

## 1 GENERAL

- 1.1 The work of this section includes the provision of all design, labour, materials, equipment and services required to fabricate and install electrical service and distribution as required for a complete project. The work includes, but is not necessarily limited to, the items referenced herein:
- 1.1.1 Transformers
  - 1.1.2 Low Volt Switchgear
  - 1.1.3 Power Distribution Cables
- 1.2 Submittals:
- 1.2.1 Submit shop drawings.
  - 1.2.2 Electrical load calculations.
- 1.3 Operations and Maintenance Manual:
- 1.3.1 Provide maintenance details for inclusion in Operations and Maintenance Manual.
  - 1.3.2 Provide list of spare parts and suppliers.
- 1.4 Commissioning:
- 1.4.1 Equipment supplied shall be tested, commissioned by an independent testing company and a full report submitted. Put into operation, complete with all test and acceptance certificates.
  - 1.4.2 Provide co-ordination study of all primary and secondary protection devices and transformers.
- 1.5 Warranty:
- 1.5.1 The Owner shall be furnished with a comprehensive warranty for 1 year from date of acceptance of commissioned system.

## 2 DESIGN

- 2.1 Building Distribution
- 2.1.1 The distribution system within the building shall be subdivided into the following categories:
    - 2.1.1.1. 347/600 V, 3 phases, 4 wire for fluorescent and H.I.D. interior/exterior lighting, electric heating (if applicable) and mechanical equipment for motors rated 1 HP and over.
    - 2.1.1.2. 120/208 V, 3 phases, 4 wire for incandescent lighting, miscellaneous power and mechanical equipment rated up to 1 HP.

- 2.1.1.3. Dedicated 120/208 V, 3 phases, 4 wire for electronic equipment and non-linear loads.
- 2.1.1.4. Applicable voltage rating to any specialized equipment or areas other than the ones mentioned above.
- 2.1.2 These systems are to be completely isolated from each other downstream of the main distribution switchboard. The power distribution system shall be designed to be safe and reliable and shall be heavy-duty commercial grade.
- 2.2 Provide a dedicated electrical room to accommodate the service entrance switchgear and sub distribution equipment. Locate the electrical room centrally, preferably on the main level.
- 2.3 Locate electrical closets strategically to provide maximum flexibility for power distribution and easy access to all portions of the floor area served.
- 2.4 Provide plywood backboards on all walls and emergency lighting in each room. Provide at least one non dedicated general purpose duplex receptacle in each closet and two receptacles in the main electrical room.
- 2.5 Use transformers of one manufacturer throughout the project.
- 2.6 Transformers and services are to be sized to provide 25% spare capacity above maximum demand.
- 2.7 Use zigzag and, or double zigzag transformers for non-linear loads.
- 2.8 Use panel boards and breakers of one manufacturer.
- 2.9 Distribution system shall be designed such that lighting loads are separate from HVAC loads to permit use of check metering.
- 2.10 Branch circuit distribution panels to be 60 circuit capacity. Provide lock-on devices for night lights circuit, exit lights circuit.
- 2.11 Distribution panels to be sized to provide 25% additional spaces and not less than two 100A 3 pole space per distribution panel. Provide at least six 15A 120V spare breakers in each branch circuit panelboard.
- 2.12 All non-linear loads such as computer equipment etc. shall be fed from dedicated distribution panels. Each circuit to be equipped with an insulated ground conductor. Panels to have 200% neutrals, standard ground bus, and isolated ground bus.
- 2.13 A dedicated full size neutral shall be provided for all non linear load circuits.
- 2.14 The building electrical system shall be provided with automatic power factor correction equipment to obtain a minimum of 95% power factor with the building in a normal full load condition.

- 2.15 Provide motor control equipment and starters for control of all mechanical equipment, starters of the same manufacturer to be used throughout the project.
- 2.16 Define co-ordination between Electrical and Mechanical trades. Identify all motors by reference number and responsibility for supply, installation and wiring for each piece of equipment. Mechanical equipment to be controlled through the Building Automation System.
- 2.17 Use three phase motors for 1 HP and above. Motors of 10 HP at 208 V and 30 HP at 600 V shall be equipped with reduced voltage starters.
- 2.18 Use adjustable motor circuit interrupters (MCPS) with all combination motor starters.
- 2.19 Where there are more than three starters in one location, group in a quadruplex or motor control centre.
- 2.20 Provide electrically held contactors controlled by auxiliary devices as required to EEMAC ICS1970 with the following features: Hand-off-auto; illuminated pilot lights; red, green, white. Devices to be heavy duty. Control relays to be field convertible.
- 2.21 Timing relays to be solid state.
- 2.22 All control wiring in grouped motor control to be brought out to terminal strips in a cabinet in a dedicated section for field wiring connections.
- 2.23 Size of service conductors are to match main service interrupter rating as per Electrical Safety Code and local hydro authority.
- 2.24 Provide electrical connection to all equipment identified in the program. The Designer is responsible for all coordination and determining all power requirements and to ensure a complete functional system.
- 2.25 Provide copper ground bus MIN 32 mm x 4 mm around interior of main electrical room and connect to ground electrodes (3m copper clad rods) connections to ground rods and all underground connections to be by thermit weld process and pressure clamps otherwise. Ground all exposed non-current carrying metallic parts of electrical equipment, raceway systems, grounding conductors in non metallic raceways and neutral conductor of wiring systems in accordance with CSA C22.1. Make grounding connections at the main service equipment and exterior grounding rods.
- 2.26 Provide empty conduits from service entrance board metering to the EMCS computer control location and to telephone room for future monitoring. Locations to be determined during design stage.
- 2.27 Emergency Power System
  - 2.27.1 Provide complete diesel and/or natural gas generator set with all fuel systems, ventilation systems, and exhaust systems for extended operation in utility power outage situations. Provide fuel storage capacity for minimum 24 hours operation at full load.

- 2.27.2 Generator to be rated for standby duty with fully automatic starting, 600/347 volt, 3 phase, 4 wire, rated for 100% of the loads connected plus 25% for future. Generator to also be used for peak shaving, controlled by BAS system.
- 2.27.3 Emergency power system to support the following loads.
  - 2.27.3.1. All exit lighting, including emergency battery units
  - 2.27.3.2. All stair lighting, including emergency battery units
  - 2.27.3.3. Designated emergency lighting fixtures for all exit routes
  - 2.27.3.4. Security system
  - 2.27.3.5. Other life safety systems
  - 2.27.3.6. All heating system, including BAS system
  - 2.27.3.7. 25% for additional future loads
- 2.27.4 Provide dedicated emergency distribution system within the building to serve all the intended equipment. All panels to have 25% spare capacity.
- 2.27.5 Acceptable manufacturers: Caterpillar; Kohler; Onan; Simpower
- 2.27.6 Comply to CAN/CSA-C282-M89 Emergency Electrical Power Supply for Buildings.

### **3 MATERIALS**

#### **3.1 Service Entrance Board:**

- 3.1.1 Rated for 600/347 V, 3 phase, 4 wire. Capacity and short circuit current ratings to suit the specific characteristics of the currently scheduled loads. Distribution system must allow for a 25% load growth without requiring modifications of, or addition to, the main distribution equipment. Copper bus, dead front. Provide with a 100% rated main service entrance moulded case electronic adjustable breaker. All feeder breakers shall also be moulded case with front adjustable electronic trip units. Ground fault protection on main breaker.

- 3.2 Meter: to measure true line/phase/max/min RMS voltages and currents, neutral currents, frequency, harmonics, kW, kVAR, kVA, power factor, and provide RS232 & RS485 communication ports. System to permit remote monitoring by Building Automation System.

#### **3.3 Transformers**

- 3.3.1 General Purpose Dry-Type Transformer

- 3.3.1.1. Transformer shall be sized to suit, plus 25% spare capacity, 3 phase, 3 coils with a common core construction, 60 Hz.
- 3.3.1.2. Primary winding shall be 600 volts, 3 phase, delta connected, complete with two full capacity 4.5% adjustment taps, 1 below (FCBN) and 1 above (FCAN) the rated voltage for 10 kVA and less, and four full capacity 2.5% adjustment taps, 2 below (FCBN) and 2 above (FCAN) the rated voltage for more than 10 kVA.
- 3.3.1.3. Secondary winding shall be 208Y/120 volts, 3 phase, wye connected, with a 30° angular displacement (lagging) with respect to the primary winding.
- 3.3.1.4. All winding conductors shall be of copper.
- 3.3.1.5. Temperature rise at full load shall not exceed 150°C with a class 220 insulation system.
- 3.3.1.6. Standard impedance at 60 Hz.
- 3.3.1.7. Audible sound level to be lower than NEMA ST-20 maximum levels.
- 3.3.1.8. Windings shall be wound with the secondary winding nearest to the core and shall be round coils.
- 3.3.1.9. The core shall be constructed of high grade, grain oriented silicon steel laminations.
- 3.3.1.10. The impregnation process for the core-and-coil assembly shall include a period under vacuum, followed by pressure impregnation using epoxy resin (EVI process).
- 3.3.1.11. The transformer shall be isolated from the enclosure to reduce noise and vibration by means of anti-vibration pads.
- 3.3.1.12. The transformer enclosure shall be fabricated from sheet steel and shall be Sprinkler-proof.
- 3.3.1.13. The enclosure coating shall be grey ASA 61, and suitable for indoor/outdoor use.
- 3.3.1.14. Transformer and enclosure shall be built as per the latest CSA standard C22.2 No.47.
- 3.3.2 Zig-Zag Transformer
  - 3.3.2.1. Transformer shall be sized as required, plus 25% spare capacity, 3 phase, 3 coils with a common core construction, 60 Hz.
  - 3.3.2.2. Primary winding shall be 600 V delta connected, complete with four full capacity 2.5% adjustment taps, 2 below (FCBN) and 2 above (FCAN) the rated voltage.

- 3.3.2.3. Secondary Windings:
- 3.3.2.3.1. For model TDZ ( Delta Transformers), the secondary winding shall be 208/120 volts, single output and interconnected to obtain a 0° angular displacement (lagging) with respect to the primary winding.
  - 3.3.2.3.2. For model TDV (Delta Transformers), the secondary winding shall be 208/120 volts, single output and interconnected to obtain a 30° angular displacement (lagging) with respect to the primary winding.
  - 3.3.2.3.3. Where required to eliminate 5th, 7th, 17th, 19th harmonic currents, secondary winding shall be double output interconnected to obtain a 0° and 30° angular displacement with respect to the primary winding.
- 3.3.2.4. Third harmonic (and 9th, 15th, 21st ...) currents shall be removed from the primary winding and primary side bus due to the secondary winding electromagnetic effect. No capacitors or electronics shall be used.
- 3.3.2.5. The 5th, 7th, 17th, 19th ... harmonic currents shall be removed from the primary side bus common to model TDZ (0°) and TDV (-30°) transformers. No capacitors or electronics shall be used.
- 3.3.2.6. All winding conductors shall be of copper.
- 3.3.2.7. Temperature rise at full load shall not exceed 150°C, with a class 220 insulation system.
- 3.3.2.8. Transformer shall be suitable for loads having a harmonic current content and shall have a K-rated factor of 13.
- 3.3.2.9. Positive and negative sequence impedance, at 60 Hz, is optimized to reduce Total Harmonic Distortion of voltage due to harmonic content of load current and shall be lower than 3.0%.
- 3.3.2.10. Zero sequence impedance, at 60 Hz, is optimized to reduce Total Harmonic Distortion of voltage due to harmonic content of load current and shall be lower than 5%.
- 3.3.2.11. Standard audible sound level.
- 3.3.2.12. Transformer shall have an electrostatic shield located between the primary and secondary windings for a common mode noise attenuation of 60 dB minimum.
- 3.3.2.13. Primary winding conductor shall be sufficient in size to limit temperature rise to its rated value even with the circulation of third harmonic (and 9th,

15th, 21st ...) currents due to unbalanced loads.

- 3.3.2.14. Conductors shall be individually insulated to minimize eddy current losses.
- 3.3.2.15. Windings shall be wound with the secondary winding nearest to the core and shall be round coils.
- 3.3.2.16. The core shall be constructed of high grade, grain oriented silicon steel laminations.
- 3.3.2.17. The impregnation process for the core-and-coil assembly shall include a period under vacuum, followed by pressure impregnation using epoxy resin (EVI process).
- 3.3.2.18. Secondary side neutral connection shall be rated for twice the ampacity of the rated phase current.
- 3.3.2.19. The transformer shall be isolated from the enclosure to reduce noise and vibration by means of anti-vibration pads.
- 3.3.2.20. The transformer enclosure shall be fabricated from sheet steel and shall be sprinkler-proof.
- 3.3.2.21. The enclosure coating shall be grey ASA 61 with an orange strip indicating harmonic treatment and suitable for indoor/outdoor use.
- 3.3.2.22. Transformer and enclosure shall be built as per the latest CSA standard C22.2 No.47. Transformer shall be built as per CSA TIL No.128 and UL standard 1561 for K-factor rating only.

#### 3.4 Distribution Panels:

- 3.4.1 Panelboards: suitable for bolt-on breakers only and complete with copper bussing, with full size neutral busses for all distribution and branch panels complete with ground bus, bonded to the panelboard for bonding conductors. Isolated ground bus plus standard ground bus for non linear (computer-electronic load) panels and 200% neutral.

#### 3.5 Power Factor Capacitors:

- 3.5.1 Capacitors to be dry type, non propagating liquid insulated in weatherproof enclosure. Unit to have discharge device to 50 V in 1 minute. Complete unit to be in accordance with CAN3-C155, EEMAC6G-1. Both individual capacitors associated with specific motors or a central common switched capacitor bank are considered acceptable.

#### 3.6 Motor Starters and Controls:

- 3.6.1 Manual starters single or three phase with quick-make quick break switching mechanism. With one or three overload heaters manual reset.

- 3.6.2 Full Voltage Magnetic Starters: Magnetic and combination magnetic starters of size, type, rating and enclosure type as required with components as follows:
  - 3.6.2.1. Contactor solenoid operated, rapid action type.
  - 3.6.2.2. Motor overload protective device in each phase, manually reset from outside enclosure.
  - 3.6.2.3. Power and control terminals.
  - 3.6.2.4. Wiring and schematic diagram inside starter enclosure in visible location.
  - 3.6.2.5. Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
- 3.6.3 Combination type starters to include disconnect switch with operating lever on outside of enclosure to control disconnect and provision for:
  - 3.6.3.1. Locking in "OFF" position with up to 3 padlocks.
  - 3.6.3.2. Locking in "ON" position.
  - 3.6.3.3. Independent locking of enclosure door.
  - 3.6.3.4. Provision for preventing switching to "ON" position with enclosure door open.
- 3.6.4 Accessories:
  - 3.6.4.1. Push-buttons and selector switches: HAND-OFF-AUTO oil tight with spring return feature on the test position, labelled as required.
  - 3.6.4.2. Indicating lights: standard, heavy duty, oil tight type.
  - 3.6.4.3. 2-N/O and 2-N/C spare auxiliary contacts.
  - 3.6.4.4. Single phase, dry type control transformer with primary voltage as required and 24 V secondary, complete with secondary fuse, installed in with starter as indicated.
  - 3.6.4.5. Size control transformer for control circuit load plus 20% spare capacity.
- 3.6.5 Reduced Voltage Starters: Unit to be Auto-Transformer closed circuit transition type with three 3 pole contactors. Auto transformer to have 50% - 65% - 80% taps. Adjustable timing relay.
- 3.6.6 Variable Frequency Drives:
  - 3.6.6.1. The Variable Frequency Drive shall provide micro processor based control of three phases motors. The controller shall be rated to suit the load. The continuous full load output current rating shall be based on 40°C ambient.

- 3.6.6.2. The VSD shall be of the pulse width modulated design converting the utility input voltage and frequency to a variable voltage and frequency output via a two steps operation.
  - 3.6.6.3. The VSD shall have an efficiency that exceeds 95% at 100% speed and load. It shall maintain the line side displacement power factor no less than 0.95 regardless of speed and load. It shall have one minute overload current rating of 150%.
  - 3.6.6.4. The VSD shall be capable of operating any 4 or 6 pole NEMA B squirrel cage induction motor, regardless of manufacturer, with full load current and horsepower rating equivalent to the capacity of the VDS.
  - 3.6.6.5. The VSD shall include a clean power line harmonic reduction system meeting the latest requirement of IEEE 529.
  - 3.6.6.6. Acceptable manufacturer: Cutler Hammer SV 9000
- 3.7 Fused and non-fused disconnect switches:
- 3.7.1 Fused and non-fused disconnect switches in CSA enclosure, size as required. Quick-make, quick-break action, provision for padlocking.
  - 3.7.2 To be weather-proof on all outdoor equipment.
- 3.8 Supply all other electrical service and distribution equipment to suit the requirements of the project. All equipment shall be fully rated, commercial grade.
- 4 INSTALLATION**
- 4.1 Install electrical equipment in electrical rooms and closets. Ensure room size allows for adequate servicing of equipment plus room for future expansion.
  - 4.2 Mount dry type transformers on 75 mm concrete pad to ensure adequate clearance for ventilation is available.
  - 4.3 Install transformers level and upright, loosen isolation pads until no compression is evident.
  - 4.4 Set and secure switchgear, service entrance equipment, motor control centre in place on channel base rigid and plumb. Mount on 75 mm concrete pad.
  - 4.5 Install circuit breaker panelboards and install circuit breakers. Connect all loads to circuits.
  - 4.6 Check all factory made connections in all switchgear for mechanical security electrical continuity. Check all trip units, heater settings, fuse sizes, test and commission, energize and put into working condition.
  - 4.7 Install starters, connect power and controls wiring. Perform starting and stopping and relays. Sequence controls, interlocking with other separate related starters,

equipment, control devices to operate to meet the requirement of the facility.

***End of Section***