# GUAM POWER AUTHORITY

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## TRANSMISSION AND DISTRIBUTION SPECIFICATION

Specification No. E-030

FOR

# 34.5 kV SWITCHGEAR

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## 1.0. SCOPE

**1.1.** This specification describes the requirements for the design, manufacture, factory testing and delivery of 38kV indoor metal-clad switchgear, as well as associated control and accessory equipment. The switchgear shall be an ANSI C37.20.7 Type 2C arc-resistant, providing compartmental protection. The switchgear shall meet the indoor requirements of ANSI C37. This general specification along with the detailed specification establishes the minimum requirements for this equipment. If there is a discrepancy between the single line diagram(s) and the detailed specifications, the detailed specifications shall take precedence. The entire switchgear shall consist of the following equipment:

a. Line circuit breaker equipment
b. Bus tie circuit breaker equipment
c. Sparing bus with removable links and a tap section for the mobile substation
d. Provisions for connection of a future line breaker to the main bus
e. Transformer circuit breaker equipment
f. Primary bus system
g. Ground bus system
h. Protective relaying and revenue grade metering equipment and devices
i. Control and status devices
j. Connection provisions for primary, ground and control circuits
k. Auxiliary compartments and transformers
l. Accessories and material

**1.2.** The switchgear shall perform satisfactorily under a non-air conditioned environment and be suitably designed for satisfactory operation under the hot tropical climate conditions and shall be dust and vermin proof. All the parts and surface, which are subject to corrosion, shall either be made of such material or shall be provided with such protective finish, which provided suitable protection to them from any injurious effect of excessive humidity.

**1.3.** The equipment shall be suitable for satisfactory continuous operation under the following tropical conditions:

a. Maximum ambient temperature: 45 °C
b. Relative Humidity: 10 to 99% (condensing)
c. **Seismic level (Horizontal acceleration): International Building Code Zone 4**

**1.4.** Any special design or installation considerations to assure compliance with this requirement shall be thoroughly documented on the Supplier drawings.

## 2.0. CONFORMANCE TO STANDARDS AND SPECIFICATION

The metal-clad switchgear shall be designed, manufactured and tested in accordance with the latest editions of the applicable, National Electrical Code (NEC), National Electrical Safety Code (NESC), EEMAC, ANSI, IEEE and NEMA standards.

### 2.1. Applicable Standards

#### 2.1.1. American National Standards Institute, Inc. (ANSI)

| | |
|---|---|
| C37.04 | IEEE Standard For Ratings And Requirements For AC High-Voltage Circuit Breakers With Rated Maximum Voltage Above 1000 V |
| C37.06 | IEEE Standard for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis - Preferred Ratings and Related Required Capabilities for Voltages Above 1000 V |
| C37.09 | IEEE Standard Test Procedures For AC High-Voltage Circuit Breakers With Rated Maximum Voltage Above 1000 |
| C37.010 | IEEE Guide for AC High-Voltage Circuit Breakers > 1000 Vac Rated on Symmetrical Current Basis |
| C37.011 | IEEE Guide for the Application of Transient Recovery Voltage for AC High-Voltage Circuit Breakers with Rated Maximum Voltage above 1000 V |
| C37.11 | IEEE Standard Requirements for Electrical Control for AC High-Voltage (>1000 V) Circuit Breakers |
| C37.20.2 | IEEE Standard for Metal-Clad Switchgear |
| C37.55 | Medium-Voltage Metal-Clad Switchgear Assemblies – Conformance Test Procedures |
| C37.90.1 | IEEE Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus |
| C57.13 | IEEE Standard Requirements for Instrument Transformers |

2.1.2. National Electrical Manufacturers Association (NEMA)

| | |
|---|---|
| CC1 | Electric Power Connection for Substations |
| SG2 | High Voltage Fuses |
| SG4 | AC High-Voltage Circuit Breakers |
| SG5 | Power Switchgear Assemblies |
| SG6 | Power Switching Equipment |

2.1.3. National Fire Protection Association (NFPA)

| | |
|---|---|
| 70 | National Electrical Code (NEC) |
| 70E | Standard for Electrical Safety in the Workplace |

2.1.4. American National Standards Institute (ANSI) C2, National Electric Safety Code (NESC)

| | |
|---|---|
| Part 1 | Rules for the Installation and Maintenance of Electric Supply Stations and Equipment |

2.1.5. International Building Code (IBC)

2.1.6. International Electrotechnical Commission (IEC)

| | |
|---|---|
| IEC 61850 | Substation Automation – Fundamentals |

2.1.7. U.S. Department of Defense – Military Specifications

| | |
|---|---|
| Mil-1-46058C | Insulating Compound, Electrical (For Coating Printed Circuit Assemblies) |

2.1.8. IPC

| | |
|---|---|
| IPC-CC-830 | Qualification and Performance of Electrical Insulating Compound for Printed Wiring Assemblies |

2.1.9. Underwriters Laboratories (UL)

| | |
|---|---|
| UL 746 E | Polymeric Materials – Industrial Laminates, Filament Wound Tubing, Vulcanized Fibre, and Materials Used in Printed-Wiring Boards |

2.1.10. International Engineering Consortium (IEC)

| | |
|---|---|
| IEC 60664-3 | Insulation Coordination for Equipment within Low-Voltage Systems – Part 3: Use of Coating, Potting or Moulding for Protection Against Pollution |

**2.2.** Deviations and Non-Conformance Requirements

2.2.1. Deviations from this specification or changes in the material 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 that are not acknowledged as specified in Section 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.

## 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 of three-line and DC Schematics and preferred format for inter-connection diagrams as a guide.

**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
   4. Communications and SCADA

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 for panels and for external devices and field equipment.

h. Potential transformer data.

i. Notes and symbols.

j. Bill of materials and manufacturers catalog sheets clearly marked.

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.

**3.3.** Installation manuals shall be submitted within 90 days after Notice to Proceed.

Operations and maintenance manuals with a section on troubleshooting shall be submitted 30 days prior to shipment.

**3.4.** Number of Copies

a. Submit two (2) hardcopies and one (1) electronic soft file in Portable Document Format (PDF) of each shop drawing, pre-printed manufacturers' data, brochures and suppliers' information for review and approval.

b. After approval and manufacturing of equipment, submit two (2) sets of full size hardcopies and two (1) set of electronic soft file copy of each shop drawing which has been specifically prepared for the Work. Indicate on the drawings that the drawings reflect the Approved Manufacturer As-Built condition of the equipment. Electronic soft file copy shall include a Portable Document Format (PDF) stored on USB Flash Drive/Storage Devices.

c. Submit two (2) hardcopies and two (2) electronic soft file copies of installation, operations and maintenance manuals with a section on trouble shooting. The electronic soft file copies shall be in Portable Document Format (PDF) on USB Flash Drive/Storage Devices.

d. Upon completion of installation and commissioning of switchgear equipment, submit two (2) sets of full size hardcopies and two (2) sets of electronic soft file copies of each shop drawing which has been specifically revised and updated based on the Commissioned As-Built condition. Indicate on the drawings that the drawings reflect the Commissioned As-Built condition of the equipment. Electronic soft file copies shall include a Portable Document Format (PDF) and an AUTOCAD 2013 format, stored on USB Flash Drive/Storage Devices.

## 4.0. QUALIFICATIONS

**4.1.** The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of ten (10) years. An acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement with the bid submittal.

**4.2.** For all equipment specified herein, the manufacturer shall have a quality system that is ISO 9001 certified.

## 5.0. QUALITY ASSURANCE

**5.1.** The manufacturer shall have a formal Quality Assurance Program. The manufacturer's Quality Assurance Manual shall consist of systematic procedures that provide confidence

that the work is in accordance with the manufacture's standard design, codes and standards referenced above, and these specifications for controlling activities affecting quality, such as welding, heat treating, and nondestructive examination. Formal training of individuals performing the work shall be an element of the Quality Assurance Program. Inspections and audits shall be conducted to insure that the Quality Assurance Program is being followed.

5.1.1. The manufacturer's Quality Assurance Manual shall be available at GPA's request and shall include descriptive information and details of the program, including program organization, documentation requirements, and quality control procedures.

5.1.2. The Quality Assurance Program shall include testing procedures, acceptance criteria, repair methods and the quality control requirements of these specifications.

**5.2.** Factory Tests

5.2.1. 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, NETA, and NEMA standards. Three (3) certified copies of the reports of production tests, including complete test data shall be submitted to the Owner. Factory tests will be witnessed by three (3) GPA representatives for a minimum of three (3) days, with additional days as required, to perform a comprehensive Factory Acceptance Testing. Supplier shall cover the cost of airfare, rooms, meals and car rental for the GPA representatives to witness the FAT testing.

5.2.2. 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 marking, nameplate markings, conductor identification and the scale of meters and instruments shall be checked.

5.2.3. Functional Tests

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

**5.3.** Factory Test Reports

Three (3) hardcopies and One (1) soft file in pdf format of certified test results shall be provided to the Owner within 30 days after performance of factory tests.

## 6.0. RATING

**6.1.** Description

6.1.1. The switchgear shall be designed to be operated on a 38 kV maximum rated voltage system and shall be suitable for operation on a solidly-grounded system rated 34.5 kV, 3-phase, 4-wire, 60Hz. The main bus shall be rated for 2,500 amperes-continuous for bulk power transfer substations and 2,000 amperes-continuous for regular/normal substations. Basic insulation level shall be 150 kV.

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

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

6.1.4. Switchgear manufacturer shall provide lifting mechanism for breakers and VT drawout.

6.1.5. The preferred manufacturer is **"Myers Power Products Inc."**.

**6.2.** Circuit Breakers

6.2.1. Unless otherwise specified or approved by GPA Engineering Department, all circuit breakers shall be **"CP HVF" or "Siemens"** circuit breakers.

6.2.2. The 34.5 kV circuit breakers shall have **vacuum interrupters, oil-less type, and be 3-pole, single throw, trip free, draw-out type**, 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.

6.2.3. 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.

6.2.4. The circuit breaker control voltage shall be **125 VDC** supplied by the substation control power.

6.2.5. Each circuit breaker shall be designed specifically for installation in the breaker compartment, and breakers of like ratings shall be completely interchangeable. Circuit breakers of 1200A rating shall not be interchangeable in a 2000A compartment as well as a 2000A rating breaker shall not be interchangeable with a 2500A compartment. 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.

6.2.6. The breakers shall have the following features:

a. 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.

b. Auxiliary switch contacts connected to the mechanism of each breaker shall be provided. 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.

c. An easy-to-read position indicator located on the front of the equipment which can be read without opening the compartment door.

d. A manual means for tripping.

e. Trip free and non-pumping operation.

f. An operations counter which can be read without opening the compartment door.

6.2.7. 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** | **80** |
| | **Impulse crest BIL, kV** | **150** |
| **c.** | **Rate continuous current, A** | |
| | **Bulk Power Transfer Station** | |
| | **Line** | **2000** |
| | **Transformer** | **2000** |
| | **Bus Tie** | **2500** |
| | **Regular/Normal Substation** | |
| | **Line** | **2000** |
| | **Transformer** | **1200** |
| | **Bus Tie** | **2500** |
| **d.** | **Rated interrupting current at rated maximum voltage, kA RMS** | **40** |
| **e.** | **Rated close and latch, kA** | **104** |
| **f.** | **Rated short time current: Three second kA** | **40** |
| **g.** | **Minimum number of trip coils per breaker** | **2 each** |

**6.3.** Enclosure

6.3.1. The switchgear assembly shall consist of **metal-clad, free-standing, vertical, deadfront** steel structures containing circuit breaker compartments and circuit breakers, primary bus system, ground bus system, auxiliary compartments and transformers, protection and control devices, control bus, and connection provisions for primary, ground and control circuits. Devices shall be arranged as shown on the contract drawings. The basic structure will be of modular construction and fabricated mainly of painted hot-dipped galvanized steel. The switchgear enclosure will be double wall construction with an air gap between sheets, so that in the event of a fault the second layer will be insulated by the air gap. The original vendor shall be the manufacturer of the enclosure and the final assembler.

6.3.2. 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 Contract Drawings. Each shipping group shall be provided with a welded base frame, so when assembled in the field it provides a completed structural metal-clad switchgear line-up assembly.

6.3.3. 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 A-60 galvanneal steel, 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.

6.3.4. The switchgear will be constructed with an indoor frame size of 36 inches wide x 95 inches high x 85 inches deep.

6.3.5. The enclosure shall be provided with 304L stainless steel ground pads with 304L stainless steel ½" – 13 UNC, 7/16" deep threaded nuts welded to the ground pads. The ground pad shall be welded to the walls and shall be free of paint.

## 6.4. Buses

### 6.4.1. Main Bus

**The main bus shall be copper, rated 2,500 amperes for bulk power transfer substations and 2,000 amperes for regular/normal substations.** The bus shall be silver-plated at joints and tap points, installed in separate compartment from other wiring by a minimum 11-gauge steel barrier which fully encloses the bus, and insulated its entire length with a high dielectric strength, flame-retarding, self-extinguishing, moisture resistant epoxy coating applied using a fluidized bed process. Use of extruded sleeves or heat shrink insulation is not acceptable. Suitable insulation covers shall be provided for bus joints. The bus supports between units shall be cycloaliphatic epoxy resin or wet process porcelain insulators for 38 kV class. Use of glass-filled polyester, dry process porcelain, ceramic or non-cycloaliphatic epoxy formulations for bus supports is not acceptable. All bus supports must have the same BIL rating as the switchgear. 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. The main bus shall comply with ANSI/IEEE temperature rise requirement.

### 6.4.2. High Voltage Connections

High voltage connections between the main buses, and circuit breaker disconnecting devices, current transformers, and potheads shall be furnished with material installed. Connections shall be made of copper bar insulated between terminals with 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.

6.4.3. 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 rated at a minimum equivalent of #4/0 AWG copper wire and equipped with a clamp connector for #4/0 AWG - 500 kcmil copper cable.

6.4.4. Sparing Bus

The sparing bus shall be same as the main bus.

6.4.5. Access

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

**6.5.** Instrument Transformers

6.5.1. 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 draw-out or tilt-out mounted epoxy construction and equipped with high interrupting capacity current limiting fuses. The voltage transformers shall be **dual-ratio rated at 20,125 primary voltage (L-G), 67.08/115 secondary voltage and 300/175:1 ratio**. One set of **3-phase** voltage transformers shall be provided for **each bus section** of the switchgear. If design drawings require synching voltage transformers, one (1) each VT shall be provided on line side of incoming lines and connected on Ø1 GPA C.

6.5.2. 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 transformer for relaying and metering shall be of **C800** relaying accuracy or as determined by CT saturation calculations. **Four (4)** current transformers shall be provided for **each breaker** and placed **2 on each side** of the breaker. Current transformer **polarity shall be away** from breaker contacts and **secondary currents** shall be **5 amperes.**

**6.6.** Surge Arresters

6.6.1. Surge arresters shall be **station class**, metal-oxide-varistor (MOV), mounted in the switchgear enclosure and connected to each circuit conductor on the line side of the associated circuit breaker. The arresters shall have a nominal **30 kV rms** rating, **MCOV of 24.4 kV rms**, and meet or exceed **33 inches of leakage distance.**

6.6.2. The following characteristics are typical of these arresters:

90 kV maximum Front-Of-Wave (FOV) Protection Level voltage for a 10 kA impulse, which results in a discharge voltage cresting in 0.5 microseconds.

The maximum discharge voltage (crest kV) at indicated impulse currents of 8x20 microseconds:

a. 68 kV at 1.5 kA
b. 74 kV at 5.0 kA
c. 80 kV at 10.0 kA
d. 90 kV at 20.0 kA

**6.7.** Wiring and Accessories

6.7.1. 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. Feeder and main 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) 1000 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 be provided at the terminations of power cables. In addition, bracket supports for the cables shall be provided.

6.7.2. Unless otherwise specified, all **secondary and control wiring** or connections shall be made with a minimum wire size of **No. 12 AWG, CT wiring** shall be **No. 10 AWG**, and **SCADA wiring** shall be **No. 18 AWG.** Switchboard wire shall be stranded, tinned copper, NEC type SIS, and rated for 600 Volts. Insulation jacket shall be gray in color. Splices will not be 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.

6.7.3. **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.

6.7.4. 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.

6.7.5 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.

6.7.6 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 Marathon Series 1600, 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.

6.7.7 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. 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.

6.7.8 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.

6.7.9 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.

c. 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.

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

**6.9.** 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.

a. Yellow 13.8 kV

b. Red 34.5 kV

c. Cyan 115 kV

**6.10.** Instrument and Control Switches

6.10.1. 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, Electroswitch Series 24, or equal, and shall have operating handles as follows:

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

6.10.2. 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.

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

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

2. Escutcheon plate for supervisory selector switch, 43R/L shall be "REMOTE-LOCAL".

**6.11** Indicating Lamps

Indicating lights shall be the manufacturer's standard transformer type units **125-volt DC** input utilizing low-voltage **LEDs with red color indicating breaker closed and LED off when breaker open.** Provide indicating lights that are capable of being re-lamped from the switchgear front. Indicating lights utilizing resistors in series with the lamps are not permitted, except in direct-current control circuits. For all breaker control switches and hand reset lockout relays, use Trip Coil Monitors in lieu of standard indicating lights.

**6.12** Substation Metering

Power delivery measurement of each power transformer and 13.8 kV feeders shall be made via Schweitzer Engineering Laboratories' SEL-735 or latest device. The **SEL-735 power quality and revenue meter** shall have intermediate PQ and recording, 256 MB memory, Form 9, vertical panel mount, ANSI optical port, 125/250 VDC/VAC power supply, 125 VDC/VAC control input voltage, 2 inputs, 3 contact outputs, 2 EIA 232 ports, one 10/100 Base T Ethernet port, IRIG, current Class CL 10/20, 60 Hz frequency, DNP 3, LAN/WAN, MV90 Translation, Synchrophasor, ANSI labeling, Accelerator Quickset compatible, and conformal coating. **Provide meter part number for review and approval.**

**6.13** 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.**

**6.14** Trip Coil Monitor

The Trip Coil Monitor shall be Schweitzer Engineering Laboratories SEL-2652 with an external red LED mounted on the switchgear. It shall be suitable for operation on 120

VDC or 120 VAC, as required for the specific circuit. The SEL-2652 shall have breaker status indicator function, **red LED color, 200 ms time delay**, and conformal coating. **Trip Coil Monitors shall be installed to monitor loss of DC for each circuit breaker and lock-out relay. Trip Coil Monitor alarm contacts will be wired to GPA SCADA RTU for TCM status.**

## 6.15 Protective Relays

### 6.15.1 General

a. Protective relays shall be semi-flush mounting-type with test facilities that automatically short current circuits and open potential and trip circuits when the relay is withdrawn from the case.
b. If the relay is not equipped with built-in test facilities, external test blocks shall be furnished.
c. Output contacts shall be rated for tripping or closing of the circuit breaker.
d. Output contacts shall be dry type.
e. SCR outputs are not acceptable.
f. Relays shall have targets to indicate which elements caused the operation.
g. Control voltage shall be 125 VDC.
h. Relays shall pass the ANSI surge withstand tests.
i. All printed circuit boards are to be covered with a Conformal Coating meeting the specification indicated in Section 2.1 and operate within a temperature range of -40°C to +75°C (-40°F to +160°F) and a relative humidity range between 0% and 100%.
j. Communication protocols shall include DNP3 and TCP/IP, fully compliant with IEC 61850.

### 6.15.2 Power Transformer Relays

a. Transformer Differential Relays – 87T

Primary transformer differential relays shall be a percentage differential type and shall have harmonic restraint. They shall be Schweitzer type SEL-787 Primary Relay or latest device. The SEL-787 transformer protection relay shall have two winding current differential or more based on drawing design. The relay shall have vertical chassis, front panel LCD display, 125 VDC/VAC power supply, 60 Hz, 125 VDC/VAC digital input, fast high-current interrupting digital output, EIA-232 port, 10/100 Base-T Ethernet, IRIG B, DNP3, IEC 61850, C37.118 Synchrophasor, Accelerator Quickset, 5-amp current winding inputs, and conformal coating. Provide relay part number for review and approval.

b. Transformer Time Overcurrent and Breaker Failure Relay – 51/51N/50BF

Backup transformer relay shall be Schweitzer type SEL-751 protection relay for overcurrent and breaker failure or latest device. The **SEL-751 Backup Relay** shall have standard overcurrent firmware, 125 VDC/VAC power supply, 60 Hz, 125 VDC/VAC digital input, fast high-current interrupting digital output, 4 pushbutton controls, EIA-232 port, 10/100 Base-T Ethernet, IRIG B, DNP3, IEC 61850, Accelerator Quickset, 3-phase AC voltage input, 3-phase AC current 5 amps input, neutral AC current 5 amp input, and conformal coating. **Provide relay part number for review and approval.**

6.15.3. Transmission Line Relays

a. Transmission Line Differential, Line Distance, Residual Time Overcurrent, Direction Ground, and Breaker Failure – 87L/21/50/51/67/50BF

Primary transmission line relays shall be advanced line differential and distance protection. They shall be Schweitzer type **SEL-411L Primary Relay** or latest device. The SEL-411L relay shall have line differential, distance elements, traveling wave fault location, horizontal mount, 125 VDC/ VAC power supply, 60 Hz, 125 VDC/VAC digital input, high speed high current interrupting digital output, connectorized type, 300 V secondary voltage inputs, 5 amp current inputs, 1300 nm IEEE C37.94 Fiber communications for Channel 1 and Channel 2, EIA-232 port, 10/100 Base-T Ethernet, IRIG B, DNP3, IEC 61850, C37.118 Synchrophasor, Accelerator Quickset, and conformal coating. **Include 100' fiber optic cables for connections to Channels 1 and 2. Provide relay part number for review and approval.**

b. Transmission Line Differential, Line Distance, Residual Time Overcurrent, Direction Ground, and Breaker Failure – 87L/21/50/51/67/50BF

Backup transmission line relays shall be line differential and distance protection. They shall be Schweitzer type **SEL-311L Backup Relay** or latest device. The SEL-311L relay shall have line differential, distance elements, horizontal mount, 125 VDC/VAC power supply, 60 Hz, 125 VDC/VAC digital input, standard output, 150 VAC maximum wye connected voltage inputs, 5 amp current inputs, 1300 nm IEEE C37.94 Fiber communications for Channel X and Channel Y, EIA-232 port, 10/100 Base-T Ethernet, IRIG B, DNP3, IEC 61850, Accelerator Quickset, and conformal coating. **Include 100' fiber optic cables for connections to Channels X and Y. Provide relay part number for review and approval.**

6.15.4. Bus Relays

a. Bus Differential Relays and Breaker Failure– 87B/50BF

Primary and backup bus differential relays shall be a percentage differential type and shall have harmonic restraint. They shall be Schweitzer type **SEL-787 Primary and Backup Relays** or latest device. The SEL-787 transformer protection relay shall have four winding current differential. The relay shall have vertical chassis, front panel LCD display, 125 VDC/VAC power supply, 60 Hz, 125 VDC/VAC digital input, fast high-current interrupting digital output, EIA-232 port, 10/100 Base-T Ethernet, IRIG B, DNP3, IEC 61850, C37.118 Synchrophasor, Accelerator Quickset, 5 amp current winding inputs, and conformal coating. **Provide relay part number for review and approval.**

6.15.5. Bus Tie Relays

a. Bus Tie Time Overcurrent and Breaker Failure Relay – 51/51N/50BF

Primary and backup bus tie relays shall be Schweitzer type SEL-751 protection relay for overcurrent and breaker failure or latest device. The **SEL-751 Primary and Backup Relays** shall have standard overcurrent firmware, 125 VDC/VAC power supply, 60 Hz, 125 VDC/VAC digital input, fast high-current interrupting digital output, 4 pushbutton controls, EIA-232 port, 10/100 Base-T Ethernet, IRIG B, DNP3, IEC 61850, Accelerator Quickset, 3-phase AC voltage input, 3-phase AC current 5 amps input, neutral AC current 5 amp input, and conformal coating. **Provide relay part number for review and approval.**

6.15.6. Zigzag Grounding Transformer Relays

a. Zigzag Grounding Transformer Overcurrent and Breaker Failure Relay – 51/51N/50BF

Primary and backup zigzag grounding transformer relays shall be Schweitzer type SEL-751 protection relay for overcurrent and breaker failure or latest device. The **SEL-751 Primary and Backup Relays** shall have standard overcurrent firmware, 125 VDC/VAC power supply, 60 Hz, 125 VDC/VAC digital input, fast high-current interrupting digital output, 4 pushbutton controls, EIA-232 port, 10/100 Base-T Ethernet, IRIG B, DNP3, IEC 61850, Accelerator Quickset, 3-phase AC voltage input, 3-phase AC current 5 amps input, neutral AC current 5 amp input, and conformal coating. **Provide relay part number for review and approval.**

6.15.7. Lockout Relays

a. Lockout Relays – 86

Lockout relays shall be electrical trip, hand-reset, 125 VDC auxiliary lockout relay type. Relays shall be multi-contact and shall be **Electroswitch Series 24. Spare contacts of 25%** shall be provided for all lockout relays.

**6.16.** Display

Each meter and relay shall have a built in LCD to display analog metered values and targets.

**6.17.** Communication Processor

The communication processor shall be Schweitzer type SEL-3530 capable of communicating with different microprocessor based devices. The **SEL-3530** shall be horizontal mount, 125 VDC/VAC power supply, 60 Hz, 125 VDC/VAC digital inputs, standard outputs, 16 EIA-232 ports, 10/100 Base-T Ethernet, IRIG B, DNP3, IEC 61850, C37.118 Synchrophasor, Accelerator RTAC, and conformal coating. **Provide part number for review and approval.**

**6.18.** GPS Satellite Clock

To synchronize relays and other devices, a GPS satellite clock shall be provided. The GPS satellite clock shall be Schweitzer SEL-2407 and have 125 VDC/VAC power supply, modulated/demodulated IRIG B BNC outputs, ±100 ns average time accuracy, LED time display, and conformal coating. Include GPS antenna, 50 ohm resistor, and 75 feet of antenna cable. **Provide part number for review and approval.**

**6.19.** Painting

The switchgear enclosure shall be thoroughly cleaned of rust, welding scale and grease using a non-acidic and non-abrasive cleaner, and shall be treated to effect a bond between the metal and paint which will prevent the formation of rust under the paint. A zinc-oxide zinc-chromate anticorrosion 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. A computerized paint system shall be utilized to apply a uniform thickness and coverage of paint to all surfaces.

**6.20.** Power Supply

The switchgear power supply shall be **120/240 VAC or 120/208 VAC,** based on available station power, and **125 VDC** control power supply.

**6.21.** Space Heaters

6.21.1. **Equip each section of the switchgear assembly with externally energized space heaters** to provide approximately 4 watts per square foot of outer surface area and designed for operation at 120/240 VAC or 120/208 VAC. Locate heaters at the lowest portion of each space to be heated. Cover terminals. **Use thermostats to regulate the temperature.**

**6.22.** Infrared Camera Windows

FLIR IRW – 4C 4 inch Infrared Windows shall be installed on switchgear rear panels at each compartment where power transformer, transmission line and station power cable-connection to switchgear bus sections are terminated. Window installation shall be so that all three phase connections are visible from infrared test equipment or as specified by the manufacturer. Infrared camera windows shall have the following specifications:

a. Body Material: Anodized Aluminum
b. Gasket: Silicone
c. NEMA Environment Type: Type 4/12 (outdoor/indoor)
d. Overall Height: 136.5 mm (5.37 in)
e. Overall Width: 127.44 mm (5.01 in)
f. Overall Thickness: 29.25 mm (1.15 in)
g. Required Hole Diameter (Nominal): 114.3 mm (4.5 in)
h. Greenlee Punch: 742BB
i. Window Thickness: 2 mm (0.07 in)
j. Crystal Insert Diameter: 95 mm (3.74 in)
k. Viewing Aperture Area: 6221 $mm^2$ (9.64 $in^2$)
l. Viewing Aperture Diameter: 89 mm (3.50 in)
m. Optic Maximum Temperature: 1355.6 °C (2474 °F)
n. Arc flash test standard: 5 kV, 63 kA for 30 cycles at 60 Hz
o. Maximum Pullout Strength: 1678 kg (3700 lbs)
p. Impact Resistant Cover

q. 15-day extreme humidity withstand
r. 102 $m/s^2$ vibration withstand
s. IP Rating: IP69
t. Maximum Operating Temperature: 260 °C /500 °F

## 7.0. CONSTRUCTION

### 7.1. Installation

Installation will be based on construction scope requirements.

### 7.2. Accessories and Spare Parts

Accessories, special tools and spare parts required for operation, proper maintenance and testing of the equipment, circuit breakers and devices shall be provided with the switchgear and shall be **turned over to GPA upon completion of the project.** Accessories, special tools and spare parts shall include the following:

#### 7.2.1. Accessories and Special Tools

a. Indicating lamp pullers.
b. Breaker test cabinet, to facilitate operation of a circuit breaker out of its cubicle for test purposes.
c. One (1) test jumper,1-12 pins for testing the breaker when removed from the cubicle.
d. Closing lever for manual operation.
e. One (1) Levering-in crank (Racking handle) for 38 HVF 38 kV breaker accessory.
f. Lifting truck for inserting and removing breaker and voltage transformer from the switchgear compartment.
g. Set of Test Plugs for each relays and meters.
h. Turning dolly for handling breaker, if required.
i. Transport truck for handling breaker outside the cubicle, if required.
j. Crank for manually charging the stored energy closing mechanism.
k. 1,200-Ampere grounding and test device with provisions for independently locking each access door with a padlock without remote control.
l. Insulated Boots for each terminal plugs and exposed joints.
m. Special tools required for proper maintenance, testing, and inspection of the equipment.

7.2.2. Spare Parts

a. Ten (10) switchboard indicating lamps or LEDs.
b. One (1) color cap for indicating lamps for each ten or less of each color and type used.
c. Resistors and lamp sockets for indicating lamps.
d. One (1) trip coil for every four power circuit breakers provided.
e. Twenty (20) control spare fuses for each rating of fuse provided in switchgear.
f. Five (5) blank nameplates of each size used.
g. Gallons of touch up paint in one quart cans, ANSI 70 Gray.
h. Spare fuses for potential transformers.
i. One (1) Manual charging handle of HVF 38 kV breaker accessory.
j. One (1) Racking handle.
k. One (1) Set – (3) each Insulated Boots for each rating.
l. One (1) 38 kV breaker, 2000A, 40KA, 5 Cycle, 150 kV BIL, 50/60 Hz. See Section 6.2 for characteristics.
m. One (1) Set – three (3) each Indoor Voltage Transformer, 34.5kV. See Section 6.5 for characteristics.
n. One set, three (3) each Circuit Breaker Vacuum Bottles, if applicable.

**7.3.** Disconnect Switches (If Required)

7.3.1. Disconnect switches (if required) shall be provided as an integral part of the switchgear lineup as shown on the drawings.

7.3.2. Disconnect switches shall be rated for 38 kV, 2000A, 3-pole, no-load break, non-fused, manual operation, and shall include a handle interlocked with operating mechanism, viewing window, and auxiliary contacts for future remote indication.

## 8.0. PACKING AND SHIPPING REQUIREMENTS

**8.1.** 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.

**8.2.** 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.

**8.3.** 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.

**8.4.** The switchgear shall be shipped in crates containing not more than two units each.

## 9.0. STATEMENT OF COMPLIANCE

The Supplier shall provide a signed statement verifying that the products being supplied fully comply with the specification stated herewith. Items not in full compliance with this specification will be identified with a description of the deficiency and any proposed substitutions must be approved by the Guam Power Authority Engineering Department, as described in Section 2.2.1.

## 10.0. WARRANTY

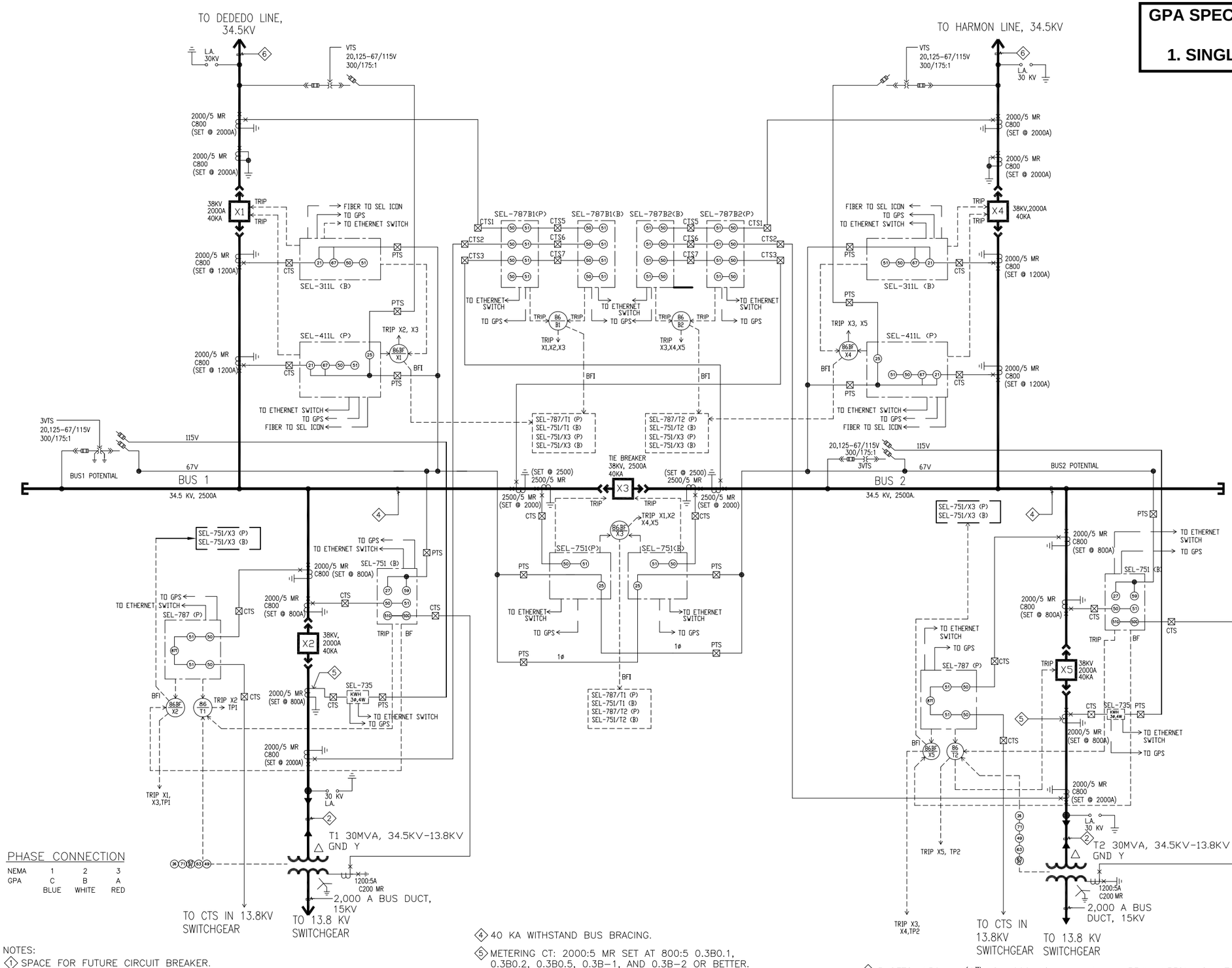
The Supplier shall warrant the satisfactory and successful operation of the equipment furnished under this specification at the rating, under the conditions, and for the service specified. The Supplier shall further warrant this equipment against defects of design, material and workmanship. All workmanship and parts shall have a warranty of at least (1) year from the date of equipment's commissioning.

## 11.0. ATTACHMENTS

**11.1.** Sample Drawings.

1. Single One Line Diagram
2. Three Line Diagram
3. DC Trip Coil Circuit Primary
4. DC Trip Coil Circuit Backup

**GPA SPECIFICATION NO E-030 RV5**
**ATTACHMENT**
**1. SINGLE ONE LINE DIAGRAM**




PHASE CONNECTION

| NEMA | 1 | 2 | 3 |
|---|---|---|---|
| GPA | C | B | A |
| | BLUE | WHITE | RED |

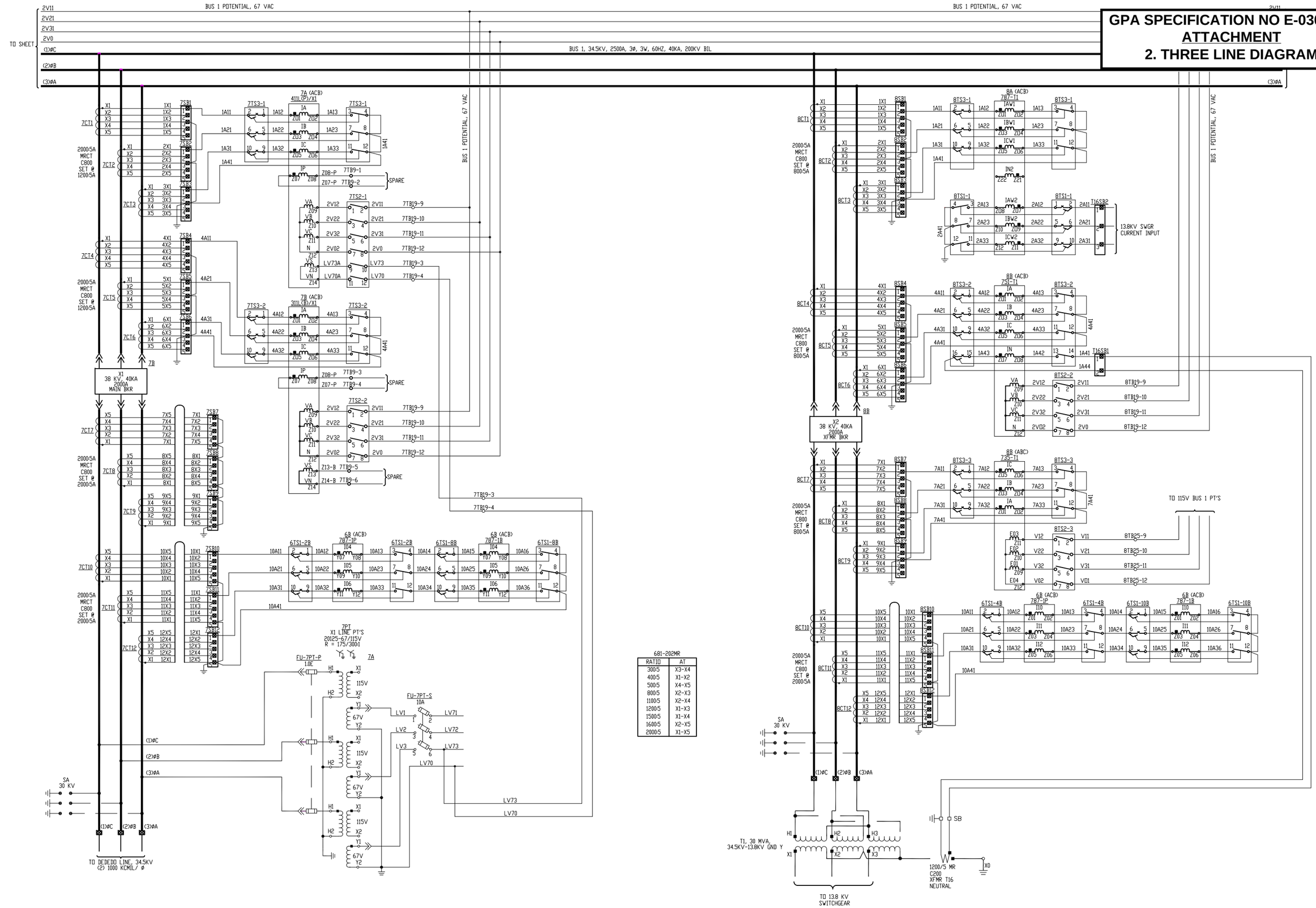
NOTES:

1. SPACE FOR FUTURE CIRCUIT BREAKER.
2. 2 SETS, 156mm (6"), 3–600 KCMIL ALUMINUM, 35KV, 133% INSULATION XLP 1#4/0 GROUND. 1–156mm(6") SPARE.
3. 1–156mm(6"), 3–500 KCMIL ALUM, 35KV, 133% INSULATION XLP, 1–156mm(6") SPARE, 1#4/0 GND.
4. 40 KA WITHSTAND BUS BRACING.
5. METERING CT: 2000:5 MR SET AT 800:5 0.3B0.1, 0.3B0.2, 0.3B0.5, 0.3B–1, AND 0.3B–2 OR BETTER.
6. 3 SETS, 156mm (6"), 2–1000 KCMIL ALUMINUM, 35KV, 133% INSULATION XLP, 1#4/0 GND. 1–156mm (6") SPARE (PROVIDE PULLWIRE).
7. 103mm (4")ø CONDUIT STUB–OUT. PROVIDE PULLWIRE.

1 E4.0 E4.0 **NEW SUBSTATION 34.5KV ONE LINE DIAGRAM**

NOT TO SCALE

# GPA SPECIFICATION NO E-030 RV5
# ATTACHMENT
# 2. THREE LINE DIAGRAM



# GPA SPECIFICATION NO E-030 RV5
# ATTACHMENT
# 3. DC TRIP COIL CIRCUIT PRIMARY

125VDC F.B.O.
34.5 DC PANEL 'DC1' CIRCUIT#1

(+) 30A 1PB-1 TPP-X1 'FU1' 20A 1TB18-5 CPP-X1

(P) 411L-X1 OUT105 CLOSE
(B) 311L-X1 OUT105 CLOSE
INSTALL JUMPER IF TOC NOT USED
52 TOC (X1)
52CS CLOSE
86BF/X2 RESET
86BF/X3 RESET
86B1 RESET
6H-X1
6F-X1
6G-X1
6E-X1
43LR R
43LR L
6-X1
11-X1
4-X1

74R/X1 RAW
TO SCADA RTU
52CS TRIP
TPPA-X1
TPPB-X1
411L(P)-X1 OUT104 TRIP
311L(B)-X1 OUT104 TRIP
86BF/X2 TRIP
86BF/X3 TRIP
86B1 TRIP
43LR L
43LR R
411L(P)-X1
IN102 TCM
OUT101 TRIP
1TB5-1
1TB5-2
2TB11-3
2TB11-4
3TB11-3
3TB11-4
5TB22-3
5TB22-4

(P) 411L-X1 ALARM
4A-X1
2TB20-9
2TB20-10
TO SCADA RTU

411L(P) STATUS THIS SHT
311L(B) STATUS SHT A5-2
787B-1(P) STATUS SHT A5-11
SPRING CHARGE IND. SPARE
SPARES
PP1A
101

52-X1
EC-1 EC-6 EC-11 EC-4 EC-9 ED-10 ED-5 ED23 ED-3 ED-7 ED-11
1 6 11 4 9 13 17 23 15 19 23

S3 S1 S21 S22 K1 M1 K1 Y9 1ST TRIP COIL
S1 52a
S41 52a
T6 T8 T1 T5 T7

EC-2 EC-7 EC-12 EC-5 EC-10 ED-2 ED-6 ED24 ED-4 ED-8 ED-12
2 7 12 5 10 14 18 24 16 20 24

3 4 1TB18-6 'FU1' 20A CPN-X1
(-) 1TBP-2 TPN-X1

'FU2' 5A 1TB18-7 PP1A-X1
EC-9 S1 52a (X1) EC-10 10-X1
43LR L PP1B-X1
411L(P) Z25 PWR Z26
411L(P) 52a (X1) IN101
411L(P) 43LR (X1) IN104
3 4 1TB18-8 PN1A-X1 'FU2' 5A

411L(P)-X1 OUT 103 TRIP
311L(B)-X1 OUT 103 TRIP
BF1R-X1
74R/86BF-X1
TO SCADA RTU
86BF/X1 COIL
86-BF
3R-X1
86BF X1

787B-1(B) STATUS SHT. A5-11
1TB23-1 PP4A MOC PP4B 1TB23-2
MOC3 MOC5 MOC7 MOC9 MOC11 MOC13 MOC15 MOC17 MOC19
MOC4 MOC6 MOC8 MOC10 MOC12 MOC14 MOC16 MOC18 MOC20
1TB23-3 1TB23-5 1TB23-7 1TB23-9 1TB23-11 1TB24-1 1TB24-3 1TB24-5 1TB24-7
1TB23-4 1TB23-6 1TB23-8 1TB23-10 1TB23-12 1TB24-2 1TB24-4 1TB24-6 1TB24-8
MOC CONTACT ASSIGNMENTS
OPERATES IN TEST AND CONNECTED POSITIONS
(CONTACTS SHOWN WITH BKR OPEN)

411L(P) 43LR THIS SHT. 43LR/X1 LOCAL
311L(B) 43LR SHT. A5-2 43LR/X1 LOCAL
74R/X1 LOCAL
PP1C-X1 PP1A-X1 6R-X1
1TB16-1 1TB16-2 1TB16-3
TO SCADA RTU
74R/86BF-X1 LOCAL
PP1D-X1 PP1A-X1 6R86-X1
1TB16-4 1TB16-5 1TB16-6
TO SCADA RTU

BREAKER AUXILIARY SWITCH
SHEET A5-11 X32B 13 14 PN4A SHEET A5-11
GREEN INDICATING LIGHT EC11 21 22 EC12 GREEN INDICATING LIGHT
THIS SHEET PP1A 23 24 101 THIS SHEET
SPARE ED3 31 32 ED4 SPARE
SHEET A5-2 PP2A 33 34 IN17 SHEET A5-2
SPARE ED7 41 42 ED8 SPARE
SHEET A5-11 X32P 43 44 PN3A SHEET A5-11
SPARE ED9 51 52 ED10 SPARE
52a / 52b

TOC1 TOC3 TOC5 TOC7 TOC9 TOC11 TOC
TOC2 TOC4 TOC6 TOC8 TOC10 TOC12
1TB30-1 1TB30-3 1TB30-5 1TB30-7 1TB30-9 1TB30-11
1TB30-2 1TB30-4 1TB30-6 1TB30-8 1TB30-10 1TB30-12
TOC CONTACT ASSIGNMENTS
(CONTACTS SHOWN WITH BKR IN DISCONNECTED/TEST POSITION)

43LR/X1
43 SELECTOR SWITCH

| LOCAL-REMOTE SW | DECK | CONTACTS | POS. LOCAL | POS. REMOTE | FUNCTION | REF. DWG. |
|---|---|---|---|---|---|---|
| LOCAL | 1 | 11 12 | X | | LOCAL TRIP X1 | THIS SHT. |
| REMOTE | | 13 | | X | REMOTE TRIP X1 | THIS SHT. |
| | | 15 16 | X | | LOCAL CLOSE X1 | THIS SHT. |
| | | 17 | | X | REMOTE CLOSE X1 | THIS SHT. |
| | 2 | 21 22 | X | | X1 L/R STATUS | THIS SHT. |
| | | 23 | | X | | |
| | | 25 26 | X | | X1 L/R STATUS | SHT. A5-2 |
| | | 27 | | X | | |

52CS/X1

| DECK | CONTACTS | POSITION TRIP | NAT | NAC | CLOSE | FUNCTION | REF. DWG. |
|---|---|---|---|---|---|---|---|
| 1 | 11 18 | X | | | | BKR TRIP X1 | THIS SHEET |
| | 1TB17-1 1TB17-2 14 15 | X | | | | WIRED SPARE | |
| 2 | 1TB17-3 1TB17-4 21 22 | | X | X | | WIRED SPARE | |
| | 26 27 | | | | X | BKR CLOSE X1 | THIS SHEET |
| 3 | 1TB17-5 1TB17-6 32 33 | | | X | X | WIRED SPARE | |
| | 1TB17-7 1TB17-8 36 37 | | | X | X | WIRED SPARE | |
| 4 | 1TB17-9 1TB17-10 42 43 | | | X | X | WIRED SPARE | |
| | 1TB17-11 1TB17-12 46 47 | | | X | X | WIRED SPARE | |

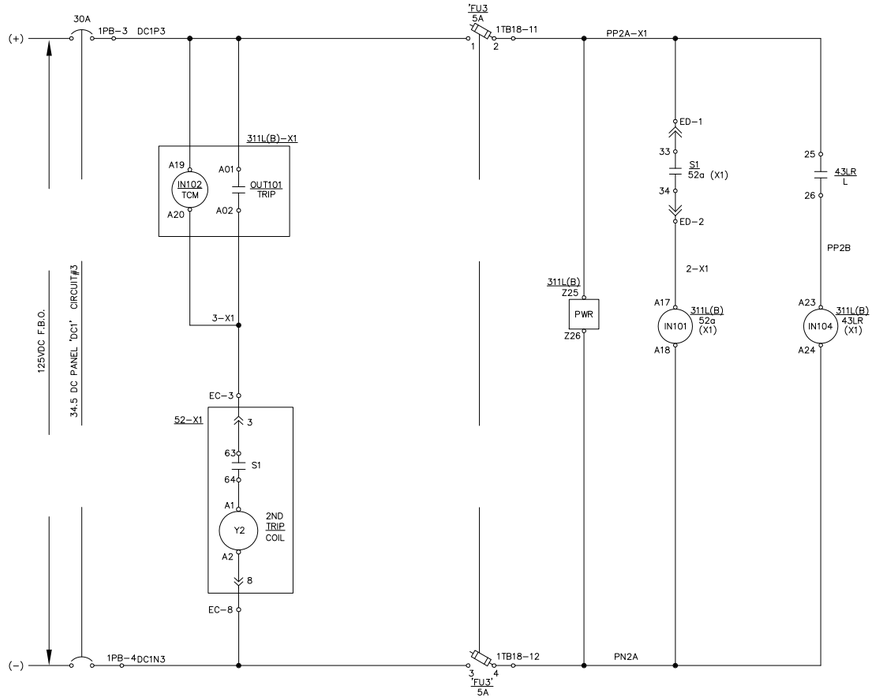
52CS BREAKER CONTROL SWITCH

LEGEND:
K1 = ANTI PUMPING RELAY
M1 = MOTOR
R1 = RESISTOR
S1 = AUXILIARY SWITCH
S3 = LIMIT SWITCH
S41 = POSITION SWITCH
S21, S22 = LIMIT SWITCH
XO = PLUG CONNECTOR (SECONDARY CONNECTION)
Y1 = TRIPPING SOLENOID (TRIP COIL)
Y2 = TRIPPING SOLENOID (2NDTRIP COIL)
Y9 = CLOSING SOLENOID
MOC = MECHANISM OPERATED CELL
TOC = TRUCK OPERATED CELL
X TB X - X = INTERCONNECTION TERMINAL POINT & SPARES
TERMINAL NUMBER
TERMINAL BLOCK NUMBER
TERMINAL BLOCK
UNIT #

86BF-X1

| DECKS | CONTACTS | POS. TRIP | POS. RESET | FUNCTION | REF. DWG. |
|---|---|---|---|---|---|
| 1 | 1TB11-1 11 1TB11-2 13 | | X | BREAKER X2 BLOCK CLOSE | SHT. A5-3 |
| | 1TB11-3 12 1TB11-4 18 | X | | BREAKER X2 TRIP | SHT. A5-3 |
| | 1TB11-5 15 1TB11-6 17 | | X | BREAKER X3 BLOCK CLOSE | SHT. A5-5 |
| | 1TB11-7 16 1TB11-8 14 | X | | BREAKER X3 TRIP | SHT. A5-5 |
| 2 | 1TB11-9 21 1TB11-10 23 | | X | WIRED SPARE | |
| | 1TB11-11 22 1TB11-12 28 | | X | WIRED SPARE | |
| | 1TB12-1 25 1TB12-2 27 | | X | WIRED SPARE | |
| | 1TB12-3 26 1TB12-4 24 | | X | WIRED SPARE | |
| 3 | 1TB12-5 31 1TB12-6 53 | | X | WIRED SPARE | |
| | 1TB12-7 32 1TB12-8 38 | | X | 74R/86BF-X1 | THIS SHT. |
| | 1TB12-9 35 1TB12-10 37 | | X | WIRED SPARE | |
| | 1TB12-11 36 1TB12-12 34 | | X | WIRED SPARE | |
| 4 | 1TB13-1 41 1TB13-2 43 | | X | WIRED SPARE | |
| | 1TB13-3 42 1TB13-4 48 | | X | WIRED SPARE | |
| | 1TB13-5 45 1TB13-6 47 | | X | WIRED SPARE | |
| | 1TB13-7 46 1TB13-8 44 | | X | BFI SEL-787/T5 | SHT. A5-3 |
| 5 | 1TB13-9 51 1TB13-10 53 | | X | WIRED SPARE | |
| | 1TB13-11 52 1TB13-12 58 | | X | BFI SEL-751/T1 | SHT. A5-4 |
| | 1TB14-1 55 1TB14-2 57 | | X | WIRED SPARE | |
| | 1TB14-3 56 1TB14-4 54 | | X | BFI SEL-751(P)/X3 | SHT. A5-10 |
| 6 | 1TB14-5 61 1TB14-6 63 | | X | WIRED SPARE | |
| | 1TB14-7 62 1TB14-8 64 | | X | BFI SEL-751(B)/X3 | SHT. A5-10 |
| | 1TB14-9 65 1TB14-10 67 | | X | WIRED SPARE | |
| | 1TB14-11 66 1TB14-12 64 | | X | WIRED SPARE | |

# GPA SPECIFICATION NO E-030 RV5
# ATTACHMENT
# 4. DC TRIP COIL CIRCUIT BACKUP




| 411L(P)/X1 | FUNCTIONS | REF. DWG. |
|---|---|---|
| OUT101 1TB1-1 A01 — 1TB1-2 A02 | BREAKER X1 TRIP COIL 1 | SHEET A5-1 |
| OUT102 1TB1-3 A03 — 1TB1-4 A04 | WIRED SPARE | |
| OUT103 1TB1-5 A05 — 1TB1-6 A06 | 86BF/X1 TRIP | SHEET A5-1 |
| OUT104 1TB1-7 A07 — 1TB1-8 A08 | BREAKER X1 SCADA TRIP | SHEET A5-1 |
| OUT105 1TB1-9 A09 — 1TB1-10 A10 | BREAKER X1 SCADA CLOSE | SHEET A5-1 |
| OUT106 1TB1-11 A11 — 1TB1-12 A12 | WIRED SPARE | |
| OUT107 1TB2-1 A13 — 1TB2-2 A14 | WIRED SPARE | |
| ALARM 1TB2-3 A15 — 1TB2-4 A16 | SCADA RTU X1 ALARM | SHEET A5-1 |
| 1TB2-5 (IN101) A17 — 1TB2-6 A18 | BREAKER X1 S1/52a | SHEET A5-1 |
| 1TB2-7 (IN102) A19 — 1TB2-8 A20 | BREAKER X1 TCM 1 | SHEET A5-1 |
| 1TB2-9 (IN103) A21 — 1TB2-10 A22 | WIRED SPARE | |
| 1TB2-11 (IN104) A23 — 1TB2-12 A24 | 43LR STATUS SCADA | SHEET A5-1 |
| 1TB3-1 (IN105) A25 — 1TB3-2 A26 | WIRED SPARE | |
| 1TB3-3 (IN106) A27 — 1TB3-4 A28 | WIRED SPARE | |
| OUT201 1TB3-5 B01 — 1TB3-6 B02 | WIRED SPARE | |
| OUT202 1TB3-8 B04 — 1TB3-9 B05 | WIRED SPARE | |
| OUT203 1TB3-11 B07 — 1TB3-12 B08 | WIRED SPARE | |
| OUT204 1TB4-1 B09 — 1TB4-2 B10 | WIRED SPARE | |
| OUT205 1TB4-4 B12 — 1TB4-5 B13 | WIRED SPARE | |
| OUT206 1TB4-7 B15 — 1TB4-8 B16 | WIRED SPARE | |

| 311L(B)/X1 | FUNCTIONS | REF. DWG. |
|---|---|---|
| OUT101 1TB6-1 A01 — 1TB6-2 A02 | BREAKER X1 TRIP COIL 2 | THIS SHEET |
| OUT102 1TB6-3 A03 — 1TB6-4 A04 | WIRED SPARE | |
| OUT103 1TB6-5 A05 — 1TB6-6 A06 | 86BF/X1 TRIP | SHEET A5-1 |
| OUT104 1TB6-7 A07 — 1TB6-8 A08 | BREAKER X1 SCADA TRIP | SHEET A5-1 |
| OUT105 1TB6-9 A09 — 1TB6-10 A10 | BREAKER X1 SCADA CLOSE | SHEET A5-1 |
| OUT106 1TB6-11 A11 — 1TB6-12 A12 | WIRED SPARE | |
| OUT107 1TB7-1 A13 — 1TB7-2 A14 | WIRED SPARE | |
| ALARM 1TB7-3 A15 — 1TB7-4 A16 | WIRED SPARE | |
| 1TB7-5 (IN101) A17 — 1TB7-6 A18 | BREAKER X1 S1/52a | THIS SHEET |
| 1TB7-7 (IN102) A19 — 1TB7-8 A20 | BREAKER X1 TCM 2 | THIS SHEET |
| 1TB7-9 (IN103) A21 — 1TB7-10 A22 | WIRED SPARE | |
| 1TB7-11 (IN104) A23 — 1TB7-12 A24 | 43LR STATUS SCADA | THIS SHEET |
| 1TB8-1 (IN105) A25 — 1TB8-2 A26 | WIRED SPARE | |
| 1TB8-3 (IN106) A27 — 1TB8-4 A28 | WIRED SPARE | |
| OUT201 1TB8-5 B01 — 1TB8-6 B02 | WIRED SPARE | |
| OUT202 1TB8-8 B04 — 1TB8-9 B05 | WIRED SPARE | |
| OUT203 1TB8-11 B07 — 1TB8-12 B08 | WIRED SPARE | |
| OUT204 1TB9-1 B09 — 1TB9-2 B10 | WIRED SPARE | |
| OUT205 1TB9-4 B12 — 1TB9-5 B13 | WIRED SPARE | |
| OUT206 1TB9-7 B15 — 1TB9-8 B16 | WIRED SPARE | |