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Specification No. E-030

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PREPARED BY ENGINEERING DEPARTMENT

GUAM POWER AUTHORITY
Post Office Box 2977
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TRANSMISSION & DISTRIBUTION SPECIFICATION

Specification No. E-030

for

34.5 KV SWITCHGEAR

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34.5 KV SWITCHGEAR

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1.0 SCOPE

- 1.1 This specification includes the requirements for the design, manufacture, factory testing and delivery of indoor metal-clad switchgear and associated equipment. The switchgear shall meet the requirement of ANSI C37. The switchgear shall consist of the following equipment in accordance with the single-line circuit diagram:

- Line circuit breaker equipment
- Bus tie circuit breaker equipment
- Sparing bus with removable links and a tap section for the mobile substation
- Provisions for connection of a future line breaker to the main bus
- Transformer circuit breaker equipment
- Auxiliary compartments
- Accessories and material

- 1.2 Zone 4 seismic requirements shall apply. ANSI MC8.1 temperature and humidity requirements shall also apply.

2.0 CONFORMANCE TO STANDARDS AND SPECIFICATIONS

The metal-clad switchgear shall meet the requirements of the following standards and specifications, including the latest revisions with respect to material design and tests.

2.1 Applicable Standards

Provisions of the following standards shall apply:

1. ANSI C37
2. NEMA SG2 High Voltage Fuses.
3. NEMA SG4 AC High-Voltage Circuit Breakers.
4. NEMA SG5 Power Switchgear Assemblies.
5. NEMA SG6 Power Switching Equipment.
6. ANSI C57.13 Requirements for Instrument Transformer.
7. ICEA Specifications for Wire and Cable.
8. National Electrical Code.
9. E11 Electrical Indicating Instruments.

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2.2 Deviation and Non-Conformance Requirements

- 2.2.1 Deviations from this specification or changes in materials or design after the Purchase Order has been placed must be approved by the GPA Engineering Department and acknowledged by a Purchase Order Amendment.
- 2.2.2 Units received with deviations or non-conformances which are not acknowledged as specified in Sub-Paragraph 2.2.1 are subject to rejection. The Supplier is responsible for any corrective action including but not limited to materials, labor and transportation necessary to dispose of, or make the units conform to the specification.
- 2.2.3 Notification of defects discovered before or after installation that are believed to be inherent to manufacturing problems or workmanship shall be made and forwarded to the Supplier. The description of the item, documentation of the problem and the described information, disposition and/or follow-up (as appropriate) that GPA expects from the Supplier will be specified. The Supplier's response shall be made within thirty (30) days unless an extension is acknowledged and approved in writing by the GPA Manager of Engineering.
- 2.2.4 GPA shall be allowed two (2) weeks to review and approve drawings without affecting the shipping date. Delays in delivery due to drawings which are not approved during this review period are the responsibility of the Supplier.

2.3 Warranty

The Supplier shall warrant the satisfactory and successful operation of the apparatus furnished under this specification at the rating, under the conditions, and for the service specified for a period of not less than one (1) year. The Supplier shall further warrant the apparatus against defects of design, material and workmanship.

3.0 SUBMITTALS

- 3.1 Equipment outline drawings shall be submitted for approval within 30 days after Notice to Proceed. The remaining Shop Drawings shall be submitted within 60 days after Notice to Proceed. GPA will provide the successful bidder samples for three line and DC Schematics and preferred format for inter-connection diagrams as a guide.

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3.2 Shop Drawings and data shall include the following:

- a. General arrangement, floor plan, elevations and sections, anchor bolt details, overall dimensions and weights.
- b. Interior structural drawings, elevations and sections of main bus, sparing bus, breakers and potential transformers.
- c. A complete set of ac and dc schematic diagrams, one for each piece of equipment, including, but not necessarily limited to the following:
 - (1) Protection and controls
 - (2) Breaker controls
 - (3) Auxiliary equipment controls
- d. Current transformer data, including excitation and ratio correction factor curves and mechanical and thermal short-term ratings.
- e. Nameplate data.
- f. Wiring diagrams with terminal block and device connections for each panel and cubicle. Tabular format is not acceptable.
- g. Interconnection diagrams.
- h. Potential transformer data.
- i. Notes and symbols.
- j. Bill of material.
- k. Three-line diagram.
- l. One-line diagram.
- m. Panel layout drawing.
- n. Other drawings, diagrams, and instructions required for installation, operation and maintenance of the equipment.

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- 3.3 Instructions for installation shall be submitted within 90 days after Notice to Proceed.
- 3.4 Operations and maintenance manuals with a section on troubleshooting shall be submitted 30 days prior to shipment.
- 3.5 Number of Copies
- a. Submit five (5) copies of each shop drawing, pre-printed manufacturers' data, brochures and suppliers' information for review and approval.
 - b. After approval and manufacturing of equipment, submit one (1) reproducible transparency and five (5) prints of each shop drawing which has been specifically prepared for the Work. Indicate on the drawings that the drawings reflect the as-built condition of the equipment.
 - c. Submit five (5) copies of operations and maintenance manuals with a section on trouble shooting and instructions for installation.
 - d. Submit one (1) copy of the shop drawings on AUTOCAD Rel. 12 using 3.5" high density diskettes.

4.0 QUALITY ASSURANCE

4.1 Factory Tests

4.1.1 General

Not less than 30 days prior to factory tests, a factory test plan shall be submitted to the Owner for approval. Each item of electrical equipment and similar equipment supplied as spare parts, shall be given the manufacturer's routine factory tests and also other tests as specified, to ensure successful operation of parts of the assemblies. The factory test equipment and the test methods used shall conform to the applicable requirements of ANSI, IEEE and NEMA standards. Five certified copies of the reports of production tests, including complete test data shall be submitted to the Owner. Factory tests will be witnessed by the Owner.

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4.1.2. Assembly Tests

Units of the switchgear shall be assembled at the factory and checked for alignment and fit. Each circuit breaker to be supplied with the switchgear assembly shall be installed in the assigned unit after the switchgear has been fully assembled. Checks shall include correct operation of shutters, interlocks, auxiliary contacts, racking mechanisms and for ease of installation and withdrawal of circuit breakers. Wiring shall be given point-to-point circuit continuity tests and shall be subjected to dielectric tests in accordance with requirements of ANSI Standard C37.20. The control switches shall be checked for proper contact operation. Device markings, nameplate markings, conductor identification and the scale of meters and instruments shall be checked.

4.1.3 Functional Tests

Current and potential tests shall be made on relays, instruments, meters and transducers for proper operation, direction and calibration. Operational tests shall be performed to verify the functional controls.

4.2 Factory Test Reports

Four (4) copies of certified test results shall be provided to the Owner within 30 days after performance of factory tests.

5.0 RATING

5.1 Description

5.1.1 The switchgear shall be rated 34.5 kV and shall be suitable for operation on a solidly-grounded system rated 34.5 kV, 3-phase, 4 wire, 60 Hz. The main bus shall be rated for 1,200 Amperes, continuous. Basic insulation level shall be 200 kV.

5.1.2 Equipment and materials shall be the products of manufacturers regularly engaged in the production of such equipment and materials.

5.1.3 The switchgear arrangement and dimensions shall be as specified in the design drawings.

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5.2 Circuit Breakers

- 5.2.1 The 34.5 kV circuit breakers shall be of the oil-less type and be 3-pole, single throw, trip free, drawout-type breakers, rated on the symmetrical current basis. Each breaker shall have its characteristics based on a 15 second close-open duty cycle, and shall be capable of interrupting its rating in 5 cycles or less from the time the trip coil is energized until the arc is extinguished.
- 5.2.2 The circuit breaker closing shall be operated by a stored energy mechanism, which is normally charged by an electric motor, but which can also be charged by a manual handle for emergency manual closing or testing. The power supply for the stored energy mechanism shall be 125 VDC.
- 5.2.3 The circuit breaker control voltage shall be 125 VDC. GPA will provide the 125 VDC station control power.
- 5.2.4 Each circuit breaker shall be designed specifically for installation in the breaker compartment, and breakers of like ratings shall be completely interchangeable. Each breaker shall be self-contained, equipped with self-coupling primary and secondary disconnect contacts, and with either fixed and swivel casters or fixed casters and a fifth wheel accessory, or a maintenance and handling device to permit easy mobility. Provisions shall be made and accessory materials and equipment furnished to permit complete disconnection of the breaker from the line and bus and testing of the breaker within the switchgear compartment. Breakers shall be mechanically interlocked to ensure that the breaker is tripped before being withdrawn from or inserted into the connected position.
- 5.2.5 The breakers shall have the following features:
- sturdy, self-aligning, silver-plated, primary disconnect contacts with high contact pressure. The circuit breaker element, primary disconnect shall be an integral part of the element.
 - auxiliary switch contacts connected to the mechanism of each breaker. A minimum of 10 "a" and 10 "b" contacts for the Owner's use shall be supplied and shall be wired to terminal blocks. Contacts shall be field changeable from "a" to "b" and vice versa.

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- c. an easy-to-read position indicator located on the front of the equipment.
- d. a manual means for tripping.
- e. trip free and non-pumping operation.
- f. an operations counter.

5.2.6 The circuit breakers shall meet their ratings as listed in ANSI C37.06. Principal breaker ratings shall be as follows:

a.	Rated maximum voltage, kV	38
b.	Withstand test voltages - Low frequency RMS, kV Impulse crest, kV	80 150
c.	Rated continuous current, Amperes: Line Transformer Bus Tie	1,200 1,200 1,200
d.	Rated short-circuit current at rated maximum voltage, symmetrical Amperes, RMS	21,000
e.	Maximum symmetrical interrupting capability, Amperes RMS	35,000
f.	Rated Short Time Current: Three second Amperes	35,000

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5.3 Enclosure

- 5.3.1 The switchgear shall have a suitable framework of structural steel to provide self-supporting rigid and stable structures. Channel base members shall be provided as part of the frames for proper alignment. The panel and structure shall be sufficiently rigid to support the equipment without vibration and shall be sized as shown on the Contact Drawings.
- 5.3.2 The panels and enclosure shall consist of selected sheets of smooth sheet steel. The panels shall be all the same size for front, rear and top alignment. Sheet steel shall not be less than No. 11 US Standard Gauge, forming structural shapes or having bent angle or channel edges with corner seams welded and ground smooth. Stiffeners shall be provided as required. The exposed exterior surfaces shall not be drilled or welded for attaching wires or devices if holes or fastenings will be visible after installation. Vertical wiring trough shall be provided on both sides of panels. Doors to each enclosure shall be the same material and thickness as the housing sheets. Doors shall be braced or constructed so as to hang true and prevent warping. Doors shall have a 1 inch allowance from the floor. Hinges shall be the concealed, loose-pin type which will permit the panels or doors to swing out not less than 105°. Doors shall be provided with 3-point latches. Ventilated openings shall be grill or louver type and provided with corrosion-resistant screens to prevent entrance of insects and rodents. Lights shall be provided within each enclosure.

5.4 Buses

5.4.1 Main Bus

The main bus shall be copper, rated 1,200 Amperes, silver-plated at joints and tap points, installed in a separate compartment from other wiring, and insulated along its entire length with high dielectric strength, flame-retarding, self-extinguishing, moisture resistant material. Suitable insulation covers shall be provided for bus joints. Bracing shall be provided as required for the bus to withstand short circuit current equal to the momentary rating of the breakers furnished with the switchgear.

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5.4.2 High Voltage Connections

High voltage connections between the main bus and the circuit breaker disconnecting devices, the current transformers, and the potheads shall be furnished with material installed. Connections shall be made of copper bar insulated between terminals with an insulation comparable to that required for the main bus bars. The cross-section of bars and joints shall be uniform and smooth to permit a flow of current equal to the full load rating of the breaker without excessive temperature rise. Joints shall be silver-plated and bolted. Joints shall be relieved of voltage stress by metallic gauze or other suitable conducting material, and insulated with tape and glyptal to provide insulation levels equal to or better than those of the main insulated buses. High voltage connections between the main bus or breaker load terminals and fixed studs of potential transformer assemblies shall be made with high voltage cable having insulation coordinated with basic impulse levels required for the switchgear. Supports, bushings, terminal lugs and joint insulation shall be furnished as required, and the leads installed to form a complete installation.

5.4.3 Ground Bus

Copper ground bus shall be 1/4-inch by 2-inches solidly connected to each switchgear unit and extended into the power cable entrance compartment of each unit. Ground bus shall be equipped with a clamp connector for 4/0 - 500-kcmil copper cable. Provisions for external ground connections shall be provided at each end of the bus. Materials for interconnecting the ground bus on adjacent shipping groups shall be provided, as required. Bars of the various sections shall be bolted together to form an integral ground for the entire switchgear. At least 3 studs shall be provided on the bar for connection of the external station ground.

5.4.4 Access

Removable panels shall be provided for access to the bus compartment.

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5.5 Instrument Transformers

- 5.5.1 Voltage transformers shall be rated for 200 kV BIL with ANSI accuracy classification of 0.3 at burdens W, X, Y and Z. Potential transformers shall be dry-type drawout or tilt-out mounted and equipped with high interrupting capacity current limiting fuses. The ratio shall be 300/175:1.
- 5.5.2 Current transformers shall be the toroidal type, suitable for metering or relaying as required. Metering current transformers shall have an accuracy rating equal to or better than 0.3B-0.1, 0.3B-0.2, 0.3B-0.5, 0.3B-1 and 0.3B-2. Multi-ratio current transformers for relaying and metering shall be of C400 relaying accuracy.

5.6 Surge Arresters

Surge arresters shall be connected to each circuit conductor on the line side of the associated circuit breaker. The arresters shall have a nominal 30-kV rating.

5.7 Wiring and Accessories

- 5.7.1 The metal-clad switchgear shall be completely wired at the factory, ready for installation and connection by others. Inter-panel wiring required between shipping groups shall be brought to terminal blocks on adjacent panels necessitating only on-site reconnections of factory-supplied jumpers. Terminal blocks and jumper cables shall be properly identified for assembly. Unused terminals on relays and auxiliary contacts shall be brought to conveniently located terminal blocks. Line and transformer power cables and all control and meter connections will enter from the bottom. The incoming cables for the line breaker will consist of two (2) 600 kcmil cables per phase. The manufacturer shall ensure that sufficient vertical and horizontal clearances are provided for training and terminating these cables in the cable compartment without requiring excessive bending or the use of special adapter plates furnished by the cable installer. Rubber insulators shall also be provided at the terminations of power cables. In addition, bracket supports for the cables shall be provided.
- 5.7.2 All secondary wiring shall be stranded. No. 14 AWG shall be used for control circuits, #10 for CT circuits and #18 for SCADA indication or as indicated in the design drawings. Switchboard wire shall be NEC type SIS, and rated for 600 Volts. Insulation jacket shall be gray in color. Splices will not be

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permitted. Wires shall run in conduits, raceways or trays. Suitable, extra flexible wiring shall be provided over door hinges or other locations where leads may be subjected to flexing.

- 5.7.3 Ring-tongue terminals shall be used for secondary wiring. Spade, slotted spade, flanged spade, and hook terminals are not acceptable. The strength of the terminals shall be such that the terminals will not break during vibration of the equipment in which the terminals are installed. Ring-tongue terminals shall be Thomas & Betts Stakon.
- 5.7.4 Terminals shall have insulated ferrules. To assure positive electrical connections, and to avoid damage to the ferrule, it is mandatory that the crimping tool be used in accordance with manufacturer's instructions, and that the proper terminal and crimping tool be used for each wire size. Crimps shall be made with the crimp indentation opposite to the connector seam.
- 5.7.5 Miscellaneous accessories, such as resistors, fuses, fuse blocks, and capacitors not shown on the Contract Drawings but required for proper operation of the switchgear shall be furnished.
- 5.7.6 Terminal blocks for current transformer leads shall be 6-point and shall be provided with short-circuiting devices to permit removing or testing of wiring without opening the current transformer circuits. Leads from multi-ratio current transformers shall be brought out to the terminal blocks. Terminal blocks shall be GE type EB25 and EB27, Westinghouse Bulletin 34-350, or as approved by the Owner. Terminal blocks shall be provided for all wires leaving switchboard panels and shall have marking strips for Owner's 6-digit number identification system. Terminal blocks shall have washer head binding screw terminals, barriers between terminals, high flame retarding properties, mechanical toughness and high electrical strength. At least 20% spare terminals shall be provided on each panel. Each wire shall be identified at both ends with a permanently machine-embossed black identification on white plastic, heat-shrinkable, tubular slip-on marker.
- 5.7.7 Terminal blocks for grouping of SCADA wiring shall be thermo-plastic insulation type, rated 300 Volts, with test socket screws, knife switch contacts and shall be mounted on rails.

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The marking system shall be Dekafix consecutive vertical numbering system and Peso white blanks for Owner's marking. Terminal blocks shall be furnished complete with mounting rails, end brackets, end plates, partitions and test equipment. Wiring to the SCADA terminal blocks shall be made with No. 18 wire minimum.

5.7.8 Wiring for transducer output circuits shall be No. 18, twisted pair, shielded conductor. Meter pulse circuit wiring shall be No. 18, 3-conductor shielded cable.

5.7.9 Wiring Format

- a. All terminals shall be numbered, and the numbers shall correspond to the numbers on the wiring diagram.
- b. All wires shall be identified at their termination points with the opposite end designation identification by labeled plastic sleeves or equal. Identification shall correspond to the lettered device, numbered terminal format of the wiring diagrams.

5.7.10 System Phase Rotation. The system phase rotation for the island-wide system is GPA C-B-A or NEMA 1-2-3 and all equipment purchased under this contract shall be wired and connected NEMA 1-2-3. All phase markings shall be NEMA 1-2-3. Instrument and relay arrangement shall be 1-2-3 left to right with neutral relays underneath phase grouping. GPA will make the external connections of the incoming and outgoing lines such that GPA C-B-A is connected to NEMA 1-2-3. Phase markings C-B-A shall be reserved for GPA's use.

5.8 Nameplates

Nameplates shall be furnished and installed for panels, switches, relays and devices, including those internally mounted, and shall be of laminated plastic or formica with white letters on black background and shall be sized for easy reading. Nameplates shall be securely fastened to the panel with stainless steel panhead screws to prevent detachment and loss. Nameplate data shall be submitted for Owner's approval. Designations shall be machine engraved in upper case letters and shall be centered on the nameplates. Each metal-clad switchgear unit shall be provided with a circuit

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identifying nameplate, letters approximately 3/4-inch high, and mounted at the top of the switchgear.

5.9 Mimic Bus and Devices

Mimic bus shall be 3/8-inch in width and shall be anodized aluminum, approximately 1/16-inch thick, fastened to the panels with adhesive backing or blind metal fasteners. Mimic devices shall be made of the same materials as the bus, and shall indicate the required symbol. The Contractor shall obtain the colors for the mimic bus from the Owner.

yellow	13.8 KV
red	34.5 KV
cyan	115 KV

5.10 Instrument and Control Switches

5.10.1 Instrument and control switches shall be the rotary, cam-operated type with silver contacts and a positive means for maintaining contact position. Contact requirements shall be as shown on the Contract Drawings or as specified. Switch contacts shall be totally enclosed to prevent the accumulation of dust, grit, and foreign matter on the contact surface. The switches shall be GE type SB-1, Westinghouse type W-2, Electroschwitch Series 24, or equal, and shall have operating handles as follows:

- a. Large red pistol-grip handles for power circuit breaker control switches.
- b. Black oval handles with arrow for transfer, and auxiliary switches.

5.10.2 Control switches for circuit breakers shall be momentary contact, spring-return type for both trip and close operation. Operation indicators showing the last operation shall be provided.

5.10.3 The switches shall have escutcheon plates marked as specified with standard circuit designation, except where otherwise specified, and shall be as follows:

- a. Escutcheon plate for circuit breaker control switches, 52CS, shall read "TRIP-CLOSE".

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- b. Escutcheon plate for supervisory selector switch, 43S/L shall be SUPV-LOCAL.
- c. Escutcheon plate for recloser cutout switch, 79CO, shall be CUTIN-CUTOUT.

5.11 Indicating Lamps

Indicating lamps to be mounted on the switchgear shall be Westinghouse Minalite lamps, or GE type ET-6, complete with lamp, resistor and lens or color cap as indicated on the Contract Drawings. Lamps shall be suitable for operation on 125 VDC or 120 VAC, as required for the specific circuit. Lamps shall be T-2 slide-base type rated 32-38 milliamperes.

5.12 Auxiliary Relays

Control, timing, auxiliary and SCADA interposing and command relays shall operate on 125 VDC. Relay contacts shall have a minimum voltage rating of 480 Volts and a continuous current capacity of not less than 10.0 Amperes ac. The contacts shall be field reversible and capable of breaking 20 Amperes at 120 VAC and 5 Amperes at 125 VDC. Contact arrangement shall be as required for the specified control. The control and auxiliary relays shall be utility grade. Time delay relays shall be Agastat Series 7000.

5.13 Instruments and Meters

5.13.1 General

Each meter and instrument shall be semi-flush mounted, back-connected, dustproof, switchboard type with a dull black case for mounting on a No. 11 United States Standard gauge metal panel. Each indicating meter and instrument shall have a removable cover, either transparent or with a transparent window.

5.13.2 Indicating Instruments

Indicating instruments shall be digital LED-type displays with numerals at least 1/2 inch high. The input signal for each instrumental shall be 0-1 mA or 4-20 mA from transducers selected to interface with the Owner-furnished SCADA

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system. Transducers shall be connected with hardwired circuits. The digital indicators shall be Bitronics™ MutiCom™ Multifunction Digital Power Monitor, Model MTWIE1A-S113 or approved equal.

5.14 Test Switches and Devices

Current and potential test switches and test plugs shall be provided with the test switches semi-flush mounted on the switchboard. Test switches shall be connected to the appropriate circuits to permit the checking and calibrating of meters, instruments or relays individually against portable standards connected in series with the instruments or relay undergoing tests, under service conditions or by means of a phantom load. The switches and plugs shall permit "in service" testing as well as calibration and checking of instruments, meters and relays from separate sources of power. Provisions shall also be included for connecting current measuring devices in series with the current circuits of the switches. Switch blades shall be separated by insulated barriers and each switch handle shall be provided with a recessed section for inserting circuit identification cards. Switches shall automatically short circuit current transformer circuits so they cannot be opened inadvertently. Current test switches shall be ABB type FT-1.

5.15 Alarm Annunciator

5.15.1 General

- a. A 24-point annunciator with solid state circuitry shall be provided for each control and relay switchboard. The annunciator system shall consist of a backlighted window and plug-in module for each alarm point, and a set of pushbuttons: TEST, ACKNOWLEDGE, RESET. The annunciator shall be suitable for flush panel mounting and shall be designed for 125 VDC operation. Each annunciator point shall be provided with a field contact follower relay for retransmitting alarms to the Owner's SCADA system.
- b. The annunciator panel dc input and dc output shall be properly filtered to prevent internally generated voltage and current spikes from appearing on the dc bus or alarm bus.

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- c. The annunciator shall withstand ANSI (SWC) surge test waves applied to alarm inputs, power inputs and alarm outputs in both common and transverse mode.

5.15.3 Windows

Each annunciator window shall be approximately 3-inch wide by 2-inch high with engraved markings as shown on the Contract Drawings. The engraving shall be on interchangeable plastic plates. Each window shall be illuminated by 2 lamps which shall be accessible from the front. A terminal block external to the annunciator shall be provided for connections to the system.

5.15.4 Trouble Contacts

The annunciator shall perform properly with input wiring impedance such that a normally open (NO) contact is defined as having an impedance of 150 Kohms to infinity.

5.15.5 Operation

- a. In the event of trouble or abnormal conditions, the normally - open (NO) alarm contact shall close, causing the annunciator window to illuminate, flashing on and off, the alarm horn to sound and the associated auxiliary follower contact to close. Operating the acknowledge pushbutton shall silence the horn and cause the lamp to stay on steady. The lamps shall remain energized until the initiating alarm contact has been opened and the reset pushbutton operated locally. When several lamps have illuminated simultaneously, pushing the reset button shall clear all of the lamps with open alarm contacts leaving illuminated those with alarm contacts still closed.
- b. Lamps shall operate immediately upon closing of the alarm contact with which they are associated, regardless of the number of alarm contacts closing simultaneously.
- c. When the TEST pushbutton is operated, alarm lamps shall be illuminated and the alarm horn sounded. The auxiliary follower contacts shall not respond to the TEST condition.

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5.15.6 Horn

The horn shall operate from the annunciator internal power supply or from the dc source to the annunciator. Horn volume shall be adjustable. A local cutout switch and a time delay relay adjustable from 5 to 300 seconds shall be provided to silence the horn.

5.15.7 Annunciator shall be Beta Annunciator Series 1000.

5.16 Trip Circuit Monitor

The trip circuit monitor shall be e-max™ type RAW-1, part number 632A301. RAW-1 is a panel-mounted relay that contains a series LED for visual indication and blocking diodes for prevention of alarm indication when the breaker is opened. Trip circuit monitors shall be installed to monitor loss of DC for each circuit breaker and lock-out relay.

5.17 Protective Relays

5.17.1 General

Protective relays shall be the semi-flush mounted, back connected, dustproof switchboard type, with a rectangular case for mounting on a No. 11 United States Standard gauge metal panel. Electro-mechanical relays shall have a removable transparent cover or a cover with a transparent window with provisions for sealing. Relay trip functions shall be equipped with an operation indicating target with a manual front-of-case reset device. Trip contacts shall be designed for operation on 125 VDC. Loading resistors, where needed to secure reliable target operations, shall be furnished. Each relay shall operate with instrument transformer ratios and connections as shown on the Contract Drawings under both normal and short-circuit conditions. Each overcurrent and differential relay shall provide continuous operation at the current coil tap ratings. Protective relays shall be the type and model indicated below. Substitutions are not acceptable.

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5.17.2 Power Transformer Relays

a. Transformer Differential Relays - Device 87T

Transformer differential relays shall be a percentage differential type and shall have harmonic restraint. They shall be Schweitzer type SEL-587.

b. Transformer Neutral Time Overcurrent Relays - Device 50/51N

Transformer neutral overcurrent relays shall be an inverse time type with a range which includes 1.5 to 12 Amperes and a 10 to 80 Amperes instantaneous element. The neutral overcurrent relay shall be GE type IAC or Westinghouse CO-8 or Schweitzer type SEL-501.

c. Transformer Primary Instantaneous and Time Overcurrent Relay-Device 50/51

Time overcurrent relays shall have inverse characteristics and a range of 1.5 to 12 Amperes. The instantaneous element shall have a range of 10 to 80 Amperes. The overcurrent relay shall be GE type IAC or Westinghouse CO-8 or Schweitzer type SEL-501 with an instantaneous element.

5.17.3 Transmission Line Relays

Transmission Line Distance, Residual Time Overcurrent and Directional Ground Relays - Device 21/50G/67

The relay shall be a packaged, static type, 3-zone, phase distance relay with residual overcurrent and ground directional overcurrent elements. The relay shall have capabilities for fault locating and event reporting. The relay shall be Schweitzer type SEL-321.

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5.17.4 Communication Processor

The communication processor shall be Schweitzer type SEL-2020 capable of communicating with different microprocessor based devices. This device shall be packaged with an Input/Output Board (16 inputs, 4 output contacts), 14.4 Kbaud or faster Internal Modem, and a 2 Mbyte Flash RAM with non-volatile memory for long-term data storage. No substitutions allowed.

5.17.5 Bus Differential Relays - Device 87B

Bus differential relays shall be General Electric PVD, or Westinghouse KAB.

5.17.6 Breaker Failure Relay - Device 50 BF

Breaker failure relays shall have independently adjustable pick-up current settings for phase and ground currents and an adjustable timer to allow the primary breaker to operate. The relays shall be GE type SBC.

5.17.7 Lockout Relays - Device 86

Lockout relays shall be electrical trip, hand-reset, 125 Volt dc auxiliary lockout relay type. Relays shall be multi-contact and shall be GE type HEA.

5.17.8 Transfer Trip Equipment - Device RFL-9745

Transfer trip equipment shall be used to implement permissive overreaching transfer trip (POTT) with distance relays and direct transfer trip (DTT) with breaker failure relays. Provide 2-channel equipment with an audio communication interface. Transfer trip equipment shall be Dowty type RFL-9745. No substitutions allowed.

5.18 Transducers (Multifunction Digital Power Monitors)

5.18.1 The transducers shall have the following characteristics:

- a. Accept inputs of 120 volts and 5 Amperes nominal at a frequency of 60 Hz.
- b. Meet the requirements of IEEE/ANSI C37.90.

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- c. Shall have 1500 VAC minimum isolation.
- d. Update at least once per second.
- e. Operate between -20°C and $+60^{\circ}\text{C}$ and to 90% relative humidity, non-condensing.

5.18.2 The input terminals shall be 10/32 threaded studs. The output shall be RS-232, DNP3.0 format, on a barrier strip screw terminal block.

5.18.3 Power transducers (Multifunction Digital Power Monitors) shall be used in 34.5 kV switchgear for monitoring and displaying voltage, current, real power, reactive power, energy and frequency. The instrument power supply shall be 24 VDC. The transducers shall receive voltage inputs of 120 Volts nominal line to neutral @ 60 Hz and current inputs of 5 Amps nominal full scale @ 60 Hz. The outputs monitored and displayed shall be voltage, current, frequency, power factor, MW, MVA, KWh and KVARh. The manufacturer shall be BitronicsTM MultiComTM Multifunction Digital Power Monitor, Model MTWIE1A-S113 or approved equal.

5.19 Painting

The switchgear enclosure shall be thoroughly cleaned of rust, welding scale and grease, and shall be treated to effect a bond between the metal and paint which will prevent the formation of rust under the paint. A priming coat shall be applied immediately after the bonding treatment. A final finish shall consist of not less than one coat for concealed surfaces and two coats for exterior surfaces. Final finish shall be light gray, ANSI Color No. 70. The interior shall be painted with 2 coats of white enamel.

5.20 Control AC Power Supply

GPA will provide the 120/240 VAC station power and control.

6.0 CONSTRUCTION

6.1 Installation

Installation will be provided by others.

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6.2 Accessories and Spare Parts

Accessories, special tools and spare parts required for proper maintenance and testing of the equipment, circuit breakers and devices shall be provided with the switchgear and shall include the following:

Ten switchboard indicating lamps.

One color cap for indicating lamps for each ten or less of each color and type used.

Indicating lamp pullers.

Five spare blank annunciator windows for the annunciator

Color caps of each color for indicating lamps.

Twenty control spare fuses of each rating used.

Resistors and lamp sockets for indicating lamps.

One decoil for each five or less mechanically latched in auxiliary relays.

Breaker test cabinet, to facilitate operation of a circuit breaker out of its cubicle for test purposes.

One timing relay for each type used.

Test jumper for testing the breaker when removed from the cubicle.

One audible alarm relay.

Blank nameplates of each size used.

One diode for each 5 or less of each type not mounted on cards or module units.

One varistor for each 5 or less of each type (non-module or card)

Gallons of touchup paint in one quart cans.

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Closing lever for manual operation.

Levering device for breaker positioning.

Set test plugs for relays and meters.

Turning dolly for handling breaker, if required.

Transport truck for handling breaker outside the cubicle, if required.

Crank for manually charging the stored energy closing mechanism.

Spare fuses for potential transformers.

1,200-Ampere grounding and test device with provisions for independently locking each access door with a padlock without remote control if applicable.

Special tools required for proper maintenance, testing and inspection of the equipment.

Spare vacuum bottle, if applicable.

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7.0 PACKING AND SHIPPING REQUIREMENTS

- 7.1 Because of severe transportation conditions, the Supplier shall pay particular attention to the proper packaging and bracing of the apparatus to assure its safe arrival.
- 7.2 The Supplier shall prepare all materials and equipment for shipment in such a manner as to protect from damage in transit. All small parts and unit components shall be separately boxed or bundled to prevent galling due to rubbing of one part against another. Each item, box or bundle shall be plainly and individually identifiable for content according to item number, GPA P.O. Number, and Supplier's Identifying Number.
- 7.3 A complete itemized Bill of Lading, which clearly identifies and inventories each assembly, sub-assembly, carton, package, envelope, etc., shall be furnished and enclosed with each item or items at the time of shipment.
- 7.4 The switchgear shall be shipped in crates containing not more than two units each.

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