1.1 SCOPE

A. This specification is for a medium voltage three phase metal-enclosed automatic capacitor bank consisting of ________ steps of ________ kvar at ________ kv. The bank shall be automatically switched based on power factor. All controls, switching devices, and protection features are enclosed in an all-welded compartmentalized steel enclosure. The bank shall come fully assembled and ready for interconnection. All exceptions to this specification shall be clearly stated with your bid. If no exceptions are taken, the bid should include the phrase "no exceptions have been taken".

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

- Nominal System Voltage, (Kv)
- Maximum System Voltage, (Kv)
- System BIL, (Kv)
- Three Phase Short Circuit Rating at Capacitor Bank (RMS Symmetrical Amps)
- Line-Ground Short Circuit Rating at Capacitor Bank (RMS Symmetrical Amps)

1.2 SCHEDULE

A. Shop drawings to be submitted within 2 weeks of contract award.

B. Equipment to be delivered in (month) of (year).

1. This schedule is based upon the vendor receiving an order by (month), of (year).

1.3 REFERENCES

A. The metal enclosed automatic capacitor bank shall conform to or exceed the applicable requirements of the following standards and codes:

1. UL-347, High Voltage Industrial Control Equipment
2. UL-508, Industrial Control Panels, Issue Number : 2, October 1993
3. UL-50, Standard for enclosures for Electrical Equipment
4. Applicable portions of Article 710 in the National Electrical Code
5. Article 460 of the National Electrical Code
6. ANSI C57.12.28-1988 – Pad Mounted Equipment Enclosure Integrity (Delete this line if the capacitor bank is going to be placed in a substation, switchgear room, or vault)
7. ANSI C37.20.2 – Guide for Enclosure Categories and Related Requirements (Delete this line if the capacitor bank is going to be placed in an area accessible to the public)
9. NESC Standards
10. IEC Publication 871-1 (1987) or latest revision
12. NEMA standards publication CP-1 - 1988 (Shunt Capacitor) or latest revision

1.4 SUBMITTALS

A. Submit under provisions of Section 01300

B. Upon issue of a purchase order, the supplier shall provide 3 copies of approval drawings. The submittals shall include, but not be limited by the following:

1. Installation Instructions
2. Single-Line and three-line diagrams
3. Pad and cable entry drawings
4. Drawings showing component layout
5. Data sheets for all internal components
6. Material listing
7. Time coordination plots between capacitor fuses, main disconnect fuses, case rupture curves, and upstream overcurrent protective devices. Damage curve for the capacitor supply cables shall be coordinated with upstream overcurrent protective device.
8. Upon approval of above, a digital copy on CD ROM shall be provided.

C. As-Built Drawings: If layout or locations of devices are changed during construction or installation, a clean copy of “as-built” drawings shall be provided at job completion.

1.5 SUPPLIER QUALITY SYSTEM

A. Supplier must have a documented quality system established with a focus on prevention versus detection.

B. Quality system shall be designed and administered according to a recognized quality system standard, such as the ISO 9000 series or equivalent.

C. Supplier must provide a quality manual which describes the company policy with respect to elements of the ISO 9001 Quality System Standard or equivalent. Quality Manual shall describe policy with regard to:

1. Management Responsibility
2. Quality System Requirements
3. Design Control
4. Document and Data Control
5. Purchasing
6. Product Identification and Tractability
7. Process Control
8. Inspection and Test
9. Control of Inspection, Measuring and Test Equipment
10. Inspection and Test Status
11. Control of Non-Conforming Product
12. Corrective and Preventive Action
13. Handling, Storage, Packaging, Preservation, and Delivery
14. Control of Quality Records
15. Internal Audits
16. Training
17. Servicing
18. Statistical Techniques

D. Supplier must provide a written quality policy with the bid.

E. All policies shall be supported by lower level documentation and quality records. Quality records shall be available upon request of the customer and shall provide evidence that the quality system is in control.

F. The supplier quality system must meet all applicable industry standards, such as UL, NEMA, NEC, ANSI/IEEE, etc.

G. Supplier shall have on staff, experienced, licensed professional engineers (PE’s) with degrees in Power Engineering (preferably with advanced degrees) as evidence of technical proficiency.

H. Supplier must provide a medium voltage metal enclosed customer list with contact information for the purpose of reference checks.

I. Supplier must allow factory audits to occur at mutually agreed upon dates between the customer and supplier.

1.6 BID REQUIREMENTS

A. Supplier must state all exceptions in the Bid. If no exceptions are taken, the supplier must state that there are no exceptions

B. Supplier must have optional extended warranty and field service agreements available. These policies shall be provided with the bid.

C. Supplier must provide their written quality policy with the Bid.

D. Quotes are to be FOB factory, freight allowed
1.7 DELIVERY, STORAGE, AND HANDLING

A. Equipment shall be shipped on a flat-bed truck. A crane or fork-lift of suitable size shall be capable of off-loading the equipment.

B. Supplier shall provide instructions and recommendations on storage and handling of equipment.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. General Electric, 381 Broadway, Fort Edward New York 12828

B. Substitutions: Not permitted.

2.2 EQUIPMENT COMPLETENESS

A. All equipment shall be functionally complete.

B. All equipment shall be completely engineered, fabricated, pre-wired and ready for installation into an operating condition. Field assembly shall not be required.

2.3 MATERIALS

A. Enclosure:

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 processes such as cleaning and surface preparation, welding, priming, and painting. Verification of enclosure manufacturing by supplier (on-site visit, photos, raw material invoices) may be required. No exceptions allowed.

2. The capacitor bank shall consist of a single compartmentalized enclosure with NEMA 3R 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.

3. The enclosure shall be fabricated from 11-gauge A60 cold rolled galvanneal 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.

4. 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 providing access to high voltage compartments shall be equipped with door stays to hold doors in the open position.

5. The compartment containing the load-interrupter switch and ground switch shall be equipped with an internal hinged protective screen or door that is either bolted shut, pad-lockable, or key interlocked, to guard against inadvertent entry to the terminals of the load-interrupter switch. Access to any portion of the load-interrupter switch shall be blocked by the protective screen while allowing access to the load-interrupter main fuses and capacitor compartments.
6. The base of the enclosure shall be equipped with C4x5.4 structural steel channel. Removable steel lifting plates consisting of 1/2" steel shall be located at each corner. Formed channel bases will not be accepted.

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

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

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

10. Each door of the enclosure shall be equipped with self-adhesive vinyl 14" x 10" 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".

11. The enclosure shall have a continuous 1/4" x 1" Silver-plated Copper ground bus that spans the full width of the enclosure.

12. The enclosure shall be prepared and painted with a high-solid epoxy coating as specified below. The paint shall be ANSI gray 61 – Munsell No. 8.3G 6.10/0.54, ANSI Gray 70 – Munsell No. 5BG 7.0/0.4 or Green - Munsell No. 7Gy 3.29/1.5.

Surface Preparation:
All steel surfaces shall be prepared per SSPC-SP2, 3, 6, 7, 10, 11 or the paint manufacturer’s recommendations. Exceptions to the manufacturer’s requirements shall be approved by the paint manufacturer and provided with the submittal documents.

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

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/m².
• Adhesion (ASTM D4541): 900 PSI
• NFPA Class A Qualification

Top Coat 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 maximum. 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 supporting 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.

13. The following items (items 13, 14 and 15) can be specified as required. It should be noted, however, that banks that are accessible to the public (i.e. banks built in accordance with C57.12.28 should not include these items.

14. 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.

15. 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.

16. 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.

B. Load Interrupter – Air Disconnect Switch

1. The capacitor bank shall be supplied with an external chain 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 bank's 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.

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 is allowed.

C. Ground Switch

1. An externally 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.

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.

D. Main Incoming Fuses

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 the bank 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 incoming air-disconnect switch compartment.

E. Lightning/Surge Arresters

1. The capacitor bank shall be equipped with Heavy Duty Distribution Class Surge/Lightning Arresters. The rating of the Surge Arrester shall be recommended by the capacitor bank supplier.

F. Transient Inrush Reactors

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.

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.

3. The transient inrush reactors shall be the TI-\textit{Reactor}™ as manufactured by Northeast Power Systems, Inc.
G. Vacuum Switches

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.

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 forced on or off, regardless of the automatic controller output signal.

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

4. The vacuum switches shall be interlocked with the bank’s air-disconnect switch and ground switch.

H. Capacitors

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 General Electric.

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

3. The capacitors shall be connected in ungrounded-wye and shall be protected from sustained over voltages due to capacitor unit failure and/or system ground faults by a neutral unbalanced voltage detection system.

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

5. Capacitors shall be mounted horizontally and shall be mounted on C4x5.4 structural steel channel. The capacitors shall be removable from the front of the enclosure.

6. Capacitor case material shall be type AISI# 409 stainless steel suitable for outdoor service.

7. Capacitor Bushings shall be wet processed porcelain and shall be welded to the top of the case with a weldable flange to provide a strong, hermetically sealed system. Capacitor bushing shall color be light gray. The creep shall be a minimum of 12” for 75 or 95 kV BIL and 18” for 125 and 150 kV BIL.

8. The capacitor case color shall be painted ANSI #70 sky gray. The paint system shall be a durable Epoxy/Urethane composition which meets the requirements of ANSI C57.12.31 (Pole Mounted Transformer Enclosure Coating Integrity). A portion of the bottom of the mounting bracket shall be left unpainted to allow proper grounding of unit to the capacitor bank.
9. The bushing terminal(s) and ground lug shall be stainless steel and be equipped with a clamp-type terminal connector to accommodate copper or aluminum conductors from number 10 solid to number 1 stranded. The nut shall be plated soft brass to strip, if excess torque is applied, before damage to the bushing or stud.

10. The nameplate shall be anodized aluminum and shall be located on the narrow side of the capacitor and contain the following information.
   a. name of manufacturer
   b. unique serial number
   c. catalog number
   d. year of manufacture
   e. rated reactive power
   f. rated rms voltage
   g. number of phases
   h. rated frequency
   i. rated BIL
   j. amount of fluid, indicate flammable or not flammable
   k. statement that the capacitor contains internal discharge device

11. The capacitor shall be identified as containing NO PCB's by means of a BLUE colored label.

12. Capacitor units shall be of the "all-film" design using 2 sheets of Hazy Polypropylene Film as the solid dielectric material.

13. Connection to capacitor elements shall be by means of a mechanical crimp. For designs with extended aluminum foil, the inter-element connections shall be made of ultrasonic welds.

14. Each capacitor shall be provided with a discharge resistor assembly to reduce the residual voltage to 50 volts or less within 5 minutes after the capacitor is disconnected from rated voltage (for capacitors rated over 600V).

15. Prior to fluid impregnation, each capacitor shall pass a helium mass spectrometer leak test sensitive to a rate of $1 \times 10^{-6}$ cc per second.

16. The capacitor unit shall be filled and sealed under positive pressure to insure full impregnation and improved performance.

17. Insulating fluid shall be Non-PCB Synthetic Aromatic Hydrocarbon suitable for use in outdoor shunt capacitors and shall comply with all current environmental standards.

18. Capacitor units shall be capable of continuous operation provided that the following limitations are not exceeded:
   a. 135% nameplate kVar
   b. 110% of rated voltage rms, including harmonics
   c. 135% of rated current rms, including fundamental and harmonic currents

19. Capacitor units shall be capable of meeting the permissible overload operating conditions as specified in the applicable Standards.

20. The capacitors shall be of design and construction which have been validated by the type tests specified in the applicable Standards. Additional tests may be required to
verify adequate over voltage endurance and life for which the manufacturer may supply a certified test report.

21. For applications requiring conservative design practices, manufacture shall supply capacitor design capable of passing test of DC 6.25 x rated voltage.

22. Each capacitor shall be subjected to the routine production tests as specified in the applicable standard. Production tests shall include:
   a. Short-time over-voltage test:
      Terminal-to-terminal test: AC at 2 x rated voltage
      Terminal-to-case test (2 bushing units): Dependent on BIL
   b. Capacitance test at rated voltage
   c. Loss determination test at rated voltage
   d. Discharge resistor test
   e. Leak test

23. Design tests shall be performed by the manufacturer on a sufficient number of capacitors to demonstrate that the design meets industry standards. Capacitors shall first meet production tests before being subjected to design tests. Design tests shall include:
   a. Impulse withstand test
   b. Bushing test
   c. Thermal stability test
   d. Radio influence voltage test (RIV)
   e. Voltage Decay Test

24. Each proposal shall include the following bid documentation for evaluation purposes:
   a. Outline drawing and description of capacitor units
   b. Material safety data sheet and quantity of insulating fluid per unit
   c. Manufacturers failure data on previous 3 years’ shipments for year of manufacture and following year
   d. Certification of ability to pass capacitor design tests including over-voltage endurance as well as long-term life.
   e. Certification that paint meets requirements of ANSI C57. 12.31 (Pole-Mounted Transformer Enclosure Coating Integrity)

I. Capacitor Protection

1. Each capacitor shall be protected by a full range current limiting fuse with blown fuse indicators. Fuses shall be a tab-tab design and shall be visible and accessible from the front of the Enclosure.

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.

3. External Indication of a blown fuse shall be provided by an externally 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.

J. Copper Phase and Ground Bus

1. All phase and ground bus shall be Silver plated Copper for maximum conductivity and corrosion resistance. The copper shall be CA110 Square 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 lockwasher between the flat washer and the nut. The bus shall not have a current density greater than 1200 amps/in2. Where expansion capability is required, the bus shall be rated for the maximum capacity of the bank.

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

3. 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.

K. Key Interlock System

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

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:

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

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

   Use the “A1” key to unlock the air disconnect switch. Open the Air-Disconnect Switch and close the mechanically interlocked Ground Switch.

   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 terminals of switch unless upstream device was locked out.)

Use the “A3” key to open the first door that has access to the capacitor compartment. (Upon turning of the “A3” key, the vacuum switches 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.

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

The above procedure is repeated until all doors are open.

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 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.

4. The door key interlocks shall not require adjustment in the field. If adjustments are required, the supplier will be required to make such adjustments in the field at their cost.

L. Controls

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 externally 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.

2. All Control wires that connect to components inside high voltage compartment shall be enclosed in metal conduit or wire troughs that are formed as part of the capacitor bank

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 a facilities power factor 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 consists of the following features:

   Digital setting of individual parameters including target power factor, switching time, step limit, etc.
   Digital indication of preset power-factor, preset parameters, and specified installation data.
   Automatic Self-Adjustment to any capacitor step value.
   Facility to Connect a Mini-printer.
   Plug-in Terminal Connection.
   Automatic elimination of defective capacitor steps and their indication (e.g. blown capacitor fuses, welded contacts, etc.).
4. The bank shall be provided with a maintenance interval timer that can be set to alert plant personnel of a maintenance requirement.

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

7. Each stage shall be equipped with on/off/auto switches, stage on indicator (green) and stage off indicator (red). 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.

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.

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

10. A 15-amp GFI Convenience outlet shall be provided in the control compartment.

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

12. UL class CC 600 volt current limiting fuses shall be provided to protect the control circuit.

13. All Current transformer circuits shall be wired with a minimum of 10 gauge 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.

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 equipment from over-voltages that may be present during light loads. The relay shall have two individual set-points that can alarm as well as trip the bank off-line.

15. A three-phase panel meter shall be provided. This meter shall receive its voltage and current signals from three current transformers and two potential transformers located inside the capacitor bank. The meter shall be pre-programmed at the factory and shall have the following features:
PART 3 EXECUTION

3.1 UNLOADING AND STORAGE

A. Unloading of equipment at Owner's site will be by others:

1. Supplier shall furnish weight and size information, along with all special rigging requirements. This information shall be included with the Shop drawings.

2. Supplier shall notify Owner at least 15 days prior to delivery, giving schedule of delivery to site.

   a. At least 24 hours prior to delivery the shipper to notify Owner confirming delivery time.

3.2 FIELD INSTALLATION

A. Installation of equipment at Owner's site will be by others.

1. Supplier shall furnish adequate instructions, manuals, connection diagrams, and similar materials for use by Owner's installing contractor.

3.3 INSTALLATION CHECKOUT AND TESTING

A. Supplier shall provide a field service engineer to perform all manufacturer's recommended inspections and tests on installed equipment before equipment is energized and to confirm proper installation and operation. Minimum testing shall be:

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

2. Compare nameplate information with the drawings and specifications.

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

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

5. Verify proper operation of grounding switch, air-disconnect switch and safety interlocks.

6. Confirm functional operation of equipment before closing air-disconnect switch. Minimum tests include the following:

   a. Confirm bank is properly grounded.
   b. Confirm vacuum switches energize in the manual mode.
   c. Confirm vacuum switches operate from the automatic power factor controller.
   d. Confirm vacuum switches trip off-line for all protective relay functions.
   e. Confirm beacon light turns on when bank is tripped off-line.
f. Confirm enclosure lights, strip heaters, and fan(s) function.
g. Confirm power factor controller has adequate current for sensing power factor.
h. Confirm power quality meter is reading correct.

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

3.4 FIELD INSTALLATION AND ASSEMBLY

A. Installation of equipment and assembly at Owner's site will be by others.

1. Supplier shall furnish adequate instructions, manuals, connection diagrams, and similar materials for use by Owner's installing contractor.

2.

3.5 FIELD INSTALLATION AND ASSEMBLY

A. Installation of equipment and assembly at Owner's site will be by others.

1. Supplier shall furnish adequate instructions, manuals, connection diagrams, and similar materials for use by Owner's installing contractor.

END OF SECTION