Low Voltage Power Factor Correction Equipment Specifications
Fast Automatic Detuned, Fast Automatic Tuned (APQvar)

Part 1 - General Scope and Product Description

1.0 This specification contains the minimum design and manufacture requirements, standards, general equipment type, warranty and installation for power factor correction, detuned and tuned power factor correction equipment. Equipment shall be intended for the improvement of power factor, for low voltage AC electrical power distribution systems. Reference specification Section 26 - 263533 or Section 16 – 16280.

1.1 Exception to any part of this specification shall be indicated by reference to each item number, when providing a project bid.

1.2 Manufacturer of power factor correction equipment shall have been engaged in the application, design and production of such equipment for a minimum of twenty years. Manufacturer specified shall be ISO 9001 certified. The finished product shall be engineered, assembled, tested, and shipped by manufacturer. Equipment provided in any other manner is not acceptable.

1.3 Power factor correction equipment shall be suitable for indoor or outdoor (NEMA rated) environments. Finished design may be stand-alone type, or integrated with other electrical equipment. Equipment shall be provided for low voltage classifications, with a range from 240vac to 600vac, suitable for automatically switched configurations, with the compatibility to include fixed (non-automatic) power factor correction. In general, equipment shall be used on three phase, 3-wire, three phase 4-wire, grounded wye, ungrounded wye, or delta wire systems at 50 or 60 Hz. Equipment is designed for reliable, continuous operation in ambient temperatures of ° C to + ° C, up to 3300 feet (1000 meters) above sea level, with relative humidity of 70% at ° C or higher, when controlled by thermostats, conditioned air, heaters and/or fans, as required.

1.4 A power system analysis may be required to determine the harmonic content and requirement for filters, as part of the power factor correction equipment. It will be the responsibility of the owner, consultant, contractor or power quality service company to provide the manufacturer, at the time of request for quote, such data.

1.5 The finished power factor correction equipment shall be UL listed to 508A and cUL.

Part 2 - Standards and References

2.0 American National Standards Institute (ANSI)

2.1 Institute of Electrical and Electronic Engineers (IEEE)

2.2 National Electrical Manufacturers Association (NEMA)

2.3 Underwriters Laboratories, Inc. (UL)

2.4 National Electrical Code (NEC)

2.5 Canadian Standards Association (CSA)

2.6 International Electrotechnical Commission (IEC)

2.7 European Standards, EN

Part 3 - System Ratings

3.0 The voltage rating of the power factor correction equipment shall be _____ volts AC between phases.

3.1 The total capacity of the unit shall be_____kvar.

3.2 The total kvar shall be divided into # steps_____; automatically switched _____ kvar.

3.3 The fixed kvar_____non-switched.

3.4 The automatic capacitor bank shall have future provisions for expansion to _____kvar.

Part 4 - Primary Component Description

4.0 The finished assembly shall provide a general design arrangement to accommodate an externally fused capacitor configuration as either switched, fixed and switched; and incorporating electronic switches, filter reactors, copper bus work and control device, with all components mounted, wired and housed in a NEMA rated enclosure.

4.1 Power Capacitors, shall comply with applicable industry standards IEEE Std. 18, NEMA CP-1, CSA 22.2, IEC 831, and UL 810. Each capacitor housing shall be aluminum, with an internal self healing, metalized polypropylene film and resin encapsulation (dry type), or “green, environmentally friendly” liquid impregnation (wet type). Capacitors shall include a safety overpressure device and discharge resistors, which reduce residual voltage to 50VAC or less, within one minute from de-energization. Capacitors shall be designed for proper overcurrent, overvoltage, low watt loss, and long life capabilities. A THD of up to 10% shall not affect the life of the capacitors.

4.2 Current Limiting fuses shall be class J type rated at 200kaic, utilized for protection of major faults on all three phases of each switched step and each fixed step. Fuse mounting

arrangement shall be in such a manner to provide convenience for inspection and servicing and shall include blown fuse indication.

4.3 Capacitor switching devices employed shall be thyristor based, static power electronic type, providing for rapid-speed operations. Switches shall be designed to provide efficient, reliable and long life switching duty, at the zero crossing point, capable of multiple switching, without the need to discharge capacitors. The 24 volt firing signal shall be isolated from the power wiring to avoid any false signals and electrical noise in the DC circuits. Such switching shall avoid inrush currents and transients, while frequently switching within multiple cycles. Individual switches shall be either convection or forced air design.

4.4 Filter reactors shall be provided as protection for power factor correction equipment capacitors installed in a harmonically loaded environment. In general, reactors shall be detuned for the 4^{th} harmonic order and rated at 3.78 (227hz), to reduce harmonic amplification. Reactors for tuned systems shall be designed for mitigation for the 5^{th} order and rated at 4.7 (282hz). Reactors shall be three-phase, iron-core, ° C temperature rated, class H, air-cooled with Poly-Gap core and include a thermal switch. Reactors shall be provided to correct other specific harmonic orders, as required.

4.5 Control power transformer shall be rated for the supply of 120vac, with sufficient load capacity and include both primary and secondary fusing.

4.6 A three-phase zinc oxide arrester rated at 600vac shall be provided for voltage spike protection.

4.7 Optional components may be needed based upon application requirements:
- Molded case type circuit breaker 3-pole, manually operated
- Blown fuse lights, per step
- Other

Part 5 - Control and Monitoring

5.0 Power factor controller shall be door mounted and provide for automatic power factor regulation with a programmable target cosine. Controller shall by rapid response type, allowing for capacitor switching in one-cycle or less time. The microprocessor based device shall manage, measure, and display:

- under- and overvoltage
- harmonics
- defective steps
- maintenance (loss of power and amount of operations)
- temperature measuring with fan control and switching off steps
- digital input
- number of steps in use
- adjustable time settings of steps
- voltage (phase/phase and phase/neutral)

- current
- frequency
- active power
- reactive power
- apparent power
- THD voltage
- THD current
- harmonics for voltage (order 2nd – 31st)
- harmonics for current (order 2nd – 31st)
- counter active work import / export
- counter reactive work inductive / capacitive
- missing reactive power for target-cosphi
- temperature, measuring the temperature in the enclosure by use of sensor
- Controller shall be door mounted with a back-lighted, graphical LCD display and function keypad
- Modbus 485 RTU option
- SCADA management option

5.1 Supervision functions shall provide for reliable, safe operation of the compensation equipment and ensure a long life cycle of the components.

5.2 A current transformer shall be provided, split-core type, for controller measurement.

5.3 A CT (current transformer) shorting terminal block shall be provided for additional personnel safety.

Part 6 - Equipment Construction

6.0 Power factor correction equipment design and manufacture shall follow the most recent applicable ANSI, IEEE and NEMA standards and guidelines; and be neatly constructed and finished, meeting all APQ, LLC. quality and production control standards.

6.1 The enclosure assembly shall be a rigid frame structure using a minimum 16- gauge formed sheet steel outer surface. Enclosure shall be a modular bolted design and allow for ease of expansion in the field. Top, bottom or side connection entry shall be provided.

6.2 Doors shall be hinged and equipped with a positive latch-close system and include a lockable feature. The entire assembly shall provide adequate personnel safety and component security. Removable lifting eyes located at the top of the equipment, shall be provided for transport and to facilitate ease of installation.

6.3 The complete assembly shall be painted using electrostatically applied powder coated paint, providing for enhanced durability and extended protection. Standard color shall be RAL 7035 (light grey), or color as specified. NEMA 1, 12, 3R and other ratings shall be available.

6.4 Fans shall be provided for force air cooling, convection cooling is not acceptable.

6.5 All internal power wiring shall have thermoplastic insulation rated for a minimum of 90° C at 600 volts. All wiring connections shall be mechanically fixed with a nut or screw.

6.6 Main bus shall be electrical grade cooper, fully rated and integral to the equipment. At a minimum, a 65ka brace rating shall be used, to withstand specified short circuit ratings, while providing adequate clearance. Bellevue hardware shall be utilized at connection points. A grounding connection point shall also be included.

6.7 On/Off switch for control power and dry contacts for remote/external disconnect means shall be provided. Internal circuit breaker (optional) shall include shunt trip and assembly shall include door interlock system.

6.8 The equipment shall be suitable to meet applicable seismic requirements.

Part 7 - Testing, Safety and Documentation

7.0 Capacitors shall be tested at point of construction. The power factor correction equipment shall be production tested for proper operation, prior to shipment. This shall include, at a minimum: wire connections, torque connections, mechanical functional operation, controller operation, visual inspection.

7.1 Nameplates, labels, and other decals, providing safety, general operation instruction and manufacturer data, shall be included with the equipment. Such markings shall be visually accessible and conveniently located, both internally and externally on the equipment.

7.2 A manual for the purpose of operation, maintenance, and service instruction shall be included with the finished equipment. A general bill-of-material list, external and internal outline mechanical and electrical drawings shall be included with the equipment. Documentation shall be provided in a CAD format for approval or reference, as required.

Part 8 - Installation and Service

8.0 Installation and operation of equipment is intended for general business, commercial, industrial, government and energy service providers.

8.1 Correct installation is required for proper performance and function of the equipment. Physical inspection of equipment for damage is suggested, prior to any installation. Indoor storage shall be in a clean, dry environment.

8.2 National Electrical Code (NEC), electric utility company or service provider codes shall be adhered to during the installation. Electrical connections shall also be in compliance with required codes

8.3 Installer/Contractor shall inspect and verify proper alignment, anchorage, leveling and grounding, proper connections and tightness of connections, prior to any start-up procedures.

8.4 Appropriate personnel shall start-up and operate equipment upon installation approval.

8.5 All maintenance and inspection of the power factor correction equipment shall be done with the system disconnect device in the open position.

8.6 Routine maintenance and inspections should be limited to 15-30 minutes, as to not disrupt utility billing practices.

8.7 An annual inspection of the capacitors, fuses, contactors and reactors shall be performed.

Part 9 - Equipment Warranty

The manufacturer shall provide its standard warranty for equipment of this type. The warranty shall provide for repair or replacement of the equipment, should it be found to be defective within twelve months from the date of being first energized, or eighteen months from date of shipment, or whichever occurs first.

Approved Manufacturer

Power factor correction equipment designer and manufacturer shall be:

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