

SECTION 26 35 33.16

LOW VOLTAGE POWER FACTOR CORRECTION EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

- A. Scope: Provide labor, material, equipment, related services and including, but not limited to, manufacturing, fabrication, configuration and installation for low voltage, three-phase power factor correction/harmonic mitigation system (also identified as automatic capacitor banks, PFC equipment, tuned or detuned filter) as required for the complete performance of the work, as shown on the drawings, as specified herein.
- B. Related Sections: Related sections include, but shall not be limited to, the following:
 - 1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section.
 - 2. Applicable general requirements for electrical work specified within Division 26 Specification Sections apply to this section.

1.2 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents unless otherwise specified.
 - 1. Canadian Standards Association (CSA):
 - a. C.22.2 No. 190, "Capacitors for Power Factor Correction."
 - b. C.22.2 No. 66, "Specialty Transformers, Industrial Products."
 - c. C22.1, "Canadian Electrical Code, Part I" (CEC)
 - d. Z462, "Workplace Electrical Safety"
 - 2. Federal Communications Commission (FCC)
 - a. 47 CFR 15 Subpart B Class A, "Unintentional Radiators"
 - 3. International Organization for Standardization (ISO):
 - a. ISO 9001, "Quality Management Systems - Requirements"
 - 4. National Electrical Manufacturers Association (NEMA):
 - a. NEMA 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)"
 - 5. National Fire Protection Association (NFPA):
 - a. NFPA 70, "National Electrical Code" (copyrighted by NFPA, ANSI approved) hereinafter referred to as NEC.
 - b. NFPA 70E, "Standard for Electrical Safety Requirements for Employee Workplaces" (copyrighted by NFPA, ANSI approved).
 - 6. Underwriters Laboratories, Inc. (UL):
 - a. UL 508, "Standard for Industrial Control Equipment."
 - b. UL 810, "Standard for Capacitors."

1.3 SUBMITTALS

- A. Submittals shall offer sufficient information to determine compliance with this specification. Submittal data shall be clearly marked to identify the specific model numbers, options, and features of equipment and work proposed.
- B. Deviations from this specification shall be clearly indicated within the submittal. Each deviation shall be accompanied by a detailed written justification for the deviation.
- C. Product Data: Submit required product data specific to each product and accessory proposed including standard product literature/description.
- D. Standard warranty with extended warranty options and costs.
- E. Current UL an CSA listing from a Nationally Recognized Testing Laboratory (NRTL)
- F. Installation & Operations manuals shall be submitted prior to arrival of equipment on site.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer shall be a firm engaged in, and specializing in, electrical power factor correction equipment for a minimum of 10 years.
 - 1. The manufacturer shall have a valid ISO 9001 certification and an applicable quality assurance system. Manufacturing, inspection, and testing procedures shall be developed and controlled under the guidelines of the quality assurance system.
 - 2. The manufacturer or their representative shall have service, repair, and technical support services on call and available 24 hours 7 days a week basis.
- B. Installer Qualifications: Installer shall be a firm that shall have a minimum of five years of successful installation experience with projects related to utilizing passive power factor correction and harmonic filter equipment similar in type and scope to that required for this project
- C. All work performed, and all materials used shall be in accordance with the National Electrical Code, and with applicable local regulations and ordinances. Equipment, assemblies and materials shall be listed and labeled by Underwriter's Laboratories or by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Prior to delivery to the project site, ensure that suitable storage space. Materials shall be protected during delivery and storage and shall not exceed the manufacturer stated storage requirements. As a minimum, store indoors in clean, dry space with uniform temperature to prevent condensation
- B. Deliver materials to the project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and equipment tag number or service name as identified within the contract documents.
- C. Inspect and report any concealed damage or violation of delivery storage, and handling requirements to the engineer.

1.6 WARRANTY

- A. The manufacturer shall warrant products against defects in material and workmanship for a period of 18 months from the date of shipment or one year from the date of installation, whichever occurs first.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The acceptable manufacturers shall be from this list. A substitute may be offered by addendum to the contract prior to the bid date. In all cases the manufacturer must be compliant with intent and letter of this specification:
1. Power Survey DBA Powerside PowerVar
 2. [2nd manufacturer and model]
 3. [3rd manufacturer and model]

2.2 GENERAL REQUIREMENTS

- A. Electrical components, devices, and accessories: Electrical components, devices, and accessories shall be listed and labeled by an inspecting and testing agency acceptable to authorities having jurisdiction and marked for intended use.
- B. The complete equipment shall be manufactured per UL 508, and CSA 22.2 No. 190.
- C. The PFC equipment shall meet the following environmental conditions:
1. Operating ambient temperature range shall be -22 °F (-30 °C) to 115 °F (46 °C) maximum.
 2. Highest mean over any period of 24 hours shall be 104 °F (40 °C).
 3. Highest mean over one year shall be 95 °F (35 °C).
 4. Maximum Altitude without derating: 6562 feet (2000 m).
 5. Humidity: 0 percent to 95 percent, non-condensing.

2.3 SYSTEM CONFIGURATION

- A. The system will be configured to the following specification:
- [2.4.A] Topology: Capacitor bank or tuned filtered (3.78th harmonic)
- [2.4.A.1.a] design shall / shall not allow space for a field upgrade to a filter
- [2.4.B] Contactor: Electromagnetic or Thyristor
- [2.4.C.1] Voltage: 208Vac , 240Vac , 480Vac or 600 Vac
- [2.4.C.2] Total kVAR:
- [2.4.C.3] KVAR per step:
- [2.4.C.4] Power Factor Set Point:
- [2.4.D2] Enclosure: NEMA 1 , NEMA 12 or NEMA 3R
- [2.4.G] Main incoming lugs only or Integrated circuit breaker
- [2.4.I] Blow Fuse Indicator: Yes or No
- [2.4.J.7] Communications: RS485 , RS232 , Ethernet or Wi-Fi
- [2.5.A] CT ampacity rating:

2.4 POWER FACTOR CORRECTION UNITS

A. System topology:

1. Automatic capacitor bank or tuned filtered (3.78th harmonic to preventing resonance on a network where harmonics exist).

B. Contactors:

1. Electromagnetic contactor switched for applications with gradual load variation, electromagnetic contactors shall be used. The electromagnetic contactors shall be three poles; rated for the repetitive high inrush switching duty in the capacitor application. Contactors shall be specifically designed for capacitor switching duty that includes a pre-charge circuit to minimize transients.
2. Thyristor switched for applications with highly fluctuating loads and high harmonic distortion and loads that are sensitive to voltage transients. Transient-free switching will switch at the zero crossing.

C. System Size / Ratings

1. Operating voltage shall be 208 or 480 or 600 Vac (phase-to-phase), three phases, [60] hertz.
2. Total kVAR rating of the capacitor bank shall be [_____] kVAR.
3. Capacitor steps shall be [_____] kVAR.
4. Power factor correction set point will be set to [_____] with the ability for .50 lagging to 1.0 (unity)
5. Buswork shall be all copper and braced to withstand fault level at either 25 kA RMS amperes symmetrical plus 10 percent for four (4) cycles per ANSI C37.51. If the factory-installed circuit breaker is provided, the same shall be rated to withstand a fault level of 65 kA.
6. Step fuses will connect directly to busbar for improved heat management and improved fuse life.
7. The main circuit breaker shall be rated for a minimum of 135 percent of the capacitor system full load current at operating voltage.

D. Enclosure:

1. Enclosure(s) shall be free-standing, and shall be constructed of sheet steel, including, but not limited to a hinged door and ground lug, finished with standard ANSI 61 gray paint.
2. Enclosure(s) shall meet NEMA 250 Type 1, 12 or Type 3R.
3. Enclosure door(s) shall be full height, key lockable with door-mounted controller rated to IP54.
4. Enclosure design [_____] shall / [_____] shall not allow space for a field upgrade to a tuned or detuned filter (addition of reactors on each step).

E. Capacitors

1. Internal capacitor cells shall be UL and CSA recognized in compliance with UL 810 and CSA22.2, No. 190.
2. Liquid filled or impregnated capacitors are not acceptable. Individual capacitor elements shall be self-healing, polypropylene film, segmented metalized film, 3-phase with overpressure disconnecter.
3. Capacitors shall be capable of voltage and current ratings:

1. Current rating: 165% continuous duty of the RMS current
 2. 110% of the rated voltage for 8 hours per day.
 4. Capacitor elements shall be delta connected at rated voltage. Wye connected capacitor elements shall not be acceptable.
 5. Discharge resistors shall be provided to meet UL/CSA requirement (reduce voltage on the cells to 50 volts or less within one minute after the capacitor has been switched off).
- F. Reactors for detuned filter applications:
1. The reactor/capacitor system shall be tuned to the 3.78th harmonic (227Hz) unless otherwise specified.
 2. Reactor shall provide a precise inductance of +/-3% and engineered with many small air gaps of varying length to reduce power, heat rejection, stray magnetic field and audible noise.
 3. The reactor shall have a maximum temperature rise of 100°C over ambient.
 4. The reactor will be constructed with NEMA Class H (IEC 60085 class 180) insulation for maximum durability under high loads.
 5. The reactor shall have an over temperature thermistor contact embedded in the center coil. Contact will open when temperature reaches 170°C and will deactivate the affected capacitor stage.
- G. Control Power Requirements:
1. Shall be provided from primary connection. No secondary 120Vac shall be required.
- H. Input feed breaker:
1. Main incoming lugs only
 2. Integrated circuit breaker
- I. Blown Fuse Indicators;
1. [Shall / shall not] include a blown fuse indicator. The indicator (red) shall illuminate when the fuse for that specific stage has blown.
- J. Power Factor Controller:
1. The controller shall be suitable for operation with energy import and energy export (4 quadrant operations). The controller shall connect or disconnect the required amount of capacitor stages needed to maintain the preset power factor.
 2. Harmonic analysis THDi, THDv, V/I analysis up to the 15th harmonic will be required.
 3. All system set up, adjustments, commands and monitoring shall be available via the controller front panel user interface with a graphic LCD display (188 × 80 minimum resolution). Password protection is required.
 4. The controller shall provide control a minimum of 8 steps expandable to 14. Each step will be programmable.
 5. The controller shall support Modbus RTU and Modbus ASCII
 6. The controller shall be equipped with a real-time clock for accurate event time stamps.
 7. The controller shall provide following communications options: RS485, RS232, Ethernet with integrated web server and Wi-Fi (for programming, data download, diagnostics and firmware updates)

8. All communications options shall be capable of being added in the field to support changes in building and energy management systems.
9. The controller shall be capable of a master-slave function with up to eight (8) slave controllers.
10. The controller shall be capable of locking an individual step in so as to maintain a minimum correction regardless of automatic action.

2.5 External Current Transformer (CT):

- A. A current transformer shall be provided to be installed upstream of where the automatic capacitor is attached to the electrical distribution system, shall be provided with a ratio of [_____] amperes to 5 amperes. The field installable CT shall be split core type with an opening large enough to facilitate installation around the cables or bus.
- B. Shorting terminal shall be provided for two incoming current transformer wires.

PART 3. EXECUTION

3.1 GENERAL

- A. Examine equipment exterior and interior prior to installation. Report any damage and do not install any equipment that is structurally, moisture, or mildew damaged.
- B. Verification of Conditions: Examine areas and conditions under which the work is to be installed and notify the contractor in writing with a copy to the owner and the engineer of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.
- C. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the installer.
- D. Install equipment in accordance with reviewed product data, final shop drawings, manufacturer's written instructions and recommendations, and as indicated on the drawings.
- E. Provide final protection and maintain conditions in a manner acceptable to the manufacturer that shall help ensure that the equipment is without damage at time of Substantial Completion.

3.2 FACTORY ACCEPTANCE TESTING

- A. Standard tests shall be performed in the factory to confirm proper operation of the capacitor bank, including, but not limited to, operation of control circuits, functioning of the PF controller, confirming of kVAR rating at rated voltage and high pot testing per UL/CSA requirements.

END OF SECTION 26 35 33.16