. Other covers, barriers, panels, and doors must be not less than [1.9] [_____] millimeter [14] [_____] gage.

Reinforce each compartment with structural members and weld together. Grind welds to a smooth flat surface before painting.

2.1.2.2 Mimic Bus

Provide mimic bus using 2.4 mm 3/32 inch red plastic laminate. Mimic bus must show breakers and bus. Fasten to switchgear using stainless steel screws or rivets.

2.1.2.3 Buses

Switchgear assemblies must be completely bused utilizing electrical grade, high conductivity, solid copper bus bar having a rectangular cross section. Uniformly position and phase sequence main, riser and bus tap connections in accordance with IEEE C37.20.1. Support and brace buses to withstand both electrically and mechanically the short circuit current ratings, rated not less than [42,000][65,000][100,000][ ] amperes symmetrical. Support and brace bus bar to withstand short-circuit stresses with momentary current ratings, in accordance with IEEE C37.20.1. Voltage and current ratings must conform to IEEE C37.20.1.

Ensure all buses are insulated.

Provide silver-plated termination and connection points on all bus bar used in the switchgear. Silver coating methods that do not use the flow of electrical current as part of the process are not acceptable. After plating the contact surface do not sand or abrade, clean only with a soft cloth immediately prior to final assembly.

All bus bar connections must be made using silicon bronze or Grade 5 steel bolts with wide flat silicon bronze or Grade 5 steel washers under the bolt head and nut. Tighten and check connections by use of a calibrated torque wrench. Other connection designs can be used with the written agreement of the Contracting Officer.

[Make main bus readily accessible for connection of future switchgear assemblies at either end. Main and auxiliary control drawout type connections must be silver-to-silver contact, positive pressure, self-aligning, with enclosure-to-enclosure stationary mechanism when

breaker is in drawout position.
]
Voltage rating and insulation level of switchgear assemblies must be as specified and conform to IEEE C37.20.1.

Temperature limits for buses and bus-tap connections in switchgear assemblies must be in accordance with IEEE C37.20.1.

Extend a continuous rigid copper ground bus throughout the entire assembly and ground the stationary structure and equipment. Ground bus must be capable of carrying the rated short circuit current of the protective devices in the switchgear assembly for a minimum period of 30 cycles.

Metal-enclosed bus must be of non-segregated group phase construction. Include rigid insulated conductors and supports in a grounded metal enclosure with associated ventilation and space-heater enclosures, condensation barriers, expansion and connection joints, and fittings in accordance with IEEE C37.20.1.

Completely bus enclosures and transition cabinets with an insulated solid rigid copper bus bar of rectangular cross section. Uniformly position and phase sequence bus bar and connections within the enclosure for adaptation to metal-clad switchgear assemblies and power transformers, in accordance with IEEE C37.20.1.

Insulating supports must consist of track-resistant, flame-retardant IEEE Class 130 electrical insulating materials. Voltage rating and insulation level must conform to IEEE C37.20.1.

2.1.2.4 Switchgear Foundations

Submit Switchgear Foundation Design Data for switchgear assemblies. Include plan dimensions of foundations and relative elevations, equipment weight and operating loads, horizontal and vertical loads, horizontal and vertical clearances for installation, and size and location of anchor bolts.

2.1.3 Switchgear Components

2.1.3.1 Power Circuit Breakers

[All switchgear, main, tie, and feeder breakers must be drawout type power circuit breakers and conform to Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

] Provide air-break type power circuit breakers enclosed in ventilated housings for those rated below 600 volts with current (frame and trip), voltage, and interrupting ratings as indicated. Provide 100 percent rated drawout type circuit breakers. Comply with IEEE C37.16 and IEEE C37.13.

Provide drawout power circuit breakers with three-position operation:

a. Connected Position - Contacts are fully engaged. Breaker must be tripped before it can be racked into or out of this position.

b. Test/Disconnect Position - Position must allow for complete testing and operation of the breaker without energizing the primary circuit.

c. Withdrawn (Removed) Position - Places the breaker completely out of

the compartment, ready for removal.

d. Breaker truck switches must be wired in series or parallel with each mechanism operated contact used in control sequences such that control sequences consider breaker position.

Drawout compartments must contain the mechanisms for racking the breaker on and off the bus. Provide a barrier that covers energized bus when the breaker is in the withdrawn position.

Mount draw-out breakers on a mobile frame with primary and secondary disconnecting devices to allow complete removal of the unit for inspection and maintenance. Provide a mechanism with an electrically and remotely operated racking mechanism that moves the breaker between the connected, test, and disconnect positions by means of a remote operator. Provide interlocks to prevent the complete withdrawal of the circuit breaker from its compartment when the stored-energy mechanism is in the fully charged position. Design circuit breakers to prevent the release of stored energy unless the mechanism is fully charged. Provide provisions to manually charge, open and trip electrically operated breakers.

Upon a circuit breaker trip operation, it must not be possible to close the circuit breaker until a manual reset operation occurs locally at the breaker trip unit or a lockout relay activated by the circuit breaker trip unit.

Supply alarms, auxiliary switches, truck auxiliary switches, interlocks, and similar devices as required and indicated.

Provide breakers with a removable operating handle, provision for locking, and position indicator.

[2.1.3.2 Molded-Case Circuit Breakers

Provide circuit breakers that conform to UL 489 and NEMA AB 3 [and as specified in Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES]with frame a trip ratings as indicated.

Provide bolt-on type, molded-case, manually operated, trip-free circuit breakers, with inverse-time thermal-overload protection and instantaneous magnetic short-circuit protection. Completely enclose circuit breakers in a molded case, with a factory-sealed, calibrated sensing element to prevent tampering. Plug-in type, tandem, and half-size circuit breakers are not permitted.

Provide common trip-type with single operating handle. Design breaker such that overload in one pole automatically causes all poles to open. Maintain phase sequence throughout each panel so that any three adjacent breaker poles are connected to Phases A, B, and C, respectively.

Provide inverse-time-delay thermal-overload protection and instantaneous magnetic short-circuit protection. Provide an instantaneous [thermal-magnetic][electronic][solid-state] tripping element that is adjustable and accessible from the front of the breaker on frame sizes larger than [100][250][ ] ampere.[Provide circuit breakers with frame sizes [100][250][ ] ampere and larger with [electronic][solid-state] trip units equipped with adjustable [long-time][,][short-time][and][ground-fault] settings in addition to instantaneous.]

Provide sufficient interrupting capacity of the panel and lighting branch circuit breakers to successfully interrupt the maximum short-circuit current imposed on the circuit at the breaker terminals. Provide circuit breaker interrupting capacities with a minimum of 10,000 A and that conform to NEMA AB 3. Series rating of circuit breakers or overcurrent protective devices to achieve indicated interrupt rating is [not]permitted.

Provide the common-trip-type multipole circuit breakers having a single operating handle and a two-position on/off indication. Provide circuit breakers with temperature compensation for operation in an ambient temperature of 40 degrees C 104 degrees F. Provide circuit breakers that have root mean square (rms) symmetrical interrupting ratings sufficient to protect the circuit being supplied. Interrupting ratings may have selective-type tripping (time delay, magnetic, thermal, or ground fault).

Provide a phenolic-composition breaker body capable of having such accessories as handle-extension, handle-locking, and padlocking devices attached where required to meet lock-out/tag-out requirements of NFPA 70E.

Provide shunt trips where indicated.

Ensure branch circuit breakers supplying convenience receptacle circuits have sensitive instantaneous trip settings of not more than [10] [_____] times the trip rating of the breaker to prevent repeated arcing shorts resulting from frayed appliance cords. Provide UL listed single-pole 15- and 20-ampere circuit breakers as "Switching Breakers" at [120 volts ac] [277 volts ac].

When multiple wires per phase are specified, furnish the circuit breakers with connectors made to accommodate multiple wires.

Ensure circuit breaker spaces called out on the drawings are complete with mounting hardware to permit ready installation of the circuit breakers.

]2.1.3.3 Electronic Trip Units

****

NOTE: Switchgear circuit breakers will be supplied with electronic trip units. Select from the bracketed options below. In the items below, choose the bracketed item "main" when the item only applies to the main breaker.

A digital display for the main breaker will typically not be selected if digital metering is provided per the paragraph DIGITAL METERS is selected.

Provide ground fault protection of equipment for solidly grounded wye electrical services of more than 150 volts to ground for each service disconnect rated 1000 amperes or more in accordance with NFPA 70.

NFPA 70 requires arc energy reduction where the highest continuous current trip setting for which the actual overcurrent device installed in a circuit

breaker is rated or can be adjusted to 1200 amperes or higher. The option identified below is based on an energy-reducing maintenance switch. Add the additional appropriate information if other methods such as differential relaying or an active arc flash mitigation system are included. Identify locations of alternate arc energy reduction methods in the design.

****

Equip main and distribution power circuit breakers and molded-case breakers with trip settings [100][250] amps or greater with a solid-state tripping system consisting of three current sensors and a microprocessor-based trip unit that provides true rms sensing adjustable time-current circuit protection. Include the following:

a. Current sensors ampere rating: the same as the breaker frame rating.

b. Trip unit ampere rating: as indicated.

c. Ground fault protection: as indicated.

d. Electronic trip units: provide additional features:

(1) Breakers: include long delay pick-up and time settings, and indication of cause of circuit breaker trip.

(2) Main breakers: include short delay pick-up and time settings and, instantaneous settings and ground fault settings.

(3) Distribution breakers: include short delay pick-up and time settings, instantaneous settings, and ground fault settings.

(4) Breakers: include a digital display for phase and ground current.

(5) Breakers: include a digital display for phase voltage and current.

(6) Breakers: include provisions for communication via a network twisted pair cable for remote monitoring and control. Provide the following communications protocol:Modbus.

Equip drawout power circuit breakers with static trip (solid-state) units with long-time, short-time,[and] instantaneous elements[, and ground fault protection]. Provide breakers that are electrically and mechanically trip-free in any position of the closing stroke. Provide silver-plated main contacts and sintered tungsten alloy arcing contacts. Accomplish tripping by a shunt-trip device. Provide electrical closing operation.

Ensure trip units are digital solid-state type for low voltage power circuit breakers in accordance with IEEE C37.17. Provide trip unit electronics modules that are interchangeable between breaker frame sizes without replacing current sensors or flux trip devices already installed. Power units from current sensors and [a separate battery back-up source][switchgear UPS]. Batteries must only be used to power indicator lights and display after the unit trips. Ensure trip units are adjustable. Trip settings must not rely on rheostats, dip switches, jumpers or pins to maintain their present adjustments. Ensure instantaneous trip settings are defeatable or capable of being turned

off. Provide a sealable cover over the adjustments to prevent tampering. Ensure units do not rely solely on any volatile or nonvolatile electronic memory to maintain their settings. Provide units complete with the capability, options, accessories, devices, cabling, wiring, and appurtenances, setup, programming, testing, and certification necessary for the implementation of the zone-selective interlocking systems described in paragraph entitled "Zone-Selective Interlocking Systems."

Provide communication interface to allow the trip units to communicate using the communication system described in paragraph entitled "Switchgear Monitoring and Control System." The digital solid state trip units will be capable of clearly communicating all data to KCCS via Modbus TCP/IP communication protocol using a maximum of one hardware conversion and no software conversions. Breaker status data includes, but is not limited to, the following: breaker status, current, time of trip, operational history, cause of trip, current date and time, power (KW), energy (KWH), peak demand, self-diagnostic information and set points. Breaker remote control functions include, but are not limited to, the following: breaker open, close, and trip operations for electrically operated breakers, date/time energy clear, energy (KWH) clear and remote set date/time and trip reset.

Provide trip units equipped with test jacks on circuit breaker face for service functional testing of each trip unit function using a full function test kit for secondary injection. Provide one full function test kit to the Contracting Officer as part of this project. Test kit must be a product of the trip unit manufacturer.

2.1.3.4 Control Devices

2.1.3.4.1 Test Switches

Provide test switches between all instrument transformer circuits and protective relays/meters, and in all trip and hardwired interlock circuits, to allow full protective and metering device testing or replacement without physically disconnecting instrument transformer and control circuits. Provide ABB Type FT-1 or approved equal test switches with clear covers mounted on the door of the instrument compartment.

2.1.3.4.2 Control, Transfer and Selector Switches

Provide rotary cam operated for remote operation devices with individual stages, a dust-tight cover and contacts with a positive wiping action. Ensure contacts are silver-to-silver or an approved substitute which provides equal or superior performance. Provide contacts that have a rating adequate for the duty performed, but not less than 600 volts, 20 amperes continuous. Circuit breaker control switches will have a red and green target. Provide and wire red, amber, and green indicator lamps. Ensure circuit breaker control switches have a combination of maintained action and spring return type of operation and pistol grip handles. Equip all switches with engraved plastic escutcheons identifying its function and position.

2.1.3.4.3 Instrument Transformers

Provide instrument transformers conforming to IEEE C57.13and comply with the interference requirements measured in accordance with IEEE C63.2 and IEEE C63.4 as applicable.

a. Current transformers: Provide multi-ratio relay accuracy transformers as indicated, 60 Hz, and coordinated to the rating of the associated switchgear, trip-units, relays, meters, and instruments. Use CTs with standard multi-ration 5A secondary and a thermal rating factor of 2.0. Provide transformers that are complete with secondary short-circuiting device.

b. Potential transformers: Provide fixed mount transformers, 60 Hz, with voltage ratings and ratios coordinated to the ratings of the associated switchgear, trip-units, relays, meters, and instruments. Ensure potential transformers are provided with two current limiting fuses in the primary sized as recommended by the potential transformer manufacturer. Transformers must meet ANSI metering accuracy classifications of 0.3 W, X, Y.

2.1.3.4.4 Pilot and Indicating Lights

Provide transformer, push-to-test LED type, rated for 120 volts ac. Lights must be capable of being relamped from the front.

1. Breaker Open - Green

2. Breaker Closed - Red

3. Control Power On - Red

4. Automatic Mode - Blue

5. Manual Mode - White

6. Auto Lockout - Amber

2.1.3.4.5 Multi-Function Voltage Relays

For undervoltage relays conform to IEEE C37.90.

Provide three-phase solid-state multi-function type voltage relays, Basler or equal, with definite time characteristics and adjustable and calibrated pick-up settings for protection against negative sequence voltage, undervoltage, and overvoltage. Provide thumb wheel setting switches for pick-up and timing adjustments and equip relays with electrically separate contact circuits for all protective functions that are suitable for operation on DC or AC control circuits.

Provide relays that are of draw-out construction with built-in testing facilities and that are suitable for operation on 120VAC instrument circuits.

Provide a semi-flush mount case with matching cover to the hinged instrument panel.

2.1.3.4.6 Synchronization Check Relays

For synchronization check relays conform to IEEE C37.90.

Provide solid-state electronic relay, Basler Electric or equal, with the ability to user select synchronization check function for the following conditions:

Live Line - Dead Bus

Live Line - Live Bus

Dead Line - Dead Bus

Dead Line - Live Bus

Provide three-phase solid state relay designed to accept 120VAC inputs. Ensure dead line and live line settings are adjustable. Synchronization angle must be adjustable from 1 to 99 degrees with an adjustable time delay of 1 to 99 seconds. Provide thumb wheel setting switches for pick-up and timing adjustments and equip relays with electrically separate contact circuits for all protective functions that are suitable for operation on DC or AC control circuits.

Provide relays that are of draw-out construction with built-in testing facilities, and that are suitable for operation on 120VAC instrument circuits.

Provide semi-flush mount case with matching cover to the hinged instrument panel.

2.1.3.4.7 Timing Relays

Provide timing relays with calibrated timing head, precision-wound potted coil, and a snap-action switch assembly. The calibrated timing head will re-circulate air under controlled pressure through a variable orifice to provide a linearly adjustable timing. The precision-wound potted coil must be totally sealed without any external leads. Provide double-pole, double-throw snap-action switch assembly with copper blades and silver-cadmium oxide contacts to insure positive wiping action.

2.1.3.4.8 Lockout Relays

Provide high speed lockout relays with manual rotary cam reset and latching relay clearing contact. Provide contact deck with contacts having a rating adequate for the duty performed, but not be less than 600 volts, 20 amperes continuous. Provide door mounted control switch with mechanical targets with spring return type of operation and pistol grip handle. Ensure all switches are equipped with engraved plastic escutcheons identifying its function.

2.1.3.5 Control-Power Circuit Overcurrent Protection

Provide Branch-circuit breakers with circuit overload protection to compartment heater, lights, convenience outlets, transformer fans, and other devices.

2.1.3.6 Control-Power Circuit Transfer Contactor

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NOTE: Delete this paragraph when the switchgear is single-ended.

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[Design contactor for automatic transfer of control-power for 120/240-volt, single-phase, 60-Hz service with current rating. Make contactor the open type, two-pole, double-throw with solid neutral

connections and must automatically transfer its load circuits to the alternate power supply upon loss of power in the normal supply. Device must be electrically operated and [electrically] [mechanically] held and obtain its operating current from the source to which the load is transferred. Provide contactors for automatic transfer of control power suitable for installation in metal-enclosed switchgear. [Provide two extra normally open and two extra normally closed contacts. One set of contacts must be wired to the PLC for status indication.]]

2.1.3.7 Service and Maintenance Devices

Include the following service and maintenance devices as a part of the switchgear:

A manual handle for operating the air and power circuit breaker isolating mechanism

Removable manual maintenance closing devices for air and power circuit breakers

Facilities for operating air and power circuit breakers in the test or removed position

Facilities for withdrawing air and power circuit breakers for inspection or maintenance

Test plugs and cable for meters and relays

A NEMA 5-20R receptacle at each switchgear end for service tools

2.1.4 Remote Racking System

****

NOTE: UFC 3-520-01 requires consideration of remote racking methods for switchgear circuit breakers. Determine if this feature is desired by electrical personnel that will operate and maintain this equipment. The remote racking mechanism design varies among manufacturers; however the method of connection to the racking mechanism tends to be similar. Determine if the project budget can fund this device (might cost as much as $40,000 with all options including camera and wireless system). Do not select this option if other remote racking mechanisms are available within the activity and can be used for this location.

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Provide a remote racking mechanism to allow an operator to rack a circuit breaker in or out from at least 20 feet away from the front of the equipment.

2.1.5 Local/Remote Switches

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NOTE: Eliminate the Local/Remote switches for shuttle projects (i.e. when circuit breakers can be controlled through a second device such as the power meters and not just the PLC).

****

[Install a manually operated, two position rotary snap-action switch with silver-plated contacts to disengage all automatic and remote controls from the switchgear when in local mode. Locate this switch in the bus tie section of the switchgear.

Label the states of the switch "Local" and "Remote". Refer to paragraph, entitled "Local/Remote Operation." Provide at least two extra normally open and two extra normally closed sets of switch contacts. One set of contacts must be wired to the PLC for status indication.]

2.1.6 Surge Protective Device

Provide parallel type surge protective devices which comply with UL 1449 in the locations indicated on the drawings. Provide surge protectors in a NEMA Type enclosure per NEMA ICS 6. Provide the following modes of protection:

FOR THREE PHASE WYE CONNECTED SYSTEMS -

Each phase to neutral {L-N)

Neutral to ground (N-G)

Phase to ground (L-G)

Ensure surge protective devices have a minimum surge current rating of 80,000 amperes per mode minimum. The maximum line to neutral (L-N) Suppressed Voltage Rating {SVR) is 900V for 480Y/277V, three phase systems.

The minimum MCOV (Maximum Continuous Operating Voltage) rating is 600/320V for 480Y/277V, three phase systems.

Provide EMI/RFI filtering for each mode with the capability to attenuate high frequency noise. Minimum attenuation is 20db.

2.2 WEATHERPROOF PRE-FABRICATED STRUCTURE

2.2.1 Construction

Install switchgear in a pre-fabricated custom walk-in style weather-tight corrosion-resistant structure. The structure must be designed for outdoor service with ventilation openings, and gasketing provided to ensure a weather-tight assembly under rain, corrosive atmospheres, and hurricane conditions. The structure must include hinged external rear doors to provide unfettered access to the cable terminations in the rear of each section (main, distribution, [bus-tie,]and auxiliary) without requiring the removal of any bolts. No other barriers will be located between the cable terminations and the external rear doors. Provide external doors with handles/latching mechanisms with provisions for locking.

Provide minimum 1-1/2 inch square tube welded to the interior floor as mounting base for switchgear. Coordinate new square tube with mounting dimensions of switchgear to ensure proper mounting of equipment.

Structure must be weatherproof, prefabricated, with exterior walls and roof constructed from self-framing interlocking panels to house and protect the internal equipment installed in configuration shown on the

drawings. Structural grid base and floor must be designed for applicable floor loading allowing the structure to be lifted and transported with (as applicable) the interior equipment installed.

Basic design loads, as well as auxiliary and collateral loads include live load and wind load, in addition to the dead load.

Structure must provide for an aisle along the front of the switchgear of adequate width and height to allow the removal and insertion of circuit breakers.

2.2.2 Materials

Structural steel frame fabricated from steel channel, wide flange and angle sections forming a self-supporting grid to support floor.

a. Steel Grade: ASTM A572/A572M (Cl0 and larger) or ASTM A36/A36M (CB and smaller).

b. One (1) set of removable lift lugs.

c. All welding to be in accordance with AWS D1.1/D1.1M Structural Welding Code.

d. All bolts for field assembly of primary structural members (where required) must be high strength bolts conforming to ASTM A307 and be a minimum of 1/2-inch diameter.

Floor Plate - 5/16-inch, ASTM A240/A240M type 304 or 304L stainless steel.

Base Structure - galvanized steel with epoxy paint finish.

Exterior Walls - 12 gauge interlocking ASTM A240/A240M type 304 or 304L stainless steel panels with stainless steel fasteners.

Insulated Roof Panels - 12 gauge interlocking ASTM A240/A240M type 304 or 304L stainless steel insulated panels (2 inch thick rigid insulation between stainless steel sheets) with stainless steel fasteners. Provide polyurethane, polyisocyanurate, or manufacturer's standard insulation with a maximum flame spread of 25 and a smoke developed rating of 450 per ASTM E84. Penetrations of, or through insulated roof panels are not permitted.

2.2.3 Doors and Hardware

2.2.3.1 Personnel Doors

Provide two exterior personnel doors on either side of switchgear front access aisle, minimum 3ft x 7ft x 1-3/4in, 18 Gauge ASTM A240/A240M type 304 or 304L stainless steel, out swing, with 3-inch Factory Stainless Steel Frame. Each door must be equipped with the following:

a. Stainless Steel Hinges

b. Stainless Steel Panic Hardware - Lockwood/Magnokrom (or approved equal)

c. N1500-5XOT53 x 32D w/Cylinder Lock Exterior Trim (or approved equal)

d. Closer w/Stopping Arm

e. Crash Chain

f. Aluminum Threshold

g. Weatherstripping

h. Stainless Steel Drip Edge

i. Removable Transom above Door (MRT)

j. Sign "Danger Electrical Equipment/ Authorized Personnel Only"

2.2.4 Equipment Doors

Equipment Doors, Louvered (stamped louvers in doors), 12 Gauge ASTM A240/A240M type 304 or 304L stainless steel, size and swing as required for equipment access. Each must include the following:

a. Stainless Steel Hinges

b. Hold Open Device

c. Padlocking Handle

d. Adjustable Cam w/2 Notches Hub for Unthreaded Shank Pawl

e. Equipment Door Locking

f. Equipment Door Access Brackets

g. Adjustable Rod Guide

h. 60-inch Closer Rods

i. Full Gasketing

j. Drip Shield

k. Sign "Danger High Voltage/ Keep Out"

2.2.5 Finishes

Prepare surface per coating manufacturer's instructions/recommendations. Shop Applied High Performance Primer and Finish coats per requirements of IEEE C57.12.29. Provide one (1) quart touch-up paint for each type and color used. Paint colors will be as follows:

a. Exterior - ANSI 61 "Gray"

b. Interior - "White"

c. Floor and Base - ANSI 61 "Gray"

Floor underside must have undercoating of Transcoat 101 (or approved equal), minimum 10 mils dry-film thickness. Clean and prepare surfaces in accordance with manufacturer recommendations. Final coating must be zero volatile organic compound (VOC), asbestos free with a flame spread rating of zero.

2.2.6 Lighting

2.2.6.1 Interior Lighting

Provide a minimum average maintained illumination on the floor of 30 footcandles. Lighting must be accomplished using vapor-tight LED luminaires. Provide lighting control using a timer switch located adjacent to the main access door.

2.2.6.2 Emergency/Exit Lighting

Provide 120VAC, LED type, combination emergency light/exit sign (green). Light may be wall or ceiling mounted.

2.2.6.3 Exterior Lighting

Exterior fixtures must be located over personnel access doors. All exterior luminaires are required to be Certified and Approved by Florida Fish and Wildlife Conservation Commission (FWC) as Sea Turtle/Wildlife Friendly. LED Lighting must be true red, orange, or amber diodes. Filters are not permitted. Provide lighting control through photo cell integrated with each luminaire fixture, one per light fixture.

2.2.7 Receptacles

Provide one exterior and two interior 20A, 120VAC, NEMA 5-20R, industrial grade ground fault circuit interrupter (GFCI) type duplex receptacles. The interior receptacles must be located at each end of the structure for servicing the switchgear.

2.2.8 Grounding and Bonding

a. Ground Pads - 4 Hole Stainless Steel Welded

b. Ground Lug - #4/0 AWG

c. Copper Ground Bar 2-inch x 1/4-inch, installed on Mounting Anchors 3 inches below ceiling mounted on wall

d. Ground Drops from Ground Bar to Ground Lugs at Base or Equipment Ground Bus - #4/0 AWG bare copper cable

2.2.9 Ventilation

a. Exhaust Fan Assembly 16-inch diameter - 117 CFM w/Aluminum Damper and Thermostat

b. Power Circuit - 120 VAC, 1-Phase, 20A powered from switchgear panelboard

c. Intake Louver Assembly - 24-inch x 24-inch w/Damper and Aluminum Mesh Filter

2.3 SWITCHGEAR MONITORING AND CONTROL SYSTEM (SMCS)

Provide complete switchgear monitoring and control system that includes, but is not limited to, a programmable logic controller (PLC) that monitors and controls remote devices, touch screen display human machine interface

(HMI), electrical power monitoring system, device communications interface hardware, intercommunication wiring, software, startup and training services, and ongoing technical support. This system must comply with the applicable portions of IEEE 802.3. The Contractor's specialist and the CITECT integrator will demonstrate that the communication systems provided under this project will communicate efficiently with the KCCS Citect software. Efficiently implies that the data will be transmitted and received such that the response time to the KCCS workstation will be less than 4 seconds. This demonstration must include multiple trip units, meters, a PLC and a laptop loaded with the KCCS Citect project software. Provide two licensed copies of all software and all hardware necessary to modify and download the program to the touch screen.

Main and tie-bus circuit breakers must be electrically operated with capability to be both operated locally via touch screen and remotely via KCCS. Main-Tie-Main (M-T-M) circuit breakers must be electrically interlocked so that only two of the three breakers may be closed for any extended length of time by operation of the respective breaker closing. Provide a separate hardware timer that will trip the tie-bus circuit breaker if all three circuit breakers are closed for a period adjustable from 0-900 seconds.

Main circuit breakers must include multi-function voltage relays with adjustable pick-ups and time delay.

A control-power circuit transfer contactor must be provided for the automatic transfer of control power.

Ensure the UPS unit supplies power to the power meters, trip units, I/O circuit power, indicating and status lights, PLC touch screen, PLC, the communication equipment such as the unmanaged Ethernet switch and media converters, and a double duplex receptacle in the controls compartment. Ensure the receptacle on UPS power is clearly marked "UPS POWER" using a laminated plastic nameplate having 3/16-inch high white letters on black background.

Provide main and tie-bus circuit breakers equipped with three-phase sync-check relays, hardwired to main and tie-bus circuit breaker control schemes for fail safe operation. These functions will be available even when the PLC is not functioning.

Ensure any main or tie circuit breaker trip activates a separate lockout relay that electrically blocks any subsequent close operation, automatic or manual, for that breaker. If a main or tie breaker trips, block close circuits will ensure that the faulted section cannot be re-energized from another source until the lockout relay is reset.

Ensure all transfer control functions are accomplished via the PLC and that circuit breakers remain in the last state if PLC is taken off-line.

Ensure all timing and control for automatic transfer are performed via the PLC. Auxiliary relays will only be used where circuit breaker control circuit exceeds the rating of the PLC output contacts. Auxiliary relays will only be used to directly connect one circuit breaker control circuit. Use of auxiliary relays to provide relay logic or timing functions is not permitted. Provide industrial grade, octal based, single tier relays with screw terminals, pilot light, retainer clip, vibration resistant 10 amp rated output contacts.

Design switchgear transfer control to auto transfer load on loss of power on either of the two sources and provide automatic re-transfer on source return after an adjustable time period. Ensure the re-transfer operation is selectable either open or closed transition from touch screen display or KCCS remote operator. Provide touch screen display controls that allow the user to enable/disable the automatic transfer function and initiate the appropriate changes to the PLC logic to allow the selection of the desired switchgear modes of operation. Modes of operation are 'Automatic' or 'Manual' with re-transfer options for either 'Open' or 'Closed' transition.

The touch screen display controls must also allow the user to change the time delays for the transfer scheme. Ensure these changes do not require the use of additional equipment such as a laptop computer or additional PLC programming software. Provide touch screen display controls for operating circuit breakers that requires two step commands, the first to initiate the command and the second to confirm the command.

Selection of 'Closed' transition, selectable from the touch screen display, also disables electrical interlocks functions, specifically, circuit breakers can be configured such that all three breakers (M-T-M) can be closed simultaneously for a limited duration. This protective function is intended to ensure the three circuit breakers are not closed for an extended duration.

2.3.1 KCCS Integration

Integration of the Monitoring and Control System with the existing KCCS (CITECT) system will be performed by the Contractor in coordination with the Contractor's specialist and the CITECT integrator.

Provide Engineering and Technical Support for on-site modifications to the existing user interface screens used by the Government power coordinators as part of the Kennedy Complex Control System (KCCS). The Contractor must provide technical support to develop additional screens and/or modifications to existing screens required to incorporate the new Monitoring and Control System into the KCCS system. The additional screens will allow the Government power coordinator to monitor and control each circuit breaker via Citect "Genies" and "Super-Genies." The Government will perform the final integration of the new screens, Genies, and Super-Genies into the existing KCCS file server. The existing KCCS system will be modified to incorporate all the changes associated with the installation of the new relays. The modifications to the project includes but is not limited to, adding/deleting variable tags, alarm tags and trend tags, modifying/building "genies and super genies," and modifying/creating user interface screens. All modifications to the Citect project must comply with the KCCS Software Architecture Standard. The following minimum information and control will be available to the user through the developed genies:

a. Individual phase and ground currents

b. Phase-to-phase and phase-to-neutral voltage

c. Alarm on circuit breaker trip, cause of trip and magnitude of the fault current (trip records)

d. Circuit breaker status including open, close, tripped, truck position and connected, test, or disconnected if available

e. Time-stamped trip data including magnitude and cause of trip

f. Remote circuit breaker open and close commands

g. Control power indication

h. Auto/Manual and Open/Close Transition statuses

i. UPS/Control Power Status

j. Synchronization status

k. Power Meter data

A Government sample KCCS Citect project containing a library of Citect symbols, Genies and Super Genies will be provided to the Contractor to use for development of the new operator screens. If the SMCS communication architecture described in the design documents are followed, new development for existing components will not be required. New operator screens depicting the new switchgear are still required but they can be developed using the existing KCCS Citect library. Additional and/or new programming and Citect integration resulting from the use of an approved equal will be the responsibility of the contractor.

Three KCCS integration design reviews will be scheduled by the Contractor to ensure that all of the parties involved in developing any new Citect interfaces (screens, Genies, Super Genies, alarms data exchange methods) are properly coordinated. The first meeting will be a kickoff meeting where the Government will provide a sample KCCS Citect project to assist in the development of new interfaces. Provide KCCS Integration Project Data for the second and third review meetings. At the second meeting, the Contractor will provide a sample of all the new types of Citect interfaces that are being developed. At the third meeting, the Contractor will provide a fully working sample of the entire project. Schedule the first meeting within 75 days of the contract award.

2.3.2 Programmable Logic Controller (PLC)

For compatibility, PLC will be NASA KSC Standard, Schneider Electric M-580 or approved equal. Citect example projects using the M580 PLC are available to the contractor. Additional and/or new programming and Citect integration resulting from the use of an approved equal will be the responsibility of the contractor. Provide two (2) original licensed copies of all software.

Provide the following discrete input points to the PLC:

a. Secondary voltage monitors

b. Main circuit breaker status open/close

c. Tie-bus circuit breaker status open/close

d. Automatic/Manual transfer mode status

e. Feeder/branch circuit breaker status open/close

f. Open/Closed Transition mode

g. Circuit breaker truck position

h. Trip lockout indications on all electrically operated circuit breakers

i. Normal configuration

j. UPS control contactor position indication

k. Internal status registers of the PLC {communication via Ethernet connection TCP/IP or connection with M580 PLC}

Provide the following discrete output points to the PLC:

a. Main circuit breaker open/close

b. Tie-bus circuit breaker open/close

c. Automatic/Manual transfer control function

d. Open/Close retransfer control function

2.3.3 Human Machine Interface (HMI) Touch Screen Display

Provide touch screen display with the following characteristics and features:

a. Industrial grade

b. Impact and scratch resistant

c. Color screen with greater than or equal to (228 mm) 9 inch screen size

d. Screen lockout for cleaning

e. Field replaceable display that is capable of being replaced while in service

f. Provide one spare display for each display installed

g. Integrated drivers for direct serial connection to PLC

h. Simultaneous communications with multiple PLCs

i. Two licensed copies of software

j. Windows based configuration software

k. Support for third party graphics

1. Dynamic object based graphics

m. Bitmap graphics

n. Software manuals

o. Users manuals

p. Interface cables

2.3.4 Electrical Power Monitoring System

Where indicated, provide metering equipment to monitor energy usage on the circuit indicated. Provide metering appurtenances, including cables, as required for complete and proper operation. Power device from switchgear control power supply, confirm with device characteristics. Install metering equipment in accordance with the metering equipment manufacturer's published installation instructions. Mount metering equipment in strict accordance with the orientation recommendations of the metering equipment manufacturer.

For compatibility, provide NASA KSC Standard metering equipment, Schweitzer Engineering Laboratories SEL-735 Power Quality and Revenue meter or approved equal. Ensure metering equipment is UL recognized, CSA certified and also complies with IEEE C37.90.

a. Meter Monitoring Functions: Provide meter designed for use on a 3-phase, 3- or 4-wire, system with 3 current transformers and 2 or 3 voltage transformers as indicated. Ensure the meter provides direct reading metered or calculated values and auto ranges between units, kilo-units, and mega-units for all metered values.

b. Case: Display case mounted semi-flush to a hinged panel door. Power supply and other metering components may be fixed mounted within an auxiliary compartment.

c. Meter Enclosure: Provide a separate NEMA 3R enclosure or specific compartment within the switchgear. Include a back-panel for mounting power supply, terminal strip, and similar components and a hinged interior panel for mounting the display case. Provide a warning label on the hinged panel indicating energized line voltage components are behind the hinged panel.

d. Test Blocks: Provide six pole current and four pole potential test blocks, General Electric Type PK, Eaton Type FT or approved equal in line after the power monitor for additional metering or testing.

e. Meter Fusing: Provide a fusible disconnecting switch upstream of a fully enclosed pullout, dead-front type fuse block containing one fuse per phase to protect the voltage input to the watt-hour meter. Size fuses as recommended by the meter manufacturer.

f. Provide short-circuiting type terminal strips for connecting meter to current transformer circuits.

2.3.5 Communication

Ensure the control system provides for the exchange of data via Ethernet communications with the following:

a. KCCS.

b. Circuit breaker trip unit interface.

c. Electrical Power Monitoring System (Modbus TCP/IP).

Provide industrial unmanaged Ethernet switch, N-TRON 309FXE-ST or approved equal. Provide industrial media adapters as required. Unless otherwise

noted, ensure ethernet communications employs 4-pair #23 AWG CAT6 UTP Type CM indoor/outdoor rated fully water blocked and sunlight resistant cable. Provide ethernet communications extending outside of switchgear using 62.5/125 .um multimode (OMl) indoor/outdoor all dielectric riser (OFNR) rated backbone fiber optic cable (FOC) conforming to ICEA S-104-696, TIA-568-C.3, UL 1666, and NFPA 70.

2.3.6 Sequence of Operation

M-T-M transfer scheme must have two operating modes: Automatic and Manual each with selectable open transition and closed transition switching. Ensure modes of operation are selectable via the touch screen display or remotely via KCCS. Circuit breakers must remain in the last state when mode is changed except when going to the automatic mode. Only controls under the current mode will have any control capability over the circuit breakers. Over current, under voltage, and synchronization check trip or block close features must not be defeated in any mode. Use synchronization relay and lockout relay contacts to provide trip and block close functions independent of the PLC.

The normal configuration for switchgear is with the main circuit breakers in the closed position, the tie-bus circuit breaker in the open position, and the PLC program in 'Automatic' transfer and 'Closed' transition modes.

Design the switchgear transfer control to auto transfer load on loss of power on either of the two sources and provide automatic re-transfer on source return after an adjustable time period. Ensure the re-transfer operation is selectable either Open or Closed transition from touch screen or KCCS remote operator.

2.3.6.1 Automatic Operation

"Automatic" transfer mode is designed as the normal configuration for the M-T-M transfer scheme and gives the PLC at the substation complete and autonomous control of the switchgear. Ensure the PLC program allows KCCS to take control of the switchgear remotely through an Ethernet connection to the PLC by enabling or disabling the 'Automatic' transfer mode. An indicator light seen on the front of the switchgear will illuminate while in the 'Automatic' transfer mode.

Automatic Transfer operation is predicated the switchgear being in normal substation configuration.

Automatic Transfer operation must be disabled if:

a. The M-T-M circuit breakers' protective/control relays' Automatic Transfer statuses are inconsistent (such as in a 'non-normal' state, locked-out, etc.), or

b. A manually asserted trip or an overcurrent trip is detected or

c. Either main breakers' bus lockout signal is asserted

Automatic Transfer sequence is as follows:

If KCCS has enabled the 'Automatic' transfer mode, the circuit breakers will remain in their current positions unless one of the following situations occur:

a. Loss source feeder (A-Side operation described, B-Side is the same):

1. If the multi-function voltage relay for A-Main detects phase voltage imbalance, loss of voltage, under voltage, or over voltage, for a period adjustable from 1 to 600 seconds initially set at 10 seconds,

   A-Main: If B-Main is closed with acceptable supply voltage then the A-Main breaker opens. After the A-Main breaker has opened and if acceptable voltage is present on the alternate source (B-Side) the Tie circuit breaker closes.

   The switchgear will then act as a single-ended switchgear.

2. When voltage returns to the A-Main circuit breaker, all circuit breakers will remain in the transferred state until a retransfer is initiated by the transfer scheme calling for an automatic retransfer as follows:

   A-Side with live bus condition and both automatic retransfer mode and closed transition mode enabled: After utility voltage synchronized across A-Main breaker returns for a period adjustable from 1 to 600 seconds initially set at 60 seconds, the A-Main closes and, when verified closed, the Tie opens.

   A-Side with automatic retransfer enabled and either dead bus condition or open transition mode enabled: After utility voltage returns to the A-Main breaker with a de-energized load bus for a period adjustable from 1 to 600 seconds initially set at 15 seconds, the Tie opens (if closed) and, when Tie is verified open, A-Main closes.

b. Loss of both main source feeders:

1. If the multi-function voltage relays detect phase voltage imbalance, loss of voltage, under voltage, or over voltage on both of the main source feeders simultaneously (plus or minus 3 seconds adjustable), then both main circuit breakers will open and the tie-bus circuit breaker will remain open.

2. If the voltage returns to one of the main source feeders for a period adjustable from 1 to 600 seconds (initially set at 60 seconds), the main circuit breaker on that side must close, the main breaker the other side remains open, and the tie-bus circuit breaker will close.

2.3.6.2 Manual Mode

The "Manual" transfer mode is designed to give either a local operator or the KCCS operator (at a remote location) complete control of the switchgear. The operator takes control of the switchgear by enabling or disabling the 'Automatic' transfer mode. An indicator light visually seen on the front of the switchgear will illuminate while in the 'Manual' transfer mode. When the operator engages the 'Manual' transfer mode, the circuit breakers will remain in their current positions and the following apply:

a. Mains and Tie 'Open' functions operate directly from KCCS commands and touch screen display.

b. Mains and Tie 'Close' functions operate by KCCS and touch screen after verification of the sync-check relay and respective breaker trip

lockout device.

c. Open Transition mode prevents the paralleling of the main and tie breakers.

d. Closed Transition mode (selectable from the touch screen) enables closed transition switching if the sources are synchronized per the settings on the synchronization relay.

e. Breaker controls must be electrically interlocked so that at the most two of the three breakers (M-T-M) can be closed for an extended amount of time. If two out of the three breakers are closed and if the third breaker is called to close, the source feeders will be verified through the sync-check relays that each source feeder is synchronized before the third breaker is closed.

2.4 EQUIPMENT FINISH

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NOTE: For all outdoor applications and all indoor applications in a harsh environment refer to Section 09 96 00 HIGH-PERFORMANCE COATINGS. High performance coatings are specified for all outdoor applications because ultraviolet radiation breaks down most standard coatings, causing a phenomena known as chalking, which is the first stage of the corrosion process. For additional information contact The Coatings Industry Alliance, specific suppliers such as Keeler and Long and PPG, and NACE International (NACE).
****

2.4.1 Protective Coatings

Verify the intended location of equipment, materials, and degree of continuous exposure to the KSC corrosive environment. The equipment finish must meet the requirements of IEEE C57.12.28 and IEEE C57.12.29. Holidays, sags, pinholes, blistering, solvent popping or rust as part of the finish are not acceptable. Provide smooth and even finish resistant to corrosion, sunlight and abrasion with high impact strength.

2.4.2 Surface Preparation

Steel parts must be free of weld slag and mill scale. Chemically clean, rinse, phosphate coat, rinse, and de-ionize switchgear enclosure in preparation for the powder coat.

2.4.3 Powder Coat

Coat the switchgear enclosure with a corrosion resistant thermosetting polyester coating applied by electrostatic powder spray. Apply a minimum coating of 2.5 mils uniformly and pinhole free.

2.7.4 Final Coating

Following the application and cure of the powder coat and the manufacturing assembly of the switchgear enclosure, apply a final finish coat to the switchgear enclosure with silicone enamel, free from surface defects with a minimum 1.5 mil dry film thickness. The color of the final

coating must be light gray in accordance with SAE AMS-STD-595A and must be approved by the Contracting Officer prior to shipping the switchgear from the factory.

2.5 SPACE HEATERS AND HUMIDISTAT

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NOTE: Space heaters prevent moisture build-up in ventilated compartments.

Wattage supplied by heaters is one-fourth of heater nameplate rating when 240-volt heaters are operated at 120 volts.

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Equip each section of the switchgear assembly with externally energized space heaters to provide approximately 40 watts per square meter 4 watts per square foot of outer surface area. Heater power density must not exceed 4 watts per 650 square millimeter per square inch of heater element surface. Heaters must be rated at 240 volts for connection to 120 volts. Install heaters at the lowest portion of each space to be heated. Cover all terminals. Provide thermostats to regulate the temperature.

Install operable heaters at the time of shipment for use immediately upon arrival at the site, during storage, or before installation. Prominently mark connection locations on drawings and shipping covers. Provide temporary leads capable of plugging into a standard 120 volt, 20 amp receptacle for storage operation. Make connections easily accessible without having to remove shipping protection.

Provide humidistat to control space heating equipment. Ensure humidity controller is equipped with positive on-off settings and is capable of being manually or automatically operated. Provide controller with impact-resistant, molded plastic cover with fully enclosed, single pole single throw, snap-acting switch. Provide sensing element of moisture sensitive nylon ribbon to ensure reliable operation in temperature ranges from 50 degrees Fahrenheit 10 degrees celsius to 125 degrees Fahrenheit 52 degrees celsius. Ensure humidistat operates from 4% to 6% relative humidity differential. Provide controller with contacts rated to the full load of all connected heaters.

2.6 EXTERNAL VOLTAGE SOURCE

Group all externally powered wiring together as much as possible and connect to a terminal block marked with a laminated plastic nameplate having5 millimeter 3/16 inch high white letters on a red background as follows:

DANGER - EXTERNAL VOLTAGE SOURCE

Externally powered wiring must include 120-volt unit space heaters.

[2.7 UNINTERRUPTIBLE POWER SUPPLY

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NOTE: When a Facility UPS is available delete this paragraph and use the Facility UPS.

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Provide an Uninterruptible Power Supply (UPS) system sized for a minimum of 15 minutes of battery backup for the control power loads. The UPS must be capable of operating in an ambient temperature of 0 to [40][60] degrees C (32 to [104][140] degrees F) and a relative humidity of 5 to 95 percent. Mount the UPS in a spare compartment or cubicle.

]2.8 SOURCE QUALITY CONTROL

2.8.1 Equipment Test Schedule

The Government reserves the right to witness tests. Provide equipment test schedules for tests to be performed at the manufacturer's test facility. Submit required test schedule and location, and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled date. Provide documentation on successful completion of factory tests for the equipment prior to final activation at KSC.

Provide the following as part of test equipment calibration:

a. Provide a calibration program which assures that all applicable test instruments are maintained within rated accuracy.

b. Accuracy: Traceable to the National Institute of Standards and Technology.

c. Instrument calibration frequency schedule: less than or equal to 12 months for both test floor instruments and leased specialty equipment.

d. Dated calibration labels: visible on all test equipment.

e. Calibrating standard: higher accuracy than that of the instrument tested.

f. Keep up-to-date records that indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third party calibration, include the following:

(1) Maintain up-to-date instrument calibration instructions and procedures for each test instrument.

(2) Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

2.8.2 Switchgear Design Tests

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NOTE: Use the first bracketed option for standard switchgear. Use the second bracketed option for arc-resistant switchgear.
****

IEEE C37.20.1 and UL 1558.

2.8.2.1 Design Tests

Furnish documentation showing the results of design tests on a product of the same series and rating as that provided by this specification.

a. Short-circuit current withstand test.

b. Short-time current withstand test.

c. Dielectric test.

d. Rated continuous current test.

e. Mechanical endurance test.

f. Flame-resistance tests.

2.8.3 Switchgear Production Tests

IEEE C37.20.1 and UL 1558. Furnish reports which include results of production tests performed on the actual equipment for this project. These tests include:

a. 60-hertz dielectric tests.

b. Mechanical operation tests.

c. Electrical operation and control wiring tests.

d. Ground fault sensing equipment test.

e. Impulse withstand test.

f. Grounding of instrument transformer case test

2.8.4 Switchgear Paint Qualification Test

Submit reports showing that the paint qualification test has been performed according to IEEE C37.20.2 or IEEE C57.12.28 as applicable, to ensure the adequacy of finishes to inhibit the buildup of rust on ferrous metal materials used for enclosures.

2.8.5 Integral Assembly Test

Test switchgear as an integral assembly at the switchgear manufacturer's test facility. Test must include verification of connections between switchgear sections/cubicles, including but not limited to, main bus, ground bus, control power, and control wiring. Ensure this test conforms to IEEE C37.20.2. Once acceptance of test results is received, ship switchgear.

2.8.6 Auto-Transfer Sequence Factory Test Results

Submit report certifying successful execution of the switchgear auto-transfer sequence at the factory. The Government reserves the right to witness testing.

2.8.7 Monitoring and Control System Certification Test

Perform Certification Testing showing Switchgear Monitoring and Control System successfully communicates with existing Citect Software prior to the approval of the switchgear. Compliance Certification Testing must include a Government witness qualification demonstration of at least, but

not limited to the following equipment if the proposed hardware has not been previously approved:

a. Circuit breakers

b. Trip units

c. PLC

d. Meters

Include in testing verification of the Citect Screens using a PC and the current Citect software.

Submit certificate of compliance showing completion of certification testing.

PART 3 EXECUTION

3.1 CERTIFICATION TESTING

Perform Certification Testing showing Switchgear Monitoring and Communication System successfully communicates with existing Citect Software prior to the approval of the switchgear. Compliance Certification Testing must include a government witness qualification demonstration of at least, but not limited to the following equipment if the proposed hardware has not been previously approved (current approved hardware is from Square D):

Circuit breakers

Trip units

PLC

Meters

Include in testing verification of the Citect Screens using a PC and the current Citect software.

3.2 INSTALLATION

Installation must conform to IEEE C2 and NFPA 70.

Electrically and mechanically connect the complete assembly at the site from coordinated subassemblies shipped in complete sections from the manufacturer. Carefully align, level, and secure complete installation in conformance with the manufacturer's recommendations.

Carefully join separated switchgear assemblies to present a neat appearance, with main and ground bus joints tightened to manufacturer's recommended torque values. Handle assemblies with appropriate lifting devices.

Submit Installation Drawings for the switchgear assemblies. Include in drawings complete details of equipment layout and design.

3.3 FIELD TESTING

The switchgear manufacturer must provide the test equipment, labor and technical expertise for testing and checkout of the switchgear assembly as a connected system after it is installed. Provide manufacturer's written test results for all tests performed. Submit test reports including Testing Certificate of Compliance to the Contracting Officer prior to energizing equipment. Replace any material, equipment or devices found to be defective at no cost to the Government.

Comply with NETA ATS and NETA MTS for electrical acceptance tests of transformers, switchgear, breakers, relaying, metering and all related material, including secondary current injection tests and manufacturers recommendations. Submit a testing procedure 30 calendar days prior to field testing. Include in testing procedure complete functional testing of the entire system which evaluates the functionality and performance of all control and automatic sequencing and operation of the switchgear.

Additional testing to those described in NETA ATS and NETA MTS are as follows:

[a. Demonstrate switchgear automatic transfer scheme, timing functions and interlocks for mains and tie breaker operate as specified.]

b. Remove all controls [and UPS power] from PLC/PC and verify when power is restored, programming automatically recovers with no anomalies. This test must ensure fully functional programming is restored and ready to operate on restoration of power to PLC/PC. Perform this test three separate times.

[c. Demonstrate control voltage automatic transfer relay and components until on properly.]

d. Functionally verify SMCS system through the Ethernet connection fully operational and all I/O functions are as specified.

[e. Demonstrate switchgear local/remote switch, if installed, operates as specified.]

Final acceptance is dependent upon the satisfactory performance of the equipment under test. Provide final test data to the Contracting Officer.

3.4 RELAY SETTINGS AND TESTS

Properly coordinate all circuit-interrupting devices before the switchgear assemblies are energized. Thoroughly inspect and adjust protective relays at the site in the presence of and at the discretion of the Contracting Officer.

3.5 FIELD TESTING FOR COMMUNICATIONS

3.5.1 Field Quality Control

Furnish the services of a manufacturer's representative to assist in starting-up and programming the system. The manufacturer's representative must be factory-trained and have a thorough knowledge of the software, hardware, and system programming. The manufacturer's representative must provide the following services:

a. Perform full functionality tests on the communications network from all IEDs to the Ethernet gateway.

b. Setting all the addresses of all devices in the equipment.

c. Verifying and troubleshooting the integrity of the data line.

d. Assisting the government in correcting any data line problems.

e. Configure the SMCS software to match the field devices.

3.5.2 Field Testing

Verify complete system operation including all hardware, software and communication devices. Verify networking performance with all interfacing systems by other manufacturers.

3.5.3 Manufacturers Certification

A qualified factory-trained manufacturer's representative must certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

3.5.4 Training

Furnish the services of manufacturer representatives to train the owner's personnel in operation and programming of the system. The manufacturer representatives must be factory-trained and must have a thorough knowledge of the switchgear, PLC and touch-screen software, hardware and system programming. Include in the training session on the PLC and all controls:

a. Switchgear on-site training

(1) Full operation demonstrations of all functions.

(2) Breaker electrical and mechanical operations.

(3) Explanations and instructions for all protective devices.

b. Classroom on-site training for programming the touch screen.

3.5.5 After Start-up Support

The manufacturer must provide a 24-hour 800 telephone number manned with Engineers/Technicians expert in SMCS devices, software and communication system troubleshooting or capable of providing technical information. Provide this support at no cost to the Government for a period of five years.

3.6 ENERGIZING SWITCHGEAR ASSEMBLIES

Do not energize switchgear assembly until it is completely installed, tested, approved by the Contracting Officer, and ready for operation. Site testing must be conducted and approved by the Contracting Officer.

Using ammeter, voltmeter, and wattmeter or phase-angle meter, the values and polarities of voltage and current, measure and compare with those expected in the various relay circuits. Inspect and note all contact positions of directional elements and the voltage relays.

After inspection and satisfactory tests have been completed on all active relay circuits under a no-load condition, perform an operational test with diverted load currents or simulated ground faults on each relay.

Prepare a comprehensive report with records of connections, electrical constants, settings, test values, operating performance, and failures or weaknesses found on test.

Tests and procedures for testing must be in accordance with paragraph, entitled "Field Testing," in this section and the manufacturer's recommendations. Upon completion of all testing and approval of the Contracting Officer, the switchgear must be energized, as approved by the Contracting Officer.

-- End of Section --