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AUTHORITY

SPECIFICATION NO. E-025

PAGE 1 OF 20

OCTOBER 4, 2024

PREPARED BY THE
ENGINEERING DEPARTMENT

REV. 3

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Post Office Box 2977
Hagåtña, Guam 96932

TRANSMISSION & DISTRIBUTION SPECIFICATION

Specification No. E-025

For

CONTROL AND RELAY PANEL

EFFECTIVE DATE: 10-4-24

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GUAM POWER
AUTHORITY

SPECIFICATION NO. E-025

PAGE 2 OF 20

OCTOBER 4, 2024

PREPARED BY THE
ENGINEERING DEPARTMENT

REV. 3

CONTROL AND RELAY PANEL TABLE OF CONTENTS

SECTION	PAGE
1.0 SCOPE	3
2.0 CONFORMANCE TO SPECIFICATION REQUIREMENTS	3
3.0 PRODUCTS, ASSEMBLIES, AND SYSTEMS	4
4.0 SUBMITTAL	5
5.0 QUALIFICATIONS	7
6.0 QUALITY ASSURANCE	7
7.0 RATINGS	8
8.0 MANUFACTURE, FABRICATION AND ASSEMBLY	15
9.0 CONSTRUCTION	18
10.0 PACKAGING AND SHIPPING REQUIREMENTS	20

EFFECTIVE DATE: 10-4-24

ISSUED: 

APPROVED: 



GUAM POWER
AUTHORITY

SPECIFICATION NO. E-025

PAGE 3 OF 20

OCTOBER 4, 2024

PREPARED BY THE
ENGINEERING DEPARTMENT

REV. 3

1.0 SCOPE

- 1.1 This specification describes the requirements for designing, manufacturing, factory-testing and delivery of an indoor type, protection, control and relay panel. The protection, control and relay panel shall be furnished complete with all IED's, multiplexers, automation controllers, communication processors, satellite clocks, and miscellaneous control and indication devices to operate as a complete electrical protection control and monitoring system. The Supplier shall furnish a complete design with schematics, wiring diagrams, and interconnection diagrams.
- 1.2 The control and relay panel will provide power system protection, breaker control, alarm annunciation, local status monitoring, power monitoring, event and SER reporting, fault recording, pre-fault/post-fault analysis and local/remote configuration and settings access. The control and relay panel will connect to the GPA SCADA system for remote control, monitoring and configuration. The protection system, monitoring system and communications network are generally described in this specification and further detailed in the Contract drawings.
- 1.3 The panel and equipment 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 parts and surfaces subject to corrosion shall either be made of such material or shall be provided with such protective finish, as to protect against excessive humidity.
- 1.4 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
- 1.5 Any special design or installation considerations to assure compliance with this requirement shall be thoroughly documented on the Supplier drawings.

2.0 CONFORMANCE TO SPECIFICATION REQUIREMENTS

- 2.1 The control and relay panel shall be designed, manufactured and tested in accordance with the latest editions of the applicable, National Electrical Code (NEC), National Electrical Safety Code (NESC), ANSI, IEEE and NEMA standards.
- 2.2 Completed assemblies shall be UL inspected. The UL inspection approval label shall be installed on the panel prior to shipping.
- 2.3 The Supplier shall provide all drawings, documents and approvals necessary to support compliance of their equipment to the latest OSHA Health and Safety standards.
- 2.4 Deviation and Nonconformance Requirements

EFFECTIVE DATE: 10-4-24

ISSUED:

APPROVED:



GUAM POWER
AUTHORITY

SPECIFICATION NO. E-025

PAGE 4 OF 20

OCTOBER 4, 2024

PREPARED BY THE
ENGINEERING DEPARTMENT

REV. 3

- 2.4.1 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.
- 2.4.2 Units received with deviations or non-conformances which are not acknowledged as specified in subparagraph 2.4.1 are subject to rejection. The Supplier of units rejected in this paragraph 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.
- 2.4.3 Notification of defective units 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. Within four (4) weeks after award of contract, Shop Drawings must be submitted to the Engineering Department for GPA's approval prior to fabrication. Any changes during fabrication must be approved by GPA. Final drawings must be submitted prior to delivery.
- 2.4.4 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.

2.5 Warranty

- 2.5.1 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 PRODUCTS, ASSEMBLIES, AND SYSTEMS

3.1 General

- 3.1.1 The technical requirements shall be in accordance with the specification, attached data sheets and drawings.

3.2 Operations and Control Functionality

- 3.2.1 The substation controls shall be designed for remote operation and monitoring by a SCADA system to be furnished by GPA. Transducers and auxiliary relays for the SCADA system shall be furnished and installed for the required control, indicating functions, communication, and signal processing equipment. The Supplier shall coordinate the requirements and ratings of the transducers, auxiliary relays, other

EFFECTIVE DATE: 10-4-24

ISSUED:

APPROVED:



GUAM POWER
AUTHORITY

SPECIFICATION NO. E-025

PAGE 5 OF 20

OCTOBER 4, 2024

PREPARED BY THE
ENGINEERING DEPARTMENT

REV. 3

control devices and interconnections with the manufacturers of the control, communication and SCADA equipment.

3.2.2 Data from each IED shall be available to the GPA using standard DNP3 or IEC 61850 object types via GPA's Ethernet network. Each IED with digital outputs shall have control command capability that can be selectively enabled / disabled for each device.

3.2.3 Multiple security levels shall be provided for accessing the system. Password and User ID logins shall be used to monitor user activity and restrict system control and configuration access. A System Administrator level shall be provided for assigning User IDs, passwords and system access levels.

3.2.4 The Supplier shall provide the latest updates of all software tools during and up to the end of the warranty period.

3.2.5 The following functions as a minimum shall be included:

3.2.5.1 Alarms:

- a. Transformer alarms (low oil level, high oil temperature, high winding temperature).
- b. 115kV or 34.5kV breaker trip and breaker low gas pressure or oil level.
- c. High or Low battery voltage, dc grounded low ac voltage to battery charger, and battery charger failure.
- d. Loss of station service.
- e. Communication failure.

3.2.5.2 Status:

- a. Positions of 115kV or 34.5kV circuit breakers.
- b. Positions of supervisory control cutout switches.
- c. Transformer automatic-manual and LTC position.

3.2.5.3 Analog Measurements:

- a. 115kV or 34.5kV line currents amps per phase
- b. 115kV or 34.5kV line watts and VARs 3-phase
- c. 115kV or 34.5kV line voltages per phase

3.2.5.4 Controls:

- a. 115kV or 34.5kV line circuit breakers trip and close.
- b. 115kV or 34.5kV bus tie circuit breaker trip and close.
- c. Transformer 115kV or 34.5kV circuit breakers trip and close.
- d. Transformer automatic-manual, and LTC raise-lower.

4.0 SUBMITTAL

4.1 Product Data and Shop Drawings

EFFECTIVE DATE: 10-4-24

ISSUED: 

APPROVED: 



GUAM POWER
AUTHORITY

SPECIFICATION NO. E-025

PAGE 6 OF 20

OCTOBER 4, 2024

PREPARED BY THE
ENGINEERING DEPARTMENT

REV. 3

4.1.1 Within 30 days of the Notice to Proceed, the Supplier shall submit to the GPA a complete set of catalog cuts and manufacturer's information brochures, where applicable, for the equipment and devices to be installed in the control and relay boards. The catalog cuts shall include but shall not be limited to: control relays, time delay relays, SCADA interposing relays, control switches, pushbuttons, indicating lights, indicating meters, protective relays and related auxiliary devices, multiplexers, controllers, terminal blocks, terminating devices, mounting racks, power supplies, cables and connectors, transducers, annunciator and alarm horn.

4.1.2 Within 60 days from the Notice to Proceed, the Supplier shall submit to the GPA physical arrangement drawings showing front, back, side, and internal views showing the location of devices, terminal strips, and wiring channels; detailed schematic diagrams; wiring diagrams, and interconnection diagrams; and nameplate engraving. GPA will provide samples for three-line diagrams and DC schematics and preferred format for interconnection diagrams as a guide.

4.1.3 All data submitted shall be identified with the Customer's project number and project name, purchase order number, equipment tag number, and equipment description. Supplier catalog type drawings showing incomplete information for the Customer's project are not acceptable.

4.2 Factory Test

4.2.1 Not less than 30 days prior to factory tests, a factory test plan shall be submitted to the GPA for review and approval. The factory test plan shall include test procedures, data sheets and test setup diagrams as applicable. 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.

4.2.2 The factory test equipment and test methods used shall conform to the applicable requirements of ANSI, IEEE, NETA, and NEMA standards.

4.2.3 Not more than 2 weeks after the factory tests and prior to shipping of the equipment, the certified factory test reports shall be submitted in two (2) hardcopies and one (1) electronic soft-file in pdf format.

4.3 Installation, Operations and Maintenance manuals with a section on troubleshooting shall be submitted 30 days prior to shipment.

4.4 Number of Copies

4.4.1 Submit one (1) electronic soft-file in pdf format and two (2) hardcopies of each shop drawing, pre-printed manufacturers' data, brochures and Suppliers' information for GPA review and approval.

4.4.2 After approval and manufacturing of equipment, submit one (1) electronic soft-file in pdf format and two (2) full size hardcopies of each shop drawing which has been

EFFECTIVE DATE:

10-4-24

ISSUED:

APPROVED:



GUAM POWER
AUTHORITY

SPECIFICATION NO. E-025

PAGE 7 OF 20

OCTOBER 4, 2024

PREPARED BY THE
ENGINEERING DEPARTMENT

REV. 3

specifically prepared for the Work. Indicate on the drawings that the drawings reflect the as-built condition of the equipment. Electronic soft-file copies shall be on a USB Flash Drive/Storage Device.

4.4.3 Submit two (2) hardcopies and two (2) electronic copies of Installation, Operations and Maintenance manuals with a section on trouble shooting. Electronic soft-file copies shall be in Portable Document Format (PDF) files on USB Flash Drive/Storage Devices.

4.4.4 Submit one (1) soft-file copy of the shop drawings in AUTOCAD 2013 format on USB Flash Drive/Storage Devices.

5.0 QUALIFICATIONS

5.1 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.

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

6.0 QUALITY ASSURANCE

6.1 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.

6.1.1 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.

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

6.2 Factory Tests

6.2.1 Component Tests

The components used in the manufacture of the equipment shall be subjected to the following tests:

- a. Standard production tests
- b. Relay calibration
- c. Meter calibration and accuracy tests

6.2.2 Assembled Equipment Test

EFFECTIVE DATE: 10-4-24

ISSUED: 

APPROVED: 



GUAM POWER
AUTHORITY

SPECIFICATION NO. E-025

PAGE 8 OF 20

OCTOBER 4, 2024

PREPARED BY THE
ENGINEERING DEPARTMENT

REV. 3

The control and relay board shall be completely assembled at the manufacturing plant with components installed and tested for the functional and sequence tests. If the control and relay board is to be shipped in sections, the electrical connections across the shipping splits shall be made up for the tests. Following assembly, the control equipment shall be subjected to the following functional and sequence tests at the manufacturer's facility in accordance with the requirements of ANSI C37.20 or NEMA, as applicable:

- a. Dielectric tests
- b. Polarity and phase checks
- c. Sequence tests
- d. Functional tests of the control devices and protective relays
- e. Verification of operation of annunciator circuits
- f. Check of the wiring for continuity and absence of shorts and grounds
- g. Mechanical operation tests
- h. Test relay settings with relays mounted in their own cases
- i. Calibrate indicating devices, and recording meters

6.3 Test Reports

Test reports shall be prepared showing the date tested, description of tests and test equipment, test results and signature of tester. Equipment shall not be shipped without Engineer's approval of the test report.

- 6.4 Factory tests will be witnessed by 2 GPA representatives. Supplier shall cover the cost of airfare, rooms, meals and car rental for the GPA representatives witnessing the FAT testing.

7.0 RATINGS

7.1 Wire

- 7.1.1 Panel wire shall be 600 Volt NEC Type SIS 90°C, flame-retardant thermoset, moisture resistant Panel type, flexible stranded Class K, tinned-copper conductors with gray color insulation. Minimum wire sizes shall be No. 12 AWG for voltage and control circuits, No. 10 AWG for current transformer circuits, and No. 16 AWG for annunciator and temperature indicator circuits. Flexible strand wire shall be Class K: No. 10 AWG 105-strand, No. 12 AWG 65-strand, No. 14 AWG 41-strand, and No. 16 AWG 26-strand.

- 7.1.2 Wire terminals for No. 10 AWG conductor and smaller shall be pressure grip (solderless) ring-tongue lugs of indented barrel type with nylon insulation, Burndy Corporation Insulug type. Terminals for No. 8 AWG conductor and larger shall be pressure grip (solderless) lugs of the indented barrel type, Burndy Hylug.

7.2 Wire Ties and Tag

EFFECTIVE DATE: 10-4-24

ISSUED: 

APPROVED: 



GUAM POWER
AUTHORITY

PREPARED BY THE
ENGINEERING DEPARTMENT

SPECIFICATION NO. E-025

PAGE 9 OF 20

OCTOBER 4, 2024

REV. 3

Wire ties and tags shall be nylon, self-locking, require no twisting and shall not damage the cable insulation. Cable tags shall be metal or plastic type, easily attachable to wires or cables with identification designations stamped or otherwise permanently marked thereon. Cable ties and tags shall be Panduit Corporation PAN-TY locking cable ties and marker ties.

7.3 Wire Duct

Wire duct shall be PVC with removable covers and shall hold the vertical and horizontal bundles of wire and shall not damage the wire insulation when entering or leaving the wire duct. Wire duct shall be Panduit Panduct type plastic wiring duct.

7.4 Terminal Blocks

Terminal blocks for 125-Volt dc and 120/240-Volt ac power circuits shall be rated 600 Volts and not less than 20 Amperes, and shall be molded block type, front connected with insulating barriers and marking strips. Terminal blocks shall be Marathon straight-strap, front-connected type. Terminal blocks for control and instrumentation circuits shall be rated 300 Volts and not less than 20 Amperes. Terminal blocks shall be modular, molded nylon type with insulating barriers and either binding head screw type or box type lugs capable of receiving 2 conductors in each lug. Terminal blocks shall be complete with mounting channels, marking strips, and end plates. Terminal blocks shall be Marathon Cat. No. 16XX STD series or approved equivalent. Terminal blocks for current transformer circuits shall be 4-pole, shorting type and shall be Marathon 1604 SC.

7.5 Nameplates

Nameplates shall be furnished and installed for the control and relay boards and control and indicating devices. Nameplates shall be engraved on laminated phenolic material, with white letters on a black background. Nameplates for draw-out relays shall be affixed above the relay cover. Nameplate data shall be submitted for the GPA's approval.

7.6 Control and Indicating Devices

7.6.1 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 mimic bus colors shall be Yellow for 13.8 kV, Red for 34.5 kV and Cyan for 115 kV voltage levels.

7.6.2 Control, Selector and Transfer Switches

Control selector and transfer switches shall be the rotary type, designed for mounting on a No. 11 gage metal panel, with the contact mechanism behind the panel. Contacts shall be enclosed and shall be readily renewable, self-cleaning, wiping action type. Covers shall permit easy access to contacts. Each switch shall be insulated for 600 Volts, shall meet the requirements for dielectric tests in ANSI C37.20, and shall have a continuous rating of at least 10 Amperes. Each switch shall have an interrupting capacity on an inductive circuit of at least 2 Amperes at 125 Volts dc and 20 Amperes

EFFECTIVE DATE: 10.4-24

ISSUED:

APPROVED:



GUAM POWER
AUTHORITY

SPECIFICATION NO. E-025

PAGE 10 OF 20

OCTOBER 4, 2024

PREPARED BY THE
ENGINEERING DEPARTMENT

REV. 3

at 120 Volts ac. Each control and selector switch shall have a minimum of 4 spare contacts with 2 normally open and 2 normally closed. Circuit breaker control switches and other switches where specified shall be furnished with mechanical indicating devices to show the last operation of the switch and with slip contacts where required for interlocking. A rectangular, front of panel escutcheon plate shall be furnished and engraved showing the switch positions of control and transfer switches. The switch identification shall be engraved on a separate adjacent nameplate. Circuit breaker switches shall have heavy pistol grip handles. Control switches shall be GE Type SB-1, Westinghouse Type W-2, or Electroschwitch Series 24.

7.7 Indicating Lamps

Schweitzer SEL-2652 Trip Coil Monitors with an external red LED shall be mounted on the panel, suitable for operation on 125 VDC or 120 VAC, as required for the specific circuit (SEL Part Number 2652A1XX-Red).

7.8 Instruments and Meters

7.8.1 General

Each meter and instrument shall be semi-flush mounted, back-connected, dustproof, Panel mounted on a No. 11 United States Standard gage metal panel.

7.8.2 Indicating Instruments

Indicating instruments shall be digital LED or LCD type displays with numerals at least 1/2 inch high. The input signal for each instrument shall be 0-1 mA or 4-20 mA from transducers selected to interface with the GPA-furnished SCADA system. Transducers shall be connected with hardwired circuits. The digital indicators shall be Newport Electronics Inc. Model Q2000P, solid state switchboard type presenting a 10 ohm load.

7.9 Test Switches and Devices

Current and potential test switches and test plugs shall be provided with the test switches semi-flush mounted on the control and relay Panel. Test switches shall be connected in 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 test, under service conditions or by means of a phantom load. The switches and plugs shall permit "in-service" testing as well as calibration and check 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 FT-1.

7.10 Transducers

EFFECTIVE DATE: 10.4.24

ISSUED: 

APPROVED: 



GUAM POWER
AUTHORITY

SPECIFICATION NO. E-025

PAGE 11 OF 20

OCTOBER 4, 2024

PREPARED BY THE
ENGINEERING DEPARTMENT

REV. 3

- 7.10.1 Transducers shall accept inputs of 115 Volts nominal 60 Hz ac and/or 0-5 Amperes 60 Hz ac.
- 7.10.2 Terminals shall be screw type barrier terminal blocks.
- 7.10.3 Transducers shall meet the requirements of ANSI Surge Withstand Capability.
- 7.10.4 Transducers shall have a minimum dielectric strength of 1,500 Volts rms between input, output and case.
- 7.10.5 Transducers shall have a maximum ripple of 1% peak-to-peak of the dc output.
- 7.10.6 Transducers shall be able to respond to within 99% of a step change input within 400 milliseconds.
- 7.10.7 Output shall be 0.1 mA into a variable load of 0 -10,000 Ohms.
- 7.10.8 Transducers shall operate satisfactorily between -20°C and +60°C and zero to 90%, relative humidity, non-condensing.

7.11 Protective Relays General

- 7.11.1 All protective relays shall be micro-processor based IED's with configurable logic and settings and include communication ports that will fully support integration with the GPA SCADA system for local/remote communications access for remote control and monitoring.
- 7.11.2 All IED's and other 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%.
- 7.11.3 All IED's shall support interfacing to conventional current transformers and potential transformers.
- 7.11.4 Each IED shall have ABB test switches (FT-1, 10 pole) for current and voltage transformer inputs. The blocking switch color standard shall follow: RED for current inputs and BLACK for voltage inputs.
- 7.11.5 Power supply for the controls shall be 125 VDC derived from the 125 Volt station batteries system by GPA.
- 7.11.6 Communication protocols shall be DNP3 and TCP/IP, fully compliant with IEC 61850.
- 7.11.7 Data from the IED's shall be time-tagged to 1msec minimum. The time-tag shall remain with the data value for sequence of events reporting and alarming.
- 7.11.8 All protective relays (IED's) shall be suitable for 125 VDC supply, control and trip circuits.
- 7.11.9 Each IED shall be provided with an integral LCD display and LED trip target indications on the front panel.

EFFECTIVE DATE: 10-4-24

ISSUED:

APPROVED:



GUAM POWER
AUTHORITY

SPECIFICATION NO. E-025

PAGE 12 OF 20

OCTOBER 4, 2024

PREPARED BY THE
ENGINEERING DEPARTMENT

REV. 3

- 7.11.10 All IED's installed in protection panels shall be suitable for 19" rack mounting.
 - 7.11.11 Where available, all IED's shall include one additional expanded I/O module based on 12 standard outputs and 8 inputs.
 - 7.11.12 Each IED shall be provided with a dedicated diagnostic alarm contact for alarming purposes. Alarm contacts will be connected to a separate Remote I/O alarm management processor provided by GPA.
 - 7.11.13 Each IED shall be provided with a front RS-232 communication port for connection to a laptop as well as a rear communication port for connection to a communication processor.
 - 7.11.14 Configuration and downloading of settings and extraction of oscillography events and SER data from the IED's shall be possible using the appropriate SEL software tool. Access to the IED's shall be possible by connecting a laptop to a serial port on the appropriate communication processor or the IED front communication port or via the GPA's remote system.
 - 7.11.15 Each IED shall have the capability to display metering data, including line current, voltage, PF, kW, kVAR & kWh measurements, as a minimum.
 - 7.11.16 All IED's shall have on-board storage of sequence of event reports as well as oscillography event reports including pre-fault and post-fault data. Timestamps shall be accurate to 1 msec or better and the total number of cycles as well as the number of pre-fault cycles for each event shall be adjustable. Unsolicited SER binary reporting may not be available for remote collection from all relays, such as SEL-321 and SEL-587Z. SER event data from these relays will not be available for viewing by the SERViewer software on the GPA's operator stations. The SER data for these relays can be extracted directly from the relay using a lap-top computer with SEL software on an as-needed basis.
 - 7.11.17 A satellite clock receiver with built-in digital clock display, IRIG-B distribution ports, antenna, surge protector and 75 ft. (min.) of antenna cable shall be supplied to synchronize all of the IED's to the same time accuracy. The IRIG-B time signal shall be distributed to the communication processors for internal distribution to the IED's.
 - 7.11.18 Protective relays shall be the type and model indicated on contract drawings. The Supplier may suggest to the GPA models other than those shown but any changes must be approved by the GPA before implementation.
- 7.12 Power Transformer Relays
- 7.12.1 Transformer Differential Relays – Device 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

EFFECTIVE DATE: 10-4-24

ISSUED:

APPROVED:



GUAM POWER
AUTHORITY

PREPARED BY THE
ENGINEERING DEPARTMENT

SPECIFICATION NO. E-025

PAGE 13 OF 20

OCTOBER 4, 2024

REV. 3

vertical chassis, front panel LCD display, 125 VDC/VAC power supply, 60Hz, 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.

- 7.12.2 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 amp input, neutral AC current 5 amp input, and conformal coating. Provide relay part number for review and approval.

7.12.3 Transmission Line Relays

- a. Transmission Line Differential, Line Distance, Residual Time Overcurrent and Directional 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 outputs, wire harness (part no. WA0411LBC2A as required), 300 V secondary voltage inputs, 5 amp current inputs, 1300 nm IEEE C37.94 Fiber communications for Channel 1 and Channel 2, EIA-232 ports, 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 for 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 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.**

EFFECTIVE DATE: 10-4-24

ISSUED:

APPROVED:



GUAM POWER
AUTHORITY

SPECIFICATION NO. E-025

PAGE 14 OF 20

OCTOBER 4, 2024

PREPARED BY THE
ENGINEERING DEPARTMENT

REV. 3

7.13 Bus Differential Relays – Device 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 devices. 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.

7.14 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 circuit breaker to operate. Where solid state relays with built in breaker failure capabilities are used, the breaker failure will be programmed in the relay. Breaker failure will be programmed in SEL-411L, SEL-311L, SEL-787 etc.

7.15 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 **Electroswitch Series 24**. **Spare contacts of 25%** shall be provided for all lockout relays.

7.16 Real Time Automation Controller

The SEL-RTAC must be able to connect and gather data from the different relays and meters, and send the data by DNP protocol to the Substation RTU. The controller must be capable to monitor, log and restrict user access and provide a level of cybersecurity.

7.17 Generator Protection

The primary relay must have differential, voltage restrained overcurrent, volts/hertz, stator ground, under/overfrequency, reverse power, loss of excitation and negative sequence capabilities. Examples of the primary relay are the SEL-700G1 (Primary and Backup Part Number 0700G11ACA1A76850630).

7.18 GPS Clock

To synchronize relays and other devices, a GPS satellite clock shall be provided. The GPS 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.

7.19 Wide-Area-Networking Multiplexer

The SEL-ICON must be able to communicate between transmission line protection relays to enable current differential protection and direct transfer trip schemes. The ICON must also provide channel latency monitoring and reporting functions.

EFFECTIVE DATE: 10-4-24

ISSUED:

APPROVED:



GUAM POWER
AUTHORITY

SPECIFICATION NO. E-025

PAGE 15 OF 20

OCTOBER 4, 2024

PREPARED BY THE
ENGINEERING DEPARTMENT

REV. 3

8.0 MANUFACTURE, FABRICATION, AND ASSEMBLY

8.1 Description

The control and relay panel furnished shall be self-supporting type, constructed of steel not less than No. 11 U.S. Standard Gage in thickness with hinged front and back panels. Relays and equipment mounted on the panel exterior surfaces shall be flush or semi-flush mounted. Necessary bracing and supporting brackets for equipment shall be furnished. Panels shall be securely fastened together and to a common base channel. Overall size shall not exceed the dimensions shown on the Contract Drawing. Panel edges and trim edges shall be formed by breaking edges back 90° and shall have uniform radii. Holes, fastenings, welds and cut edges shall not be visible from panel front faces. Wiring gutters, terminal blocks, auxiliary relays and miscellaneous apparatus shall be mounted inside the panel on brackets, turned-back panel sides, or inside surfaces. Base shall be drilled for anchor bolts to secure the enclosure to the concrete floor. The equipment enclosures shall be ventilated for cooling, with screened louvered openings in end panels or back panels.

8.2 Fabrication

8.2.1 Hinged Panels

Hinged panels shall be furnished for rear access to interior equipment. Hinges shall be fully concealed piano or loose pin type. Panels shall be furnished with neoprene gaskets. Three-point concealed latches shall be furnished on panels. Each door handle shall be furnished with a keyed cylinder lock. The panel door locks shall be keyed alike.

8.2.2 Control Equipment Arrangement

The arrangement of controls and indicating devices on the boards shall be grouped as shown on the Drawings. The controls and indicating devices shall be at a convenient height for operation and maintenance. Protective relays, auxiliary relays, interposing relays, control relays, and accessory equipment shall be located in such a way to permit ready access for service and maintenance. All SCADA interposing relays shall be grouped and mounted together in one location. All control relays shall be grouped and mounted together in one location.

8.2.3 Wiring

Wiring shall be firmly secured and terminated in approved terminal blocks. Cabinet wiring should be neatly formed and brought out to the back of the relays. Wiring between devices, terminal blocks, etc., shall be facilitated through the use of plastic wire duct. Wiring in ground circuits shall have green insulation. All wiring that crosses a hinge shall be secured at both sides of the hinge. Each conductor shall be provided with a permanent wire marking system identifying the "from-to" designation at each end of the wire. The number of terminations per terminal block shall not exceed two. Wire terminations shall be the insulated, ring-tongue terminal type with solid barrel or brazed seam. All terminations shall be the correct size for the wire being terminated and made with ratchet type crimping tools; it is mandatory that the crimping tool is used in

EFFECTIVE DATE: 10-4-24

ISSUED:

APPROVED:



GUAM POWER
AUTHORITY

SPECIFICATION NO. E-025

PAGE 16 OF 20

OCTOBER 4, 2024

PREPARED BY THE
ENGINEERING DEPARTMENT

REV. 3

accordance with the instructions for its proper use. Each wire shall be continuous between terminations; there shall be no splices in wires.

8.2.4 Ground Bus

Each control and relay board shall be furnished with at least two (2) ground studs or connectors at the ends suitable for connecting a copper ground bus with No. 2 copper ground cables. The control and relay board shall have a continuous solid copper ground bus running through both sections.

8.2.5 Bases and Mounting

The control and relay boards shall be furnished with a 3-inch high mounting base channel, unless otherwise shown. A kick space (toe space) approximately 2 inches deep shall be furnished between the faces of the panels and the mounting channel on the exposed sides. The mounting channel shall be treated and painted the same color as the panel. The base channel shall be designed for leveling and drilled for installing concrete anchors for securing the equipment to the concrete floor.

8.2.6 Shop Painting

The control and relay board enclosure shall be cleaned of weld spatter, slag, mill scale, burrs, oil, grease and other surface irregularities. Following cleaning, the exterior and interior surfaces shall be primed and filled and finish painted with 2 coats using the Supplier's standard application procedures with ANSI No. 70 Gray. The cabinet interior shall be painted with 2 coats of white enamel.

8.3 Assembly

8.3.1 General

The control and relay boards shall be completely assembled, wired and tested at the location of manufacture and assembly.

8.3.2 Wiring

Electrical equipment mounted in the control and relay board shall be completely wired from terminal-to-terminal without intermediate splices. Wiring shall be supported in place or installed in wire ducts. No wiring within or external to wiring ducts shall be attached to the covers. The wiring within the ducts shall be completely accessible for operation and maintenance and removal and replacement, and shall not occupy more than 50% of the cross-sectional area of the ducts. Exposed wiring shall be kept to a minimum and where used shall be formed into compact groups, laced or bound together with cable ties and firmly supported. Exposed wiring shall be neatly run straight, horizontally, or vertically with short radius bends. Hinged wiring shall be looped around the longitudinal axis of the hinge, to preclude lateral bending when the panel or door is swung open and shut. Each wire shall be protected from abrasion where it leaves a channel or duct. Wiring connections shall be made at device studs or terminal blocks without tension on the termination. Shielded wire shall have the shield carried all the way to the terminal board. The shield shall be terminated at a terminal screw on the

EFFECTIVE DATE: 10.4.24

ISSUED: 

APPROVED: 



GUAM POWER
AUTHORITY

SPECIFICATION NO. E-025

PAGE 17 OF 20

OCTOBER 4, 2024

PREPARED BY THE
ENGINEERING DEPARTMENT

REV. 3

terminal board. There shall be no more than two wires terminated on any terminal point. Wiring for No. 8 AWG or smaller conductors shall be terminated at terminal blocks. Conductors larger than No. 8 AWG shall be connected directly to terminal studs. The circuits for external connections shall be terminated on terminal blocks.

All spare relay and control switch contacts shall be wired to and terminated on terminal blocks.

8.3.3 Conductor Identification

Control and power conductors for external circuits shall be marked near the terminal connections with a legible, permanently coded wire-marking sleeve or tag. Wire shall be marked with the designations as assigned by the equipment manufacturer. Control and power conductors used for internal wiring shall be marked at each end with a legible permanently coded wire-marking sleeve or tag.

8.3.4 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.

8.3.5 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.

8.3.6 Device and Component Identification

The devices including controls, indicating devices, circuit breakers, fuses and other electrical components shall be marked or labeled for identification of function or use. Exterior devices shall be marked with nameplates. Interior devices shall be marked with nameplates, or stamping with permanent ink on or adjacent to the devices.

8.3.7 Surge Suppressors

Each coil of the auxiliary and timing relays, contactors and motor starters of the electromechanical type shall be shunted with varistors across the coil terminals as required to limit inductive surges produced. When this is not practical, the varistors shall be connected across terminals nearest to the coil. In the event the above varistor suppression should adversely affect the relay dropout time, special suppression measures shall be furnished to limit the peak voltage to a safe voltage and to provide an acceptable dropout time that coordinates with the Supplier's entire design.

EFFECTIVE DATE:

10-4-24

ISSUED:

APPROVED:



GUAM POWER
AUTHORITY

SPECIFICATION NO. E-025

PAGE 18 OF 20

OCTOBER 4, 2024

PREPARED BY THE
ENGINEERING DEPARTMENT

REV. 3

8.3.8 Interior Lighting and Receptacle

Interior lighting shall be furnished and installed in the control and relay board. Lighting fixtures shall be installed in each compartment. Lighting switches shall be installed inside the board convenient to the access doors. Two duplex power receptacles shall be installed in the control and relay board, one near each end. The interior lighting and power receptacle circuits shall be arranged and separately wired for connection to 120-Volt, single-phase circuits. Circuit breaker protection shall be furnished for its internal lighting and power receptacle circuits.

8.3.9 Environmental Protection for Electrical Components

Equipment shall be treated to resist environmental contamination, including fungus and moisture as follows:

- a. Printed Circuit Boards shall 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%.
- b. Electrical components such as switches, fuses, contacts, and heater elements shall not be treated. Other materials and components which are inherently fungus resistant, are protected by hermetic sealing or are furnished with electrical heaters need not be treated.
- c. Circuit elements not covered above and which have a temperature rise not more than 75°F when operating at full load shall be coated with fungus resistant varnish. Circuit elements include but are not limited to cable, wires, thermal and junction blocks, junction boxes, capacitors, and coils.

9.0 CONSTRUCTION

9.1 Installation

The equipment will be installed in locations by others.

9.2 Spare Parts

9.2.1 Spare parts, as specified herein shall be furnished with the control equipment. The spare parts shall be identical and interchangeable with the original parts and shall be of the same materials and workmanship and meet the same requirements. The spare modules, functional cards, relays and operational devices requiring calibration or adjustment, shall be calibrated and adjusted for proper operation in the equipment, at the manufacturer's plant before shipment. The spare parts shall be furnished in moisture-proof containers or wrapping suitable for extended storage and shall have complete identification marking on the exterior of the packages. A complete inventory list by part number, name and usage of the spare parts supplied, together with a price list of said spare parts in effect on the date of delivery shall be furnished.

9.2.2 The following spare parts, to match those furnished as part of the control equipment, shall be furnished with the equipment.

EFFECTIVE DATE: 10-4-24

ISSUED: 

APPROVED: 



GUAM POWER
AUTHORITY

SPECIFICATION NO. E-025

PAGE 19 OF 20

OCTOBER 4, 2024

PREPARED BY THE
ENGINEERING DEPARTMENT

REV. 3

- a. One spare relay for each 5 or less of each type of control and auxiliary used.
- b. Six (6) spare fuses of each rating used.
- c. One dc coil for each five or less mechanically latched in auxiliary relays.
- d. One blank nameplate for each 10 or less of each size used.
- e. If special mounting hardware is used for mounting terminal blocks and auxiliary relays, sufficient hardware to mount the spare equipment shall be furnished.

9.3 Maintenance and Testing Equipment, Tools and Accessories

The following equipment shall be furnished with the spare parts specified herein before for maintenance and testing of the panel equipment.

9.3.1 Fuse Puller

Two fuse pullers for each type used.

9.3.2 Test Switch Accessories

One Test Switch Test Kit – includes but not limited to the following:

- One red safety patch cord wire retractable sleeve banana plug on both ends
- One black safety patch cord wire retractable sleeve banana plug on both ends
- One red UTP cable with RJ-45 male connector on both ends
- One red safety plug-on test probe
- One black safety plug-on test probe
- One red safety plug-on alligator test clip
- One black safety plug-on alligator test clip
- Separate Source Test Plug
- In Service Test Plug
- Individual current circuit test plug with open CT protection and leads with retractable jacks.

9.3.3 Special Tools and Accessories

Special tools and accessories required for normal operation and maintenance of the control equipment shall be furnished including special tools required to rewire auxiliary and control relays and control equipment.

9.3.4 Touchup Paint

One gallon of touch up paint shall be furnished in 1-quart cans.

EFFECTIVE DATE:

10.4.24

ISSUED:

APPROVED:



GUAM POWER
AUTHORITY

SPECIFICATION NO. E-025

PAGE 20 OF 20

OCTOBER 4, 2024

PREPARED BY THE
ENGINEERING DEPARTMENT

REV. 3

10.0 PACKAGING AND SHIPPING REQUIREMENTS

- 10.1 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.
- 10.2 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.
- 10.3 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.
- 10.4 Each control and relay panel shall be furnished completely assembled and shall be shipped to the GPA in not less than 2 shipping sections.
- 10.5 Delicate instruments or relays shall be removed from the cabinet and packed separately for protection from damage during shipment.

EFFECTIVE DATE: 10-4-24

ISSUED:

APPROVED: