GUAM POWER AUTHORITY
P.O. BOX 2977
HAGATNA, GUAM 96910

TRANSMISSION & DISTRIBUTION SPECIFICATION

Specification No. E-047

FOR

SUBSTATION METAL-ENCLOSED CAPACITOR BANK

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1.0 SCOPE

1.1. This specification covers GPA requirements for a medium voltage, three phase, metal-enclosed substation capacitor bank. The bank shall be automatically switched on kVAR to reduce reactive power demand on the Island Wide Power System. All controls, switching devices, and protection features are to be enclosed in an all-welded compartmentalized steel enclosure. The capacitor bank shall come fully assembled and ready for interconnection.

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

1.2.1. Maximum ambient temperature : 45°C
1.2.2. Relative humidity : 10 to 99 % (condensing)
1.2.3. Seismic Level (Horizontal acceleration) : International Building Code Zone 4
1.2.4. Corrosive sea air atmosphere
1.2.5. Sustained wind strengths of 175 MPH: International Building Code 2009

1.3. 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 SPECIFICATIONS

2.1. The capacitor bank shall meet the requirements of the following standards, including the latest revisions with respect to material, design and tests.

2.1.1. UNDERWRITERS LABORATOIES (UL)

UL-347	High Voltage Industrial Control Equipment
UL-508	Industrial Control Panels
UL-50	Standard for enclosures for Electrical equipment

2.1.2. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

Article 460	National Electric Code
Article 710	National Electric Code (Applicable Portions)

2.1.3. AMERICAN NATIONAL STANDARDS INSTITUTE, INC. (ANSI)

C37.20.2	Guide for enclosure Categories and Related Requirements.

2.1.4. INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS

std. 1036	Guide for Application of Shunt Power Capacitors
std. 18	Standards for Shunt Power Capacitors

2.1.5. NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

CP-1 Standard for Shunt Capacitors

2.2. Deviations And Non-Conformance Requirements

2.2.1. Deviations from this specification or changes in materials or design after the Purchase Order has been placed must be approved by the GPA Engineering Department and Acknowledged by a Purchase Order Amendment

2.2.2. Units received with deviations or non-conformances which are not acknowledged as specified in Sub-Paragraph 2.2.1 are subject to rejection. The supplier is responsible for any corrective action including but not limited to materials, labor and transportation necessary to dispose of, or make the units conform to the specification.

2.2.3. Notification of defects discovered before or after installation that are believed to be inherent to manufacturing problems or workmanship shall be made and forwarded to the Supplier. The description of the item, documentation of the problem and the described information, disposition and/or follow-up (as appropriate) that GPA expects from the Supplier will be specified. The Suppliers response shall be made within thirty (30) days unless an extension is acknowledged and approved in writing by the GPA Manager of Engineering.

2.2.4. GPA shall be allowed two (2) weeks to review and approve drawings without affecting the shipping date. Delays in delivery due to drawings which are not approved during this review period are the responsibility of the Supplier.

2.3. Warranty – the Supplier shall warrant the capacitor bank to be free from defects in material and workmanship under normal use and service conditions. The term of the Warranty shall be the lesser of twelve (12) months from the date of the initial installation or eighteen (18) months from date of manufacture.

2.4. Statement of Compliance – the Supplier shall provide a signed statement verifying that the products being supplied fully comply with the specifications and drawings. Items not in full compliance with the specification and drawings will be identified with a description of the deficiency and any proposed substitution. Items not in full compliance with the specifications and drawings must be approved by the GPA Engineering Department, as described in Section 2.2.1.

3.0 SUBMITTALS

3.1. The bidder shall provide with their bid the following data:

3.1.1. Installation Instructions

3.1.2. Single line and three-line diagrams

3.1.3. Pad and cable entry drawings

3.1.4. Concrete pad design specification and drawings. The concrete pad shall be designed to conform to the same tropical conditions as described in Section 1.2 for the capacitor bank.

3.1.5. Drawing showing component layout

3.1.6. Wiring Diagrams

3.1.7. Material Listing

3.1.8. Data Sheets for all internal components

3.1.9. Time coordination plots between capacitor fuses, main disconnect fuse, case rupture curves and upstream overcurrent protective devices. Damage curve for the capacitor supply cables shall be coordinated with upstream overcurrent devices.

3.1.10. Manufacture's approval documents for exceptions to the manufacturer's requirements.

3.1.11. Proposed method of shipment of equipment to the project site.

3.2. Instructions for installation shall be submitted within 90 days after Notice to Proceed.

3.3. Operations and maintenance manuals shall be submitted 30 days prior to shipment.

3.3.1. Pre-printed manufacturer's technical literature, data, brochures and suppliers' information for review and approval. Copies of the technical literature made by xerography or similar process will not be accepted.

3.3.2. Include manufacturer's maintenance and operation instructions and parts list.

3.3.3. Cover the exact equipment provided. "Marked-up" general catalog data will not be accepted.

3.3.4. Incorporate in each manual a complete set of Final, Approved, "As-built" Shop drawings and Certified Factory Test results.

3.3.5. Size 8 ½ inches by 11 inches or accordion-folded to this size.

3.3.6. Arrange information into hard-rock, three-ring binders with sections with labeled divider tab sheets to identify each section.

3.3.6.1. Table of Contents

3.3.6.2. Instruction for start-up, operation, inspection, maintenance, troubleshooting, parts list, recommended spare parts, and data sheets showing model numbers

3.3.6.3. Applicable drawings

3.3.6.4. Safety Data Sheets

3.3.6.5. Warranties and guarantees

3.3.6.6. Name and address of nearest manufacturer-authorized service facilities.

3.3.6.7. Imprint on the binder front cover:

a. Operations and Maintenance Manual
b. Equipment's Name
c. Manufacturer's Name
d. Project Name
e. Specification Number
f. Date

3.3.6.8. Imprint on the binder spines:

a. Equipment Name
b. Manufacturer's Name
c. Project Name
d. Specification Number
e. Date

3.4. Number of Copies

3.4.1. Submit six (6) copies of completely bound Operations and Maintenance Manuals covering separately all equipment for each bid item.

3.4.2. After approval and manufacturing of equipment, submit one (1) reproducible transparency and five (5) full-size prints of each shop drawing which has been specifically prepared for the work. Indicate on the drawings that the drawings reflect the as-built condition of the equipment. Shop drawings shall identify field dimensions, show relation to adjacent or critical features of Work. Sheet size shall be a minimum of 8½ inches by 11 inches and a maximum of 22 inches by 34 inches.

3.4.3. Submit two (2) electronic copies of Operations and Maintenance Manuals in Portable Document Format (PDF) files on a thumb drive

3.4.4. Submit one (1) copy of the shop drawings in AUTOCAD 2013 format on a thumb drive.

4.0 QUALIFICATIONS

4.1. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of ten (10) years.

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

4.2.1. Installation Instructions

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 manufacturer'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 Insurance 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.

6.0 PRODUCTS

6.1. Approved Manufacturer

6.1.1. Northeast Power Systems, Inc.
6.1.2. Substitution subject to Engineer's approval

6.2. Enclosure

6.2.1. The manufacturer of the enclosure shall also be the assembler of the capacitor bank. This is to ensure the highest degree of control with respect to critical enclosure manufacturing process such as cleaning and surface reparation, welding, priming and painting. GPA shall require verification of

enclosure manufacture by the Supplier (on-site visit, photo's, raw material invoices), at the Supplier's expense.

6.2.2. The capacitor bank enclosure shall be constructed for use in tropical marine weather conditions with sustained wind strengths of 175 MPH and International Building Code Zone-4 seismic level.

6.2.3. The capacitor bank shall consist of a single compartmentalized enclosure with NEMA 4X construction that will house all components, including fuses, capacitors, switches, and associated controls. All components shall be accessible and removable from the front of the enclosure. Bolted panel construction, transclosure style, and switchgear cubicle style enclosures will not be allowed and will be rejected.

6.2.4. The enclosure shall be fabricated from 12-gauge cold rolled Type 304 stainless steel. All seams shall be welded and ground smooth to present an attractive appearance. The roof shall be cross-kinked or gabled to allow for watershed.

6.2.5. The doors shall be flush and removable in the open position. They shall be equipped with stainless steel hinges and hinge pins, and 3-point latching handles. The handles shall be pad lockable. All doors shall be constructed to prevent water entrance into the enclosure during inclement weather.

6.2.6. The base of the enclosure shall be equipped with C4x5.4 structural steel channel (hot dipped galvanized after fabrication). Removable steel lifting plates consisting of ½" steel shall be located at each corner. Formed channel based will not be accepted.

6.2.7. All ventilation louvers shall be located on the front of the enclosure and shall be backed with stainless steel mesh.

6.2.8. All fasteners and associated hardware, inside and out, shall be stainless steel. Externally accessible hardware shall not be used for the support of high-voltage components or switch-operating mechanisms within the capacitor bank.

6.2.9. Thermostatically Controlled Strip Heaters shall be supplied in all compartments. When determined by the manufacturer, a thermostatically controlled fan or ventilator shall be supplied.

6.2.10. Each door of the enclosure shall be equipped with self-adhesive vinyl 14"x10" warning signs. The incoming compartment sign shall state "Do Not Enter – Authorized Personnel Only" all other doors shall state "Do Not Enter – High Voltage". The protective screen surrounding the air disconnect switch shall also have a sign that states "Danger – High Voltage". The back panel of

the control compartment shall be equipped with a sign that states "Electrical Hazard".

6.2.11. The enclosure shall have a continuous ¼" x 1" silver-plated copper ground bus that spans the full width of the enclosure.

6.2.12. The enclosure, compartments, steel barriers, structural supports, base, and all appurtenances shall be prepared and painted with a high-solid epoxy coating as specified below. The paint shall be ANSI Gray 61 – Munsell Number 8.3G 6.10/0.54 or ANSI Gray 70 – Munsell Number 5BG 7.0/0.4.

6.2.12.1. Surface Preparation:
All steel surfaces shall be prepared per The Society for Protective Coatings (SSPC) SP-2,3,6,7,10,11 or the paint manufacturer's recommendations. Exceptions to the paint manufacturer's requirements shall be approved by the paint manufacturer and documentation provided with the submittal documents.

6.2.12.2. Inaccessible Surfaces:
Prepare and coat steel surfaces inaccessible to preparation and coating after fabrication with all coats before fabrications. Inaccessible surfaces shall be considered Zone 2A per SSPC specifications.

6.2.12.3. Surfaces in contact with a minimum of two (2) inches above the mounting surface shall be designed or treated to be resistant to corrosion and abrasion when unit is skidded and slid into place on the mounting stand

6.2.12.4. Primer Specification:
All surfaces, inside and out, shall be primed with a High-Solid Epoxy (primer coat shall have a 2 to 4 mil dry film thickness) paint. The primer shall have following minimum performance and properties.

- Salt Spray (ASTM B117) 3000 Hours with no face blistering
- Humidity (ASTM D2247) 750 Hours with no face corrosion or blistering.
- Immersion (NACE TM-01-69) fresh water 1 year with no blistering.
- Abrasion resistance (ASTM D4060) 1kg load/1000 cycles, CS-17 wheel: 102 mg weight loss.
- Impact resistance (ASTM D2794): Direct 24 in.lb and Reverse 6 in.lb.
- Moisture vapor transmission (ASTM F1249): 4.49 g/m^2.
- Adhesion (ASTM D4541): 900 psi.

- NFPA Class A Qualification.

6.2.12.5. Top Coating Specification:
All surfaces, inside and out, shall be top coated with a High-Solid Epoxy paint with a dry film thickness of 2 to 4 mils. This will provide a total dry film thickness of 4 mils minimum and 8 mils minimum. The minimum acceptable measure total dry film thickness shall not be less than 4 mils. The paint utilized on the top-coat shall have the following properties:

- Salt Spray (ASTM B117) 5500 Hours with no face blistering.
- Humidity (ASTM D2247) 5500 Hours with no face corrosion or blistering.
- Gloss retention (ASTM G53) QUV-B bulb: Greater than 50% gloss retention at 26 weeks.
- Elongation (ASTM D5222) 14%
- Abrasion resistance (ASTM D4060) 1kg load/ 1000 cycles, CS-17 wheel: 53 mg weight loss.
- Impact Resistance (ASTM D2794): Direct 24 in.lb and Reverse 6 in.lb.
- Adhesion, elcometer (ASTM D4541): 2700 psi
- NFPA Class A Qualification
- Paint shall also provide excellent chemical resistance to splash, spillage, fumes and weather for acidic, alkaline, salt solutions (acidic, neutral, and alkaline salt solutions), fresh water, solvents and petroleum product environments.

Upon request, the manufacturer shall provide documents (surface preparation procedures as well as paint manufacturer's paint specifications) showing the above requirements are met. Failure to comply with this request will be cause for cancellation of order.

6.2.13. Doors providing access to interrupter switches shall be provided with a wide-view window constructed of an impact-UV-resistant material, to facilitate checking of switch position without opening the door.

6.2.14. The main incoming fuse compartment shall be equipped with a wide-view window constructed of an impact-UV-resistant material, to facilitate checking of the main fuses without opening the door or de-energizing the bank.

6.2.15. The capacitor compartment shall be equipped with a wide-view window constructed of an impact-UV-resistant material, to facilitate checking of capacitors and capacitor fuses without opening the door or de-energizing the bank.

6.3. Load Interrupter – Air Disconnect Switch

6.3.1. The capacitor bank shall be supplied with a direct drive operated load interrupting switch that accomplishes capacitive current interruption utilizing the dual arc extinguishing system based on the auto-pneumatic air-blast and hard gas nozzle principle. The switch shall be rated at 135% of the banks nominal current rating and shall have a 40-kA RMS momentary asymmetrical rating. This switch shall be interlocked with the vacuum switches to prevent it from being opened while the capacitor stages are energized. The switch shall be pad-lockable in either the open or closed position.

6.3.2. The Air Disconnect Switch shall be located in a separate compartment that is isolated from the capacitor compartment and the low voltage control compartment by a steel barrier. In addition to the exterior enclosure door, a protective hinged screen or door (behind the exterior door) shall be provided before access to the switch.

6.3.3. The switch manufacturer shall be approved by GPA Engineering Department.

6.4. Ground Switch

6.4.1. An external operated ground switch shall be provided to ground the load-side terminals of the air disconnect switch. The ground switch shall be pad-lockable in either the open or closed position. The ground switch must be tested in accordance with ANSI/ IEEE standards. Test reports shall be furnished upon request.

6.4.2. The ground switch shall be interlocked with the Air Disconnect Switch to prevent closing of the ground switch when the air disconnect switch is in the closed position.

6.4.3. The switch manufacturer shall be approved by GPA Engineering Department.

6.5. Main Incoming Fuses

6.5.1. The bank shall be equipped with main incoming current limiting fuses. The fuses shall be located on the load side of the main air-disconnect switch. They shall be accessible only when tank is de-energized by the main incoming air disconnect switch and shall be completely isolated with a steel barrier from the capacitor compartment and the and the incoming air-disconnect switch compartment. Fuse rating shall be recommended by the Supplier and approved by GPA Engineering Department.

6.6. Surge Arresters

6.6.1. The capacitor bank shall be equipped with Heavy Duty Distribution Class Surge/ Lightning Arrester.

6.6.2. The capacitor bank supplier shall recommend the rating of the surge arresters; the rating of the surge arresters requires the approval by GPA Engineering Department.

6.7. Transient Inrush Reactors

6.7.1. Each capacitor bank stage shall be equipped with transient inrush reactors. The reactors shall be completely impregnated with an epoxy resin that will reduce noise, promote heat dissipation, and provide protection in harsh environments. The reactors shall limit the di/dt of the capacitor inrush current to $3.6x10^7$ amps/second. Calculations shall be provided to confirm the manufacturer claims.

6.7.2. The inrush reactors shall be rated for at least 135% of the stage current. When expansion capability is necessary, the rating shall be sufficient for 135% of the maximum capacity of the stage.

6.7.3. The transient inrush reactor shall be the TI-Reactor™ as manufactured by Northeast Power System, Inc. or an engineer approved equal.

6.8. Vacuum Switches

6.8.1. The capacitor bank stages shall be controlled by either single-phase motor/solenoid operated vacuum switches or three-phase vacuum contactors that have been tested for capacitor switching. Capacitor switches (when utilized) shall be tested in accordance with ANSI Standard C37.66.

6.8.2. The vacuum switches/ contactors shall be controlled by an on/ off/ auto switch. In the auto position, the switches shall accept control from the digital power factor controller. In the on/ off position, the vacuum switches will be force on or off, regardless of the controller output signal.

6.8.3. The control system shall prevent the vacuum switches from operating more than once in a 5-minute period.

6.8.4. The vacuum switches shall be interlocked with the bank's air disconnect switch and ground switch.

6.8.5. The switch manufacturer shall be approved by GPA Engineering Department.

6.9. Capacitors

6.9.1. The automatic capacitor bank shall be equipped with all-film, low loss, double bushing capacitors. The capacitors shall be designed, manufactured, and tested to meet and/ or exceed all applicable NEMA and ANSI/IEEE standards. Capacitors must be manufactured in North America and shall be manufactured by Cooper, GE, or ABB or equal approved by GPA Engineering Department.

6.9.2. Each capacitor shall contain an internal discharge resistor to reduce the stored voltage to 50 volts or less within 5 minutes from disconnection.

6.9.3. The capacitors shall be connected in grounded wye and shall be protected from sustained over voltages due to capacitor unit failure by a blown fuse detection system.

6.9.4. The capacitors shall be located in a compartment that is separate from the main incoming fuses and the air disconnect switch.

6.9.5. Capacitors shall be mounted horizontally and shall be mounted on C4x5.4 structural steel channel (hot dipped galvanized after fabrication). The capacitors shall be removable from the front of the enclosure.

6.9.6. The dielectric fluid shall be environmentally friendly, biodegradable, and non PCB.

6.9.7. The capacitor case shall be stainless steel and resistant to severe corrosive atmospheric conditions. Case finish shall be prepared and painted as outlined for exterior surfaces as described in Section 6.2.12 of this specification.

6.9.8. The capacitor shall have a voltage rating of 7,960 Volts with a minimum BIL of 95kV, unless otherwise agreed to or specified by GPA.

6.10. Capacitors Protection

6.10.1. Each capacitor shall be protected by an external full range current limiting fuse. The minimum fuse size shall be 135% of the capacitor's rated current (i.e. $I_{fuse} \geq 1.35 \times kVAR_{unit}/ 7{,}960$ V). Fuses shall be a tab-tab design and shall be visible and accessible from the front of the enclosure. Fuse rating shall be recommended by the Supplier and approved by GPA.

6.10.2. A neutral unbalance voltage detection system shall be provided on each stage to indicate a blown fuse and to protect the capacitors from sustained over-voltages due to capacitor unit failure and/or system ground faults. The neutral sensor shall be a precision resistive voltage divider, calibrated to better than 1% accuracy. It shall be molded from POLYSIL, a high dielectric strength anti-tracking material. The relay shall have two (2) set points. The

first set point shall alarm for a blown capacitor fuse that will not cause damage to the remaining capacitors. The second set point shall trip the bank off-line for voltages that will cause capacitor damage. The relay shall be equipped with a digital display that indicates the neutral voltage at all times. This relay shall be factory pre-set.

6.10.3. The capacitor bank shall be equipped with a three-phase over-current relay; the recommended relay is SEL-487V Capacitor Protection and Control System. The relay shall protect the main bus of the capacitor bank from faults. The relay shall be wired to trip the upstream breaker.

6.10.4. External indication of a blown fuse shall be provided by an external mounted Roof Top NEMA 4X Strobe Light. The Strobe Light shall flash at a rate of 80 per minute and shall have a peak candlepower of 175,000.

6.11. Phase, Neutral and Ground Bus

6.11.1. All phase, neutral and ground buses shall be silver-plated for maximum conductivity and corrosion resistance. The neutral bus shall be insulated for full line voltage. The copper shall be CA110 rounded edge, hard temper per ASTM B187. Bolted copper-to-copper connections shall be made with 3/8' – 13 stainless-steel bolts with two stainless steel flat washers, one under the bolt head and one under the nut and with a stainless steel split lock-washer between the flat washer and the nut. The bus shall not have a current density greater than 1200 amps/in^2. Where expansion capability is required, the bus shall be rated for the maximum capacity of the bank.

6.11.2. The ground bus shall be located near the front base of the enclosure to allow for placement of field installed ground clamps. The bus shall run the full width of the enclosure and shall be pre-punched for connection of equipment ground conductor(s) and cable shield wires. The ground bus shall connect to stainless steel ground pads located on the ends of the enclosure to allow for external connection to the substation ground grid.

6.11.3. The bus supports, bus, and interconnections shall withstand the stress associated with the available short-circuit at the capacitor bank.

6.12. Key Interlock System

6.12.1. The capacitor bank shall equipped with keyed interlock system to prevent unauthorized and out of sequence entry into the capacitor bank.

6.12.2. The interlock scheme shall include the upstream protective device (where necessary), the capacitor banks air disconnect switch, ground switch, and the doors of the enclosure. The interlock scheme shall function as follows:

6.12.2.1. Turn all capacitor stages off manually with the on/off/auto switches.

6.12.2.2. Upon a waiting period of 5 minutes (beyond the time that all stages have been turn off), key "A1" shall be released. (Note: this key shall be held captive until all stages have been de-energized for 5 minutes.)

6.12.2.3. Use the "A1" key to unlock the air disconnect switch. Open the Air-Disconnect Switch and close the mechanically Interlocked Ground Switch.

6.12.2.4. Remove the "A2" key from the Ground Switch (Removing of the "A2" key shall lock ground switch in closed position) and proceed to the Air-Disconnect Switch External Compartment Door. Unlock the Air-Disconnect Switch Compartment Door and remove the "A3" key from the lock. (Note: Access to Air-Disconnect Switch Terminals is prevented by the interior compartment door. This door can be interlocked with upstream breaker or load interrupter if desired. This would prevent access to terminal switch unless upstream device was locked out.)

6.12.2.5. Use the "A3" key to open the first door that has access to the capacitor compartment. (Upon turning of the "A3" key, the vacuum shall close to ground all components on the load-side of the vacuum switches.) Remove the "A4" key from the first capacitor bank compartment door and proceed to the second capacitor bank compartment door.

6.12.2.6. Open the second capacitor bank compartment door, and proceed with the released key (if one is present) to the next door.

6.12.2.7. The above procedure is repeated until all doors are open.

6.12.3. The keyed interlocks on the door shall be mounted behind the enclosure doors with the key-holes protruding through the doors. The locks shall be equipped with stainless steel spring covers. The keyed interlock system shall allow all doors to be opened at one time. Master Key interchanges or externally mounted key interlocks shall not be provided.

6.12.4. The door key interlocks shall not require adjustments in the field. If adjustments are required, the Supplier will be required to make such adjustments in the field at their expense.

6.13. Controls

6.13.1. All low voltage controls (where practical) shall be isolated from the high voltage compartments. All controls shall be accessible while the bank is

energized. The control compartment shall form an integral part of the enclosure (no external mounted control compartments shall be allowed). The control compartment shall allow for bottom or top entry of customer control wires without having to enter the medium voltage compartment. The controls compartment shall be equipped with a swing out panel to allow access to panel mounted controls.

6.13.2. All control wires that connect to components inside high voltage compartment shall be enclosed in flexible aluminum conduit covered with a waterproof plastic coating that are formed as part of the capacitor bank.

6.13.3. The automatic capacitor bank shall be equipped with a power factor controller that will automatically switch equal or unequal capacitor bank stages in or out to regulate GPA facilities reactive power to a preset value. The controller shall monitor individual stages for loss in kVAR, and shall continue to regulate to a preset value in the event there is a defective stage. In addition, the controller shall consist of the following:

6.13.3.1. Zero Voltage capacitor switching to switch the capacitors on or off at zero (0) voltage.

6.13.3.2. Digital setting of individual parameters including target power factor, kVAR, switching time, step limit, etc.

6.13.3.3. Digital indication of preset power-factor, kVAR, preset parameters, and specified installation data.

6.13.3.4. Automatic Self-Adjustment to any capacitor step valve.

6.13.3.5. Facility to connect a mini-printer.

6.13.3.6. Plug-in terminal connection

6.13.3.7. Automatic elimination of defective capacitor steps and their indication (e.g. blown capacitor fuses, welded contacts, etc.)

6.13.3.8. Visual display of Harmonic Overload Alarm

6.13.4. The bank shall be provided with a maintenance interval timer that can be set to alert plant personnel of the SCADA system of a maintenance requirement.

6.13.5. A counter that counts the number of times each stage has been energized shall be provided. The counters shall be equipped with set points that allow an indicator to be lit when the set point value is reached.

6.13.6. The complete control circuit shall be protected by a main circuit breaker.

6.13.7. Each stage shall be equipped with MANUAL/OFF/AUTO switches, stage on indicator (red) and stage off indicator (green). An Interposing on-delay relay shall be provided to prevent the energization of a capacitor bank in less than 5 minutes. The manufacturer of the bank shall confirm that when going from the "Manual" position to the "Auto" position on any stage, that the corresponding stage will not be energized in less than 5-minutes. These switches shall only be functional when the bank is not controlled by the SCADA system or when the bank is in the automatic control mode. When in the "ON' position, the stage associated with the MANUAL/OFF/AUTO switch is forced off. When in the "OFF" position, the bank is controlled by the Power Factor controller.

6.13.8. The bank shall be equipped with a control power transformer that has both primary and secondary overcurrent protection. The control power transformer shall be connected between phases B and C.

6.13.8.1. The bank shall have a provision for an alternate source of control power in the event that the control power transformer has no power source.

6.13.9. The Capacitor Bank Compartment, Control Compartment, and Air-Disconnect Switch Compartment shall be equipped with lights that can be controlled by an on/off switch located in the control compartment.

6.13.10. A 15-amp GFI Convenience outlet shall be provided to protect the control circuit.

6.13.11. The Medium Voltage Capacitor Bank Control System shall be listed under UL 508A for industrial Control Panels.

6.13.12. UL Rated CC 600 Volt current limiting fuses shall be provided to protect the control circuit.

6.13.13. All Current Transformer circuits shall be wired with a minimum of #10 AWG copper wire. Knife switch style shorting blocks shall be used in all Current Transformer circuits to allow for safe removal and maintenance of control components.

6.13.14. The Capacitor Bank shall be equipped with a single-phase over-voltage relay. This relay shall protect the capacitors as well as the system from over-voltages that may be present during light loads or cause by a blown capacitor fuse. The relays shall have two individual set points that can alarm as well as trip the bank off-line.

6.13.15. The Capacitor Bank shall be equipped with SCADA system housed in the automatic control compartment, isolated from the medium voltage compartments and shall form an integral part of the capacitor bank.

6.13.16. The SCADA system shall communicate with a GE Harris remote terminal unit (RTU) or an SEL RTAC, and be equipped with an H&L Instruments' communication device, and all necessary voltage compartments and shall form an integral part of the capacitor bank.

6.13.16.1. Over-ride capability of the automatic controls of the bank to provide voltage or VAR- support:

a. Once in over-ride command, automatic mode is disabled and complete capacitor bank control is based upon commands received from the SCADA system.

b. Automatic control can be re-initiated by SCADA with a "Return to Automatic Control" signal.

6.13.16.2. Remote monitoring of status (SOE) of capacitors, switches and fuse failures;

6.13.16.3. Remote monitoring of status (SOE) of all protection, control and indicator devices within the bank.

6.13.16.4. Remote monitoring of all power system analogs and parameters associated with the capacitor bank's three-phase panel meter.

6.13.17. The Capacitor Bank shall provide a Supervisor Control "Local/ Remote" switch located on the control panel. While in "Local" control all SCADA system controls shall be disabled and the bank can only be operated from the control panel. However, the SCADA system shall continue to monitor the status of the capacitor bank and associated power system parameters. While in "Remote" control the SCADA system can control the capacitor bank, but will remain in the automatic control mode until an over-ride command is sent.

6.13.18. Communication with the Capacitor Banks shall be over single-mode fiber optic cable or ethernet. The capacitor bank shall include an H&L 570 series fiber optic transceiver or equivalent to support communications with the SCADA system over DNP 3.0 via ethernet or serial.

6.13.19. A three-phase meter shall be provided. This meter shall receive its voltage and current signals from three Current Transformers and two Potential Transformer located inside the Capacitor Bank. The meter shall have four (4) digital inputs that can be wired for relay control based on any of the measured values below. The meter shall be pre-programmed at the factory and shall have the following features:

6.13.19.1. Voltage – each phase and average

6.13.19.2. Current – each phase and average

6.13.19.3. Apparent Power – each phase and total

6.13.19.4. Power Factor - each phase and total

6.13.19.5. Voltage and current unbalance

6.13.19.6. Frequency

6.13.19.7. Imported, exported, absolute and net kWh and KVARh

6.13.19.8. Accumulated kVAh

6.13.19.9. Sliding Window, predicted, and Thermal Demand on kW, kVAR, kVA and I average

6.13.19.10. Minimums and Maximums stored for voltage, current, kW, kVAR, kVA, power factor, frequency, and sliding window demand for kW and kVA

6.13.19.11. Individual and total harmonic distortion on voltage and current inputs up to the 15th harmonic

6.14. Spare Parts

6.14.1. The following spare parts shall be provided:

6.14.1.1. Twelve (12) each capacitors fuses

6.14.1.2. Ten (10) each indicating lamps

6.14.1.3. One (1) gallon of top-coat paint

6.14.1.4. Three (3) each capacitor bank cells

7.0 RATINGS

7.1. This specification is for a medium voltage automatic capacitor bank connected in an ungrounded-wye configuration.

7.1.1. Steps: Three (3)

- Step 1 – 1,500 kVAR
- Step 2 – 1,500 kVAR
- Step 3 – 3,000 kVAR

7.1.2. Total: 6,000 kVAR

7.2. The ratings of the bank and all associated switchgear, switching devices, capacitors, fuses, and all other applicable components shall have ratings for application on the following system:

7.2.1.	Nominal System Voltage	: 13.8 kV
7.2.2.	Nominal System Frequency	: 60 hertz
7.2.3.	Maximum System Voltage	: 15 kV
7.2.4.	System BIL	: 95 kV
7.2.5.	Three-phase Short Circuit rating at capacitor bank	: 19 kA RMS Symmetrical
7.2.6.	Line-to-ground Short Circuit rating at capacitor bank	: 19 kA RMS Symmetrical
7.2.7.	Ambient Temperature	: 85°F
7.2.8.	System Connection	: 3 Phase, 3 Wire Wye
7.2.9.	Relaying Source Voltage	: 125 V DC

8.0 Construction

8.1. The capacitor bank shall be fully assembled and ready for interconnection.

8.2. The incoming compartment shall be isolated from the main fuse, capacitor and control compartments. It will contain the air disconnect switch, ground switch, surge arresters and the underground cable termination. The medium voltage termination shall be designed to accept an underground power cable with NEMA standard two-hole compression lugs.

8.3. The main incoming fuses shall be housed in a separate compartment isolated from the incoming, capacitor and control compartments.

8.4. The capacitor compartments shall be isolated from the incoming, main fuse and control compartments. It will contain the capacitors, capacitor fuses, transient inrush reactors and vacuum switches. The capacitors shall be connected in an undergrounded-wye configuration with the neutral insulated for full line voltage, because it could be momentarily at phase potential when the bank is switched or when a capacitor unit fails.

9.0 Factory Inspection and Tests

9.1. All routine tests shall be formed in accordance with IEEE Std. 18, NEMA CP1 and these specifications.

9.2. GPA may at its discretion request any additional testing to verify that the equipment complies with these specifications.

9.3. Test procedures shall be submitted thirty (30) days prior to the scheduled start of testing. Test procedures shall be the means by which factory tests are executed to demonstrate that the system and its components fully comply with the requirements specified herein. At a minimum the test procedures shall contain:

9.3.1. A statement of purpose so that the goals and methods of testing can be understood.

9.3.2. Specifications and drawing of equipment and assemblies.

9.3.3. All graphs, tables, and charts necessary for the execution of the test.

9.3.4. Design, performance, and quality requirements detailed in these specification.

9.4. GPA shall be present to witness Factory Acceptance Tests for the equipment.

9.4.1. The supplier shall be responsible for all costs involved for Factory Acceptance Tests for two (2) GPA representatives including food, lodging, travel and transportation. Travel time shall be included in these costs.

9.5. The Capacitor Bank and its components shall be inspected throughout the assembly process and upon the completed assembly of the Capacitor Bank. Inspections shall include, but are not limited to, confirming correct electrical clearances, proper connection torques/ crimps, correct types and sizes of capacitors, fuses, reactors, wire and cable have been installed,

9.6. The enclosure inspection shall include proper door alignment and sealing, proper application of paint and coatings, proper operation of fan(s) heaters, lights and interlocks, the unit is clean and clear of foreign object,

9.7. The control panel shall be fully tested for proper operation.

9.8. Electrical tests on the capacitor bank shall include ground continuity, AC power-frequency withstand, and impulse withstand.

9.9. Capacitor tests shall include leak test, low voltage capacitance test, dielectric test and discharge resistor measurement.

10.0 Field Installation

10.1. The Supplier shall install the capacitor bank according to the Manufacturer's installation instructions, manuals, and connection diagrams.

10.2. GPA will notify the Supplier regarding the schedule for the capacitor bank installation.

10.3. The supplier shall provide a Site Acceptance Test procedure for GPA's review.

10.4. The Supplier shall provide a certified field service engineer for a minimum of three (3) days to perform all manufacture's recommendations and tests on installed equipment before it is energized and to confirm proper installation and operation. The field service engineer shall work closely with GPA personnel regarding the installation checkout and testing. Minimal testing shall be:

10.4.1. Inspect the entire unit for physical damage, proper mounting, and required clearances.

10.4.2. Compare nameplate information with the drawings and specifications.

10.4.3. Verify that the capacitors are electrically connected in the proper configuration.

10.4.4. Inspect all bus and cable connections for proper torque.

10.4.5. Verify proper operation of the ground switch, air-disconnect switch, and safety interlocks.

10.4.6. Verify functional operation of equipment before closing the air-disconnect switch. Minimal tests shall include:

1. Confirm bank is properly grounded.
2. Confirm vacuum switches energize in the manual mode.
3. Confirm vacuum switches operate from the automatic power factor controller.
4. Confirm vacuum switches trip off-line for all protective relay functions.
5. Confirm beacon light turns on when the bank is tripped off-line.
6. Confirm enclosure lights, strip heaters, and fan(s) function properly.
7. Confirm power factor controller has adequate current for sensing power factor.

8. Confirm power quality meter is reading correctly.

9. Confirm SCADA analogs, digitals, and controls function properly.

10.4.7. After the capacitor bank is energized, readings shall be taken after the energization of each stage for voltage, voltage distortion, and current to ensure the proper operation of the bank and to confirm that no adverse system interaction is occurring (i.e. high voltage or current distortion).

10.5. The Supplier shall provide a certified field service engineer for a minimum of two (2) days to provide training in the operation and maintenance of the installed equipment.

11.0 Packaging and Shipping Requirements.

11.1. Following the award and contract, confirm details and route of shipment to the project site.

11.2. Arrange, pay for, and assume responsibility for shipping and handling of the equipment between the factory and the point of delivery, including off-loading of the equipment at the point of delivery.

11.3. Prepare and load items of equipment in such a manner as to provide protection from damage in transit including sea transport.

11.3.1. Assume full responsibility for any and all damage until the equipment is assembled at the project site.

11.3.2. Use moisture-proof packaging, packing, or wrapping on all shipments to preclude moisture damage in transit and during storage at the project site before installation.

11.3.3. Where necessary, mount heavy parts on skids or crates, and box or wire parts that might otherwise be lost in bundles.

11.3.4. Mark parts for clear identification including project name, manufacturer, model number, serial number, item number, GPA purchase order number and supplier's identifying number.

11.3.5. Load material so that it will not shift or become damaged during transport.

11.3.6. Prepare parts exceeding 200 pounds in gross weight for shipment so that slings for handling by crane may be readily attached. Where it is unsafe to attach slings to the box, pack with slings attached to the part, projecting through the box or crate so that attachment to the hoisting equipment can be readily made.

11.4. At the earliest practical date, but not less than 15 days in advance of the scheduled shipping dates, notify GPA as to equipment to be shipped, method of transport, carriers and routing, approximate shipping and delivery dates, and approximate shipping weight. If Supplier fails to provide the above information at least 15 days in advance of the shipping date, the Supplier shall reimburse GPA for any direct or indirect expenses incurred by GPA that would not otherwise have been incurred. The amount of such expenditures may be deducted by GPA from payments due or become due to the Supplier.

11.5. When shipment is actually made, transmit to GPA shipping notices on each shipment, including a description of the equipment shipped and the shipping weight.

11.6. Accompany each shipment with a packing list of articles included in the shipment.

11.7. Additional packing and shipping requirements are provided in applicable sections of Procurement Documents.

11.8. Receiving Inspection: Upon receiving equipment, GPA or its representative will inspect the equivalent for visible signs of damage which, if any, will immediately be reported to the Supplier. If damage is found and if requested by GPA, the Supplier shall further inspect the equipment to determine the nature and extent of damage, and recommend corrective measures to restore equipment to factory condition.