SECTION 26 35 33 – POWER FACTOR CORRECTION EQUIPMENT

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes automatic power factor correction equipment rated 600V and less.

1.3 DEFINITIONS

A. Capacitor Element: Basic component of capacitor unit consisting of 2 electrodes separated by dielectric.

B. Power Capacitor: Assembly of dielectric and electrodes in container (case), with terminals brought out, that is intended to introduce capacitance into electric power circuit. Term "power capacitor" is used interchangeably with "capacitor" or "capacitor unit" throughout Section and standards referenced in this Section.

C. Power Capacitor Bank: Assembly at one location of capacitors and necessary accessories, such as switching equipment, protective equipment, controls, and so forth, required for complete operating installation. It may be collection of components assembled at operating site or may include one or more item(s) of factory-assembled equipment.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for power capacitor banks.

2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For automatic power factor correction units.

1. Include plans, elevations, sections, and mounting details.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Include diagrams for power, signal, and control wiring.

4. Wire Termination Diagrams and Schedules: Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and

show circuit protection features. Differentiate between manufacturer- and field-installed wiring.

5. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices used. Describe characteristics of network and other data communication lines.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Product Test Reports: Factory production test reports.

C. Evaluation Reports: Energy loss statement for each type of power capacitor.

D. Field quality-control reports.

E. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For equipment to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include following:

a. Lists of spare parts and replacement components recommended for storage at Project site.

b. Detailed instructions covering operation under both normal and abnormal conditions.

c. Hard copies of manufacturer's operating specifications, user's guides for software and hardware, and PDF files on USB storage device of hard-copy submittal.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: One for every 3 of each type and rating, but no fewer than 3 of each.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

1.9 COORDINATION

A. Coordinate sensor-communication module package with data network and with monitoring equipment specified in Section 260913 "Power Monitoring and Control" for successful transmission and remote readout of remote monitoring data specified in this Section.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace power capacitors and power capacitor bank components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by qualified testing agency, and marked for intended location and application.

B. Comply with IEEE 18. Measured capacitance of unit shall not vary more than zero to 10 percent of nominal value.

C. Comply with NFPA 70.

2.2 PERFORMANCE REQUIREMENTS

A. Service Conditions: Power capacitors equipment suitable for following conditions:

1. Operating Temperature: Minus 40 to plus 115 degrees F.
2. Humidity: Zero to 95 percent, noncondensing.

2.3 POWER CAPACITOR

A. Comply with UL 810.

B. Capacitor Element: Dry metallized-dielectric, self-healing type. Each cell shall be encapsulated in thermosetting resin inside plastic container.

C. Rupture Protection: Pressure-sensitive circuit interrupter for each cell.

D. Losses: Maximum dielectric losses of 0.25 W/kVAr, and total loss of 0.5 W/kVAr.

2.4 AUTOMATIC POWER CAPACITOR BANK

A. Description: Factory-assembled unit, consisting of power capacitors, inductors, contactors, controls, and accessories, factory installed in independent enclosures. Comply with UL 508A.

B. Performance Requirements: Controls permit selection of target power factor, adjustable to value between unity and 0.80 lagging. Controls continuously sense power factor on circuits being corrected and, when power factor differs from target setting for more than 10 seconds, operate contractor to switch power capacitor bank into or out of circuit. Contactors are opened or closed as required to bring corrected circuit power factor closest to high (unity) end of target setting. Provide number of switching steps indicated on Drawings.

C. Disconnect and Overcurrent Protective Device: Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers." Operable from outside enclosure to disconnect unit, cover may be opened only when disconnect switch is open.

1. Molded-Case Circuit Breaker: Adjustable magnetic trip setting for circuit-breaker frame sizes 250A and larger.

D. Fuses for Protection of Power Capacitor Bank: Current limiting; listed and labeled as defined in NFPA 70, by qualified testing agency as complying with UL 248-12 for Class R and Class RK fuses, or UL 249-15 for Class T fuses, as recommended by manufacturer; providing interrupting capacity of 100 kA. Provide blown fuse indicator light and "push-to-test" for each fuse on bank cover.

1. Spare-Fuse Cabinet: Cabinet with hinged lockable door.

a. Comply with equipment identification requirements in Section 260553 "Identification."

E. Controls: Solid-state, microprocessor-based controls; control power shall be from low-voltage power conductors associated with bank. Include following:

1. Reactive Current Control: Field programmable:

a. Target power factor selector switch, with setting range from 70 to 95 percent lagging.

b. Time delay between steps with setting range from 5 seconds to 20 minutes to reduce hunting and allow for voltage decay.

2. Current Transformers: Type, configuration, and ratio recommended by manufacturer to suit sensing and mounting conditions.

3. Undervoltage Relay: Interrupts switching of power capacitors and disconnects power capacitors for power-supply interruptions longer than 15 minutes.

4. "Advance" and "Retard" push buttons on control panel to permit manually controlled power capacitor bank switching.

F. Contactors: Three pole; rated for repetitive high-inrush-switching duty in power capacitor application. Comply with NEMA ICS 2.

G. Discharge Devices: Factory installed and wired for each switched group of power capacitors.

H. Inductors: Air-core type, rated to limit switching surges to be within contactor ratings.

I. Enclosure: NEMA 250, Type 1, steel or aluminum, with hinged door and hand-operated catch. Door shall be interlocked with controls or main circuit breaker to de-energize power capacitors when door is opened.

1. Factory Finish: Manufacturer's standard enamel over corrosion-resistant treatment or primer coat.
2. Comply with equipment identification requirements in Section 260553 "Identification."

J. Local Display: LED or LCD type, mounted in door of enclosure, indicating following:

1. Target and actual power factors accurate to plus or minus one percent of reading.
2. Steps energized.
3. Step reconnection delay.
4. Real and reactive currents.
5. Voltage total harmonic distortion.
6. Alarm codes.

K. System Alarms: Alarm relay and local display indication of following conditions:

1. Low power factor.
2. Leading power factor.
3. Frequency not detected.
4. Overcurrent.
5. Overvoltage.
6. Overtemperature.
7. Excessive voltage total harmonic distortion.
8. Power capacitor overload.
9. Loss of capacitance.

L. Remote Monitoring Components: Sensors, associated communication modules, and network interface units, matched to and compatible with electrical power monitoring and control network. Communication module shall have capability to transmit following data to remote monitoring devices:

1. System in alarm.
2. Power factor set point.
3. Corrected power factor.
4. Number of power capacitor bank steps activated.

2.5 ARC-FLASH WARNING LABELS

A. Arc Flash Study: Comply with requirements in Section 260573.19 "Arc-Flash Hazard Analysis." Produce 3.5-by-5-inch thermal transfer label of high-adhesion polyester for each work location included in analysis.

B. Electrical Identification: Comply with requirements in Section 260553 "Identification." Produce 3.5-by-5-inch thermal transfer label of high-adhesion polyester for each work location included in analysis. Labels shall be machine printed, with no field-applied markings.

1. Label shall have orange header with wording, "WARNING, ARC-FLASH HAZARD," and shall include following information taken directly from arc-flash hazard analysis.
    a. Location designation.
    b. Nominal voltage.
    c. Flash protection boundary.
    d. Hazard risk category.
    e. Incident energy.
    f. Working distance.
    g. Engineering report number, revision number, and issue date.

2.6 SOURCE QUALITY CONTROL

A. Factory test power factor correction equipment before shipment. Include following:
    1. Routine power capacitor production tests, including short-time overvoltage, capacitance, leak, discharge resistor, loss determination, and fuse capability tests.
    2. Functional test of operations, controls, indicators, sensors, and protective devices.

PART 3 - EXECUTION

3.1 EXAMINATION

A. On delivery of power capacitor bank, and before unloading, inspect equipment for damage.
    1. Verify that tie rods and chains are undamaged and tight and that blocking and bracing are tight.
    2. Verify that there is no evidence of load shifting in transit and that readings from transportation shock recorders, if equipped, are within manufacturer's recommendations.
    3. Examine power capacitor bank for external damage, including dents or scratches in doors and sill, and termination provisions.
    4. Compare power capacitor bank and accessories received with bill of materials to verify that shipment is complete. Verify that bank and accessories comply with manufacturer's quotation and Shop Drawings. If shipment is incomplete or does not comply with Project requirements, immediately notify manufacturer in writing.
    5. Unload power capacitor bank, observing packing label warnings and handling instructions.
    6. Open compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.

B. Handling:
    1. Handle power capacitor bank per manufacturer's recommendations; avoid damage to enclosure, termination compartments, base, frame, capacitors, and internal components. Do not subject bank to impact, jolting, jarring, or rough handling.

2. Transport power capacitor bank upright, to avoid internal stresses on equipment mounting assemblies. Do not tilt or tip bank.

3. Use spreaders or lifting beam to obtain vertical lift and to protect power capacitor bank from straps bearing against enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.

C. Storage: Store power capacitor bank with compartment doors closed.

D. Examine roughing-in of conduits and grounding systems to verify following:

1. Wiring entries comply with layout requirements.

2. Entries are within conduit-entry tolerances specified by manufacturer.

3.2 INSTALLATION

A. Comply with equipment installation requirements in NECA 1.

B. Install freestanding equipment on concrete bases. Cast-in-place concrete is specified in Section 033000 "Cast-in-Place Concrete." Maintain minimum workspace per manufacturer's written instructions.

C. Install arc-flash labels as required by NFPA 70.

D. Connect remote monitoring communication module to electrical power monitoring and control data network through appropriate network interface unit.

E. Identify components per Section 260553 "Identification."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections with assistance of factory-authorized service representative.

C. Tests and Inspections:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.

b. Inspect anchorage, alignment, grounding, and clearances.

c. Verify that unit is clean.

d. Verify that capacitors are electrically connected in their specified configuration.

e. Inspect bolted electrical connections for high resistance using one of 2 following methods:

1) Use low-resistance ohmmeter.

a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method per manufacturer's published data or NETA ATS, Table 100.12.
   a) Bolt-torque levels shall be per manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.12.

2. Infrared Inspection: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of electrical power connections of power capacitor bank. Perform infrared inspection during periods of maximum possible loading. Remove necessary covers before inspection.

   a. Follow-up Infrared Scanning: Perform additional follow-up infrared scan of each switchgear 11 months after date of Substantial Completion.

   b. Instrument: Inspect distribution systems with imaging equipment capable of detecting minimum temperature difference of one degree C at 30 degrees C.

   c. Record of Infrared Inspection: Prepare certified report that identifies testing technician and equipment used and that lists following results:

      1) Description of equipment to be tested.

      2) Discrepancies.

      3) Temperature difference between area of concern and reference area.

      4) Probable cause of temperature difference.

      5) Areas inspected. Identify inaccessible and unobservable areas and equipment.

      6) Load conditions at time of inspection.

      7) Photographs and thermograms of deficient area.

   d. Act on inspection results per recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

3. Electrical Tests:

   a. Perform resistance measurements through bolted connections with low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.

   b. Perform insulation-resistance tests from phase terminals to case for one minute. Apply voltage per manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.1.

   c. Measure capacitance of terminal combinations. Investigate capacitance values differing from manufacturer's published data.

   d. Measure resistance of internal discharge resistors. Investigate capacitance values differing from manufacturer's published data. Measure capacitor residual voltage at one minute after disconnecting power capacitor bank from its power supply. Investigate cause if residual voltage exceeds 50V.

   e. Electrical Tests of Current Transformers:

1) Perform insulation-resistance test of each current transformer and its secondary wiring for ground at 1000V dc for one minute. For units with solid-state components that cannot tolerate applied voltage, follow manufacturer's recommendations. Investigate and correct values of insulation resistance less than manufacturer's recommendations or NETA ATS, Table 100.5.

2) Perform polarity test of each current transformer per IEEE C57.13.1. Polarity results shall agree with transformer markings.

3) Perform excitation test on transformers used for relaying applications per IEEE C57.13.1. Excitation results shall match curve supplied by manufacturer or be per IEEE C57.13.1.

4) Measure current circuit burdens at transformer terminals per IEEE C57.13.1. Measured burdens shall be compared to, and shall match, instrument transformer ratings.

5) Perform insulation-resistance tests on primary winding with secondary grounded. Test voltages shall be per NETA ATS, Table 100.5.

6) Perform dielectric withstand tests on primary winding with secondary grounded. Test voltages shall be per NETA ATS, Table 100.9.

7) Perform power factor or dissipation-factor tests per test equipment manufacturer's published data.

8) Verify that current-transformer secondary circuits are grounded and have only one grounding point per IEEE C57.13.3.

3.4 STARTUP SERVICE

A. Engage factory-authorized service representative to perform startup service.

1. Complete installation and startup checks per manufacturer's written instructions.

2. Connect and run installed motors and equipment to verify automatic switching of power capacitors. Verification shall include automatic switching of total capacity of installed power capacitors.

a. Provide sufficient inductive/reactive load banks, in combination with resistive load banks, for test.

3.5 DEMONSTRATION

A. Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain automatic power factor correction units.

END OF SECTION