.5 All VFD set-up operations and adjustments to be digital and stored in a nonvolatile memory (EEPROM). No analog or potentiometer adjustments to be allowed.

.6 The VFD to be capable of communicating with a communication device over the remote I/O serial link, multi-drop, typically RS485, using industry standard communication protocol. Provide software to upload and download parameters via labtop computer.

.2 Speed Droop: a speed droop feature which reduces the speed of the drive on transient overloads. The drive is to return to set speed after transient is removed. If the acceleration or deceleration rates are too rapid for the moment of inertia of the load, the drive is to automatically compensate to prevent drive trip.

.3 Speed Profile: individual adjustable settings for start, stop, slope, and minimum and maximum speed points.

.4 Process Signal Inverter: software selectable to allow speed of drive to vary inversely with input signal.

.5 Digital Interface

Provide a local interface to upload, download and read drive parameter settings through the use of a personal computer or a similar portable device.

.6 Pick up a Spinning Load (Rotating Start): The VFD shall be programmable for rotating start, enabling the VFD to start into a rotating motor, regardless of direction, without tripping and without setting the motor to zero speed. The VFD to start at the speed the motor is rotating and then accelerate the motor according to the speed reference signal.

.7 Bumpless speed transfer: Provide a bumpless speed transfer from remote control to local control, without setting the motor to zero speed.

.8 Automatic Reset/Restart

.1 Provide software programmable automatic reset/restart after any individual trip condition resulting from either overcurrent, over voltage, under voltage, or over temperature.

.2 For safety, the drive shall shut down and require manual reset if the automatic reset function is not successful within a maximum of three attempts within a short time period.

.9 IR Compensation

Complete set of parameters (programmable range) which allows for extra torque to be applied at speeds between 0.1 Hz and the set field weakening point, 140% rated torque shall be produced with 150% rated current.

.10 Torque Compensation

The automatic boost in torque to handle impulse loads or demands for fast acceleration by momentarily increasing the output volt/hertz ratio. When selected, the function to be operative at all speeds even under overload conditions, and eliminates the motor speed droop that would otherwise occur.

2.5.14 External Control and Monitoring

.1 General

Provide isolation and voltage surge suppression for contacts used for external monitoring to limit inductive switching surges to less than 200 V peak. Provide DC coils with free-wheeling diodes to limit inductive surges to 28 V peak.

.2 Wiring

Use twisted shielded pairs for control and signal wiring that connects external to the VFD. Separate signal and power wiring that may contain voltage and/or current harmonics inherent to inverter.

.3 Digital Operator Station (Front Panel)

.1 Provide an operator station on the drive door complete with the following features as a minimum:

.1 START pushbutton for local VFD control
.2 STOP pushbutton for local VFD control
.3 Start and Stop pushbuttons for Bypass control in "Local" mode
.4 Speed raise / lower pushbuttons with digital frequency display for local speed adjustment
.5 VFD RUN light
.6 VFD FAULT light
.7 Inverter - Off - Bypass selector Switch
.8 Local - Off - Remote control selector switch
.9 Green "Run" Pilot Lamp
.10 Red "Bypass On" Pilot Lamp
.11 Speed Indication
.12 Motor Current Indication.

.4 Speed Control

.1 The VFD to contain an independent parameter which provide an adjustable minimum speed setting from 0 to 60 Hz.

.2 The VFD to contain an independent parameter which provides an adjustable maximum speed setting from 40 to 90 Hz.

.3 The VFD to accept an isolated analog input speed reference of 4-20 mA and be adjustable via the digital operator station.

.4 The 4-20 mA analog input speed reference signal to be galvanically isolated. Calibration adjustments shall be provided within the speed ranges specified.

.5 Selectable stopping modes of coast, ramp to stop or DC brake to stop shall be available.

.6 Provide one adjustable skip frequencies with programmable band width.

.5 Drive Controls

.1 Provide control transformer, fuses, terminal blocks and control relay(s) interconnected in accordance with the project requirements.

.2 The VFD to accept an isolated output signal via DCS to stop and start the drive.

.3 The VFD inverter to have capability to interlock of 3n/c external interlocks.

.4 The VFD to provide 3 isolated form C contact outputs rated for 120Vac. Status of contacts to indicate:

.1 Run
.2 Ready
.3 Fault.

.5 The Drive to be wired to achieve the following functionality:

.1 Motor selected to "Remote" enables motor to be started, stopped and speed to be adjusted via BCS.
.2 Motor selected to "Local" enables motor to be started, stopped and speed to be adjusted via the front panel pushbuttons.

2.5.15 Drive Protection/Fault Annunciation

The VFD to be capable of monitoring the following conditions or sensing the following faults. Where indicated in the following text, the condition or fault shall be annunciated on the diagnostic display panel. The panel to be mounted on the front of the VFD and visible through the door of the enclosure. The VFD to instantaneously shut down when a fault condition occurs.

.1 Short circuit protection
.2 DC bus under voltage protection
.3 DC bus over voltage protection
.4 Over temperature protection
.5 Power semiconductor protection
.6 Ground Fault protection.

2.5.16 Parameter Settings

.1 Provide the following system configuring settings, field adjustable through the keypad/display unit or via the serial communication port.

.2 Motor configuration data:

- .1 Motor frequency
- .2 Number of poles
- .3 Full load speed
- .4 Motor volts
- .5 Motor full load amps
- .6 Motor HP.

.3 VFD limits:

- .1 Independent accel/decel rates
- .2 No load boost
- .3 Vmin, Vmax, V/Hz
- .4 Full load boost
- .5 Overload trip
- .6 Min/Max speed (frequency)
- .7 Auto reset for load or voltage trip select
- .8 Slip compensation
- .9 Rotating Start select
- .10 Overload trip time.

.4 Controller Adjustments:

- .1 Minimum frequency 0 - 60 Hz.
- .2 Maximum frequency 40 - 90 Hz.
- .3 Acceleration time 0.3 - 255s.
- .4 Deceleration time 0.3 - 255s.
- .5 Output current 50 - 150% of nominal current for constant torque. Output current 50 - 125% for variable torque application minimum.
- .6 Speed range 0 - 110%.
- .7 Start by: Normal acceleration or, automatic start boost or rotating start.
- .8 Stop by: Coasting or, normal deceleration or, braking.
- .9 Slip compensation.
- .10 Electronic o/l adjustment.
- .11 Automatic restart after over voltage.
- .12 Automatic restart after under voltage.
- .13 IR compensation boost between 15 - 45V depending on size of unit.
- .14 Linear or tapered V/Hz ratio.
- .15 Selection of field weakening point (V/Hz ratio).
- .16 Automatic start boost, programmable, active only at start until output frequency reaches 20 Hz or set speed reference less than 20 Hz.

2.5.17 Diagnostic Features and Fault Handling

.1 Provide a microprocessor based digital diagnostic system which monitors its own control functions and displays faults and operating conditions. Microprocessor systems must be product of the same manufacturer as the VFD to assure single source responsibility, availability of service and access to spare parts.

.2 The digital keypad allows the operator to enter exact numerical settings. A plain English user menu shall be provided in software as a guide to parameter setting, (rather than codes). Drive parameters shall be factory set in EEPROM and be resettable in the field through the keypad. Multi levels of password security shall be available to protect drive parameters from unauthorized personnel. The EEPROM stored drive variables must be able to be transferred to new boards to reprogram spare boards.

.3 The VFD to execute, on initial power-up, a self diagnostic check. The integral programming display panel shall provide first fault indication of VFD protection functions. Fault indication to be retained if input power is lost. The following faults to be displayed on the local programming panel:

- .1 Overcurrent
- .2 Short Circuit/Ground Fault
- .3 Under voltage
- .4 Over voltage
- .5 Over temperature
- .6 Power Supply Fault
- .7 Motor stalled

  - .1 Fault codes to provide direction as to board level and input/output level to aid in trouble shooting.
  - .2 The fault log record shall be accessible via a RS485 serial link as well as line by line on the keypad display.
  - .3 Self diagnostic check to indicate faulty internal components.

2.5.18 Factory Testing

.1 Provide certification that the following tests have been successfully completed.

.2 Factory tests include but are not limited to:

- .1 Testing of power transistors, diodes and other solid state components to ensure correct function and highest reliability.

- .2 All control printed circuit boards shall be dynamically tested while heat cycled.

2.5.19 Bypass

.1 Provide for a manual bypass control scheme to safely apply full voltage to the driven motor in the event of a failure to the Adjustable Speed Drive. The bypass scheme shall meet the following minimum requirements:

.1 Provide HRC time delay bypass line fuses after the door interlocked fusible disconnect.

.2 Provide primary and secondary fused 120 Vac control power.

.3 Provide motor starter contactor for Bypass and AFD operation. Selection of mode of operation will be via integral mounted Inverter-OFF-Bypass selector switch.

.4 Provide a thermal overload relay sized to protect the motor for either mode of operation.

.5 Provide a Local-Off- Remote selector switch and a interposing relay to select the run/stop operation in conjunction with BYP-OFF-AFD switch as follows:

.1 "Inverter" MODE:

.1 Selector switch in "Local" position.
.2 VFD operated by panel mounted start and stop pushbuttons, speed controlled by the keypad.
.3 Selector switch in "OFF" position VFD cannot be started.
.4 Selector switch in "Remote" position VFD operates by remote start/stop command, the speed controlled by the isolated 4 - 20mA signal.

.2 BYPASS MODE:

.1 "Local" position starts Bypass manually via panel mounted "Bypass start and stop pushbuttons".
.2 "OFF" position prevents motor from operating.
.3 "Remote" position allows motor to start by remote start/stop command.
.4 NOTE: All Interlocks are in the circuit for all modes of operation.

2.5.20 Structure Installation

.1 Install variable speed drives with the assistance of factory-trained engineers in accordance with the manufacturer's specifications.

.2 Coordinate with motor control centre supplier for the supply and installation of the drive into the motor control centre.

2.5.21 Field Test

.1 Provide manufacture engineers to test and calibrate each VFD. Allow for 1/2 day per system.

.2 Provide written report of commissioning test including all parameter settings.

.3 Reference Sections 16960, 16980 and 16990 for details of commissioning requirements.

2.5.22 Documentation

.1 Provide operating and maintenance manuals.

.2 Provide as tested, as built, find power and connection drawings.

.3 Provide as left parameter settings for all functions.

2.5.23 Training

.1 Provide operator training and maintenance and servicing seminar for 1/2 day.

.2 The on site training to cover the following topics as a minimum:

- .1 Theory
- .2 Configuration/models
- .3 Setup
- .4 Maintenance
- .5 Troubleshooting.

3. EXECUTION

3.1 Installation

.1 Install starters, variable frequency drives, connect power and control as indicated.

.2 Ensure correct overload devices elements installed.

3.2 Starter Verification

.1 Field check motor starters and variable frequency drives, supplied prior to commissioning equipment. As a minimum, verify the following:

- .1 Check of control circuits
- .2 Verify that overload relay installed is correctly sized for motor used

.3 Record overload relay size and motor nameplate amperage
.4 Ensure all connections are tight.

.2 Measure and record motor amps, under load conditions and compare with full load amps and motor service factor. Report any excessive readings and unbalance. Measure voltage as close to motor terminals as possible while motor is running

.3 Set all motor circuit protectors to the minimum level which will consistently allow the motor to start under normal starting conditions.

3.3 Overload Relays

.1 For starters provided, select overload relays in accordance with relay and motor manufacturers' recommendations, considering motor service factors, ambient temperature, temperature differences between motor and starter locations. Monitor motor operation during startup to ensure motor operation is satisfactory and relays provide proper protection. For side inlet fans and other long acceleration time loads, provide special overload relays to suite the start-up condition. Provide manufacturers' curves and data sheets where necessary to provide supporting data for motor protection.

3.4 Field Quality Control

.1 Perform tests in accordance with Section 16980 - Testing, Adjusting and Balancing of Electrical Equipment and Systems and manufacturer's instructions.

.2 Operate switches, contactors to verify correct functioning.

.3 Perform starting and stopping sequences of contactors and relays.

.4 Check that sequence controls, interlocking with other separate related starters, variable frequency drives, equipment, control devices, operate as indicated.

END OF SECTION

MOTOR CONTROL CENTRE

1. GENERAL

1.1 Related Work

.1 Cast-in Place - Concrete - Installation of anchor devices, channel base sills, setting templates: Division 03

.2 Motor Starters to 600 Volt & Variable Frequency Drives: Section 16811

.3 Connections to Mechanical Equipment: Section 16950

1.2 References

.1 CAN/CSA-Q9000, Quality Management and Quality Assurance Standards - Guidelines for Selection and Use.

1.3 Shop Drawings

.1 Submit shop drawings in accordance with Section 16010 - Electrical General Requirements.

.2 Indicate:

- .1 Outline dimensions
- .2 Configuration of identified compartments
- .3 Floor anchoring method and dimensioned foundation template
- .4 [Cable] [Bus duct] entry and exit locations
- .5 Dimensioned position and size of busbars and details of provision for future extension
- .6 Schematic and wiring diagrams.

1.4 Operation And Maintenance Data

.1 Provide operation and maintenance data for motor control centre for incorporation into manual specified in Section 16010 – Electrical General Requirements.

.2 Include data for each type and style of starter.

1.5 Maintenance Materials

.1 Provide maintenance materials in accordance with Division 01 – Maintenance Materials, Special Tools and Spare Parts.

1.6 Source Quality Control

.1 Provide manufacturer's type test certificates including short circuit fault damage certification up to short circuit values specified under bus bracing.

.2 Consultant to witness standard factory testing of complete motor control centre including operation of switches, circuit breakers, starters and controls.

.3 Manufacturer to provide proof of quality control program in accordance with CAN/CSA-Q9000.

2. PRODUCTS

2.1 Supply Characteristics

.1 600 V, 60 Hz, delta connected, 3 phase, 3 wire, grounded.

2.2 General Description

.1 Compartmentalized vertical sections with common power busbars.

.2 Metal enclosed, free standing, enclosed dead front.

.3 Indoor EEMAC type 1A gasketted enclosure, front mounting

.4 Class I Type C.

.5 Pre Approved: Square D, Siemens, Allen-Bradley Centreline, Cutler Hammer.

2.3 Vertical Section Construction

.1 Independent vertical sections fabricated from rolled flat steel sheets bolted together to form rigid, completely enclosed assembly.

.2 Each vertical section divided into compartment units, minimum 305 mm high, as indicated.

.3 Each unit to have complete top and bottom steel plate for isolation between units.

.4 Horizontal wireways, equipped with cable supports, across top and bottom, extending full width of motor control centre, isolated from busbars by steel barriers.

.5 Vertical wireways c/w doors for load and control conductors extending full height of vertical sections, and equipped with cable tie supports. Installation wiring to units accessible with doors open and units in place.

.6 Openings, with removable coverplates, in side of vertical sections for horizontal wiring between sections.

.7 Incoming cables to enter at top with terminals as indicated.

.8 Provision for outgoing cables to exit via top or bottom with terminals.

.9 Removable lifting means.

.10 Provision for future extension of both ends of motor control centre including busbars without need for further drilling, cutting or preparation in field.

.11 Divide assembly for shipment to site, as required by contractor, complete with hardware and instructions for re-assembly.

2.4 Sills

.1 Continuous 75 mm x 25 mm channel iron floor sills for mounting bases with 19 mm diameter holes for bolts.

2.5 Busbars

.1 Main horizontal and branch vertical, three phase high conductivity tin plated copper busbars in separate compartment bare self-cooled, extending entire width and height of motor control centre, supported on insulators and rated:

  .1 Main horizontal busbars: 600 A
  .2 Branch vertical busbars: 300 A.

.2 Branch vertical busbars for distribution of power to units in vertical sections.

.3 No other cables, wires, equipment in main and branch busbar compartments.

.4 Brace buswork to withstand effects of short-circuit current of 42kA rms symmetrical.

.5 Bus supports: with high dielectric strength, low moisture absorption, high impact material and long creepage surface designed to discourage collection of dust.

2.6 Ground Bus

.1 Copper ground bus extending entire width of motor control centre.

.2 Vertical ground bus strap, full height of section, tied to horizontal ground bus, engaged by plug-in unit ground stab.

2.7 Motor Starters And Devices

.1 Equip the MCC with the combination starters and variable frequency drives as specified in Section 16811 – Motor Starters to 600 V & Variable Frequency Drives, and as shown on the drawings.

2.8 Starter Unit Compartments

.1 Units EEMAC size 5 and smaller, circuit breaker units 225 A and smaller, plug-in type with self-disconnect. Guide rail supports for units to ensure that stabs make positive contact with vertical bus. Provision for units to be installed or removed, off load, while buses energized.

.2 Unit mounting:

.1 Engaged position - unit stabbed into vertical bus.

.2 Withdrawn position - unit isolated from vertical bus but supported by structure. Terminal block accessible for electrical testing of starter.

.3 Provision for positive latching in either engaged or withdrawn position and padlocking in withdrawn position.

.4 Stab-on connectors free floating tin plated clips, self-aligning, backed up with steel springs.

.3 External operating handle of circuit switch interlocked with door to prevent door opening with switch in "on" position. Provision for one and four padlocks to lock operating handle in "off" position and lock door closed.

.4 Hinge unit doors on same side.

.5 Overload relays manually reset from front with door closed.

.6 Pushbuttons and indicating lights mounted on door front.

.7 Devices and components by one manufacturer to facilitate maintenance.

.8 Pull-apart terminal blocks for power and control to allow removal of starter units without removal of field wiring.

2.9 Wiring Identification

.1 Provide wiring identification in accordance with Section 16010 – Electrical General Requirements.

2.10 Equipment Identification

.1 Provide equipment identification in accordance with Section 16010 – Electrical General Requirements.

.1 Motor control centre main nameplate: size No. 7, engraved.

.2 Individual compartment nameplates: size No. 5, engraved as indicated.

2.11 Finishes

.1 Apply finishes in accordance with Section 16010 – Electrical General Requirements.

.2 Paint motor control centre exterior light gray and interiors white.

3. EXECUTION

3.1 Installation

.1 Set and secure motor control centre in place on channel bases, rigid, plumb and square to building floor and wall.

.2 Make field power and control connections as indicated.

.3 Ensure correct overload heater elements are installed.

.4 Some re-arrangement of compartments is permitted from that indicated to suite manufacturer's standards, provided that re-arrangement give approximately the spaces shown on the drawings. Submit arrangement drawings to the Consultant before starting detailed drawings.

.5 Coordinate concrete pad with bevelled edges as shown on the drawings, sized to suit MCC, install and level channel sills and mount MCC.

.6 Provide control centres with vertical sections, each 2286 mm high, 508 m deep and 508 mm wide, assembled into a group having a common power bus and forming an enclosure to which additional sections may be readily added. Provide drip shields on all motor control centre sections.

.7 Provide main circuit carrying parts cable of withstanding, without damage, a line to line or line to ground shot circuit corresponding to a symmetrical RMS current of 42 KA, unless otherwise indicated. Brace main busses to withstand a similar short circuit.

.8 Design for all power and control connections to be made from the front. All bus and feeder bolted connections shall be accessible from the front.

.9 Sections with horizontal wiring spaces top and bottom and with 102 mm full height vertical wiring spaces with cable tile supports. Insulate wireways from horizontal and vertical bus.

.10 Incorporate starters, circuit breakers, panels, etc. as detailed. Provide shop drawings for review before commencing fabrication.

.11 Provide all spaces complete with bussing hardware and other accessories required so that additional combination starter units can be readily installed. Provide barriers to isolate the space from all bus work.

.12 For each section of structure, provide a 3 phase horizontal bus rated as shown, and a 3 phase vertical bus rated 300 amperes. Tin plate vertical and horizontal bus at each joint. Provide a continuous copper ground bus in bottom of each section. Bus shall be copper with labyrinth design insulation - isolation for vertical bus.

.13 Contain each complete control device within an individual metal enclosure complete isolated from all other equipment. Provide plug-in type units.

.14 Provide tin plated copper bus bar stabs reinforced with strong spring steel to ensure high contact pressure.

.15 Equip door of each individual unit with a removable plate replaceable with similar [plate complete with pushbuttons, pilot lights or selector switches as required. Use pilot lights of push-to-test type and push button of heavy duty oil tight construction.

.16 Provide appropriate flanges and bus connections for incoming line and feeders.

.17 All joints and connections to be tin plated, cadmium plate all bolts, nuts and lock washers to resist corrosion.

.18 Provide pull apart terminal block plug in each starter for all external control connections, such that each starter unit may be easily removed. All terminals shall be identified.

.19 Provide barriers to isolate all buswork to prevent accidental contact when starter units are removed or spaced are provided. Barriers shall also provide phase to phase isolation of the vertical bus.

.20 Complete control wiring diagrams for each starter with conductor identification clearly shown shall be affixed to the interior cover of the starter section or provide a book of wiring diagrams for all starters in each MCC.

.21 Primary and secondary H.R.C. fusing shall be installed on the control transformer.

.22 Each MCC containing three or more vertical sections shall contain a control terminal section consisting of one full stack in height and depth. It shall be barriered from the adjacent 600 volt section. The control terminal section shall be complete with a solid back pan at the rear for the installation of control terminals.

.23 Control wiring shall be extended from each starter module to the control terminal section, including all auxiliary contacts. A multi unit style terminal block having screw type terminal connections shall be installed on standoff supports on back plate.

.24 All terminals shall be number coded or otherwise suitably identified to indicate which section or module of the MCC they are associated with and their function.

3.2 Starter Verification

.1 Field check motor starters supplied prior to commissioning equipment. As a minimum, verify the following:

.1 Check of control circuits
.2 Verify that overload relay installed in correctly sized for motor used
.3 Record overload relay size and motor nameplate amperage
.4 Visual inspection of fuses and contactors
.5 Ensure all connections are tight.

.2 Measure and record motor amps, under load conditions and compare with full load amps and motor service factor. Report any excessive readings and unbalance. Measure voltage as close to motor terminals as possible while motor is running.

.3 Set all motor circuit protectors to the minimum level which will consistently allow the motor to start under normal starting conditions.

3.3 Overload Relays

.1 For starters provided, select overload relays in accordance with relay and motor manufacturers' recommendations, considering motor service factors, ambient temperature, temperature differences between motor and starter locations. Monitor motor operation during start-up to ensure motor operation is satisfactory and relays provide proper protection. For side inlet fans and other long acceleration time motors, provide special overload relays to suit the start-up condition. Provide manufacturers' curves and data sheets where necessary to provide supporting data for motor protection.

3.4 Field Quality Control

.1 Perform tests in accordance with Section 16980 – Testing, Adjusting and Balancing of Electrical Equipment and Systems.

.2 Ensure moving and working parts are lubricated where required.

.3 Operate starters in sequence to prove satisfactory performance of motor control centre.

END OF SECTION

CONNECTIONS TO MECHANICAL EQUIPMENT

1. GENERAL

1.1 Related Work

.1 Mechanical: Division 15

.2 Motor Starters: Section 16811

1.2 Requirements

.1 Provide a complete system of wiring to motors and controls as specified herein and as shown on the drawings.

.2 Unless specifically noted otherwise, wire and leave in operation all electrically operated equipment supplied under all contracts related to this project. Examine the drawings and shop drawings of all Divisions for the extent of electrically operated equipment supplied under other contracts.

.3 All control wiring diagrams shown on the drawings illustrate typical control circuits applicable to the equipment. Control circuits may vary with different manufacturers of equipment. Verify all control circuits with the suppliers of the equipment and make any corrections that may be required.

.4 Unless specifically noted otherwise, supply all pushbuttons, relays, starters, etc., necessary for the operation of equipment. Check all starters, relay coils and thermal elements to ensure that they provide the necessary protection for motors.

.5 Do not operate motors and controls until approval is obtained from the trade providing equipment.

.6 Examine drawings and shop drawings of other Divisions to obtain exact location of motors and equipment shown on drawings. Where necessary, obtain conduit locations from other trades' drawings and shop drawings.

.7 Assist in placing in operation all mechanical equipment having electrical connections.

.8 Provide three phase starters with fused 120 volt control transformers and overload relays.

.9 Provide all power wiring for all motors and control wiring as indicated on the drawings.

.10 In general, wiring for freezestats, firestats, E.P. switches, P.E. switches, dampers, temperature controllers, flow switches, solenoid valves, etc., for heating ventilating and air conditioning equipment will be under a separate contract. Provide terminations in starters and MCCs for control wiring so that starter control circuits may be extended. Where 120 volt power is required for mechanical equipment, i.e. control cabinets, etc. wiring to the equipment terminals is the work of this Division.

.11 Refer to Motor Control Equipment Schedule.

.12 Some specific definitions of equipment wiring responsibilities are as follows:

.1 Process Pumps

.1 Provide all 120V and 600 V wiring for this equipment. Provide all 120V control wiring to control panel to provide pump operation and interlocking as shown on the drawings.

.2 Fans

.1 Provide all 120V and 600 V power wiring. Except where specifically noted otherwise, all control for fans is to be supplied, installed and wired from the starter control circuits to the equipment under Division 15.

.3 Pumps for Domestic Water, Plumbing & Drainage Systems

.1 Provide all 120V and 208V and 600 V power wiring. Except where specifically noted otherwise, all control for pumps is to be supplied, installed and wired from the starter control circuits to the equipment under Divisions 15 or 17.

.4 Unit Heaters

.1 Provide power wiring and starters for unit heater fans. Install and wire line voltage thermostats supplied by others. Where thermostats are low voltage or pneumatic, control wiring is under Division 15.

.5 Forced Flow Convectors

.1 Provide 120V power supply to the convectors. Starters, speed controllers and temperature controllers will be supplied and wired under Division 15.

2. PRODUCTS

2.1 3 Phase Motor Disconnect Switches

.1 Industrial Type "A", having quick make, quick break visible blade mechanism, cover interlocks and padlocking switch in the closed or open position. Use EEMAC 4 enclosures outdoors, and EEMAC 1 indoors switches to be H.P. rated, Westinghouse heavy duty type.

2.2 120 Volt, 1 Phase Disconnect Switches

.1 Manual starter without overload relay.

2.3 208 Volt, 1 Phase Motor Disconnect Switches

.1 Manual starter without overload relay.

3. EXECUTION

3.1 Installation

.1 Provide disconnect switches adjacent to all motors.

.2 Provide all wiring between all force flow and unit heaters and their thermostats. Install wiring between all flow switches and valve monitors and the fire alarm panel.

.3 Do control wiring as indicated on the drawings and the motor control schedules.

END OF SECTION

STARTING OF ELECTRICAL EQUIPMENT AND SYSTEM

1. GENERAL

1.1 Related Work

.1 Testing, Adjusting and Balancing of Electrical Equipment and Systems: Section 16980

.2 Electrical Equipment and Systems Demonstration and Instruction: Section 16990

1.2 Coordination

.1 Coordinates starting of electrical equipment and systems with testing, adjusting and balancing, and demonstration and instruction of:

  .1 Electrical equipment and systems specified in Division 16.

  .2 Mechanical equipment and systems specified in Division 15.

  .3 Other equipment and systems specified in other Divisions.

.2 Where any equipment or system requires testing, adjusting or balancing prior to starting, ensure that such work has been completed prior to starting of electrical equipment and systems.

2. PRODUCTS – (NOT USED)

3. EXECUTION

3.1 Energizing Main Electrical System

.1 Prior to energizing main electrical system:

  .1 Verify supply authority voltage and phase rotation.

  .2 Verify voltage and phase rotation of the standby generator.

  .3 Close and open all devices to ensure proper mechanical operation.

3.2 Starting Motors

.1 Prior to starting motors:

  .1 Verify phase rotation at motor control centres.

  .2 Confirm motor nameplate data with motor starter heater overloads.

3.3 Energizing Equipment

.1 Prior to energizing equipment provided under other Sections and equipment provided by the Owner.

.2 Confirm equipment nameplate data with characteristics of power supply.

END OF SECTION

TESTING, ADJUSTING AND BALANCING OF ELECTRICAL EQUIPMENT AND SYSTEMS

1. GENERAL

1.1 Intent

.1 Except where otherwise specified, arrange and pay for testing, adjusting, balancing and related requirements specified herein.

.2 If test results do not conform with applicable requirements, repair, replace, adjust or balance equipment and systems. Repeat testing as necessary until acceptable results are achieved.

.3 Provide all labour, materials, instruments and equipment necessary to perform the tests specified.

.4 All tests shall be witnessed by persons designated by the Owner, who shall also sign the test documentation.

.5 Submit procedures proposed in writing for approval 2 weeks prior to test.

1.2 Related Work

.1 Electrical General Requirements: Section 16010.

.2 Starting of Electrical Systems and Equipment: Section 16960.

1.3 Manufacturer's Production Test Records

.1 If requested, submit copies of production test records for production tests required by EEMAC and CSA standards for manufactured electrical equipment.

1.4 Site Testing Reports

.1 Log and tabulate test results on appropriate test report forms.

.2 Submit forms to Consultant for approval prior to use.

.3 Submit completed test report forms as specified, immediately after tests are performed.

1.5 Reference Documents

.1 Perform tests in accordance with:

.1 The Contract Documents
.2 Requirements of authorities having jurisdiction
.3 Manufacturer's published instructions
.4 Applicable CSA, IEEE, IPCEA, EEMAC and ASTM standards.

.2 If requirements of any of the foregoing conflict, notify Consultant before proceeding with test and obtain clarification.

1.6 Manufacturer's Site Services

.1 Arrange and pay for the site services of approximately qualified manufacturer's representatives where site testing, adjusting, or balancing of electrical equipment or systems' performed by Manufacturer's representatives is:

.1 Specified, or

.2 Otherwise required to ensure that electrical equipment and systems are operational in full compliance with the Contract Documents.

1.7 Sequencing and Scheduling

.1 Except where otherwise specified, perform all testing, adjusting, balancing and related requirements specified herein prior to Interim Acceptance of the Work.

.2 Perform voltage testing and adjusting after user occupancy or utilization of facility.

2. PRODUCTS

2.1 Test Equipment

.1 Provide all equipment and tools necessary to perform testing, adjusting and balancing specified herein and as otherwise required.

3. EXECUTION

3.1 Testing of Wiring and Wiring Devices

.1 All power and control wiring shall be tested for insulation resistance value with a 1000 volt megger. Resistance values shall be as recommended by cable manufacturer. Test results shall be properly tabulated, signed, dated and submitted with maintenance manuals.

.2 Test service grounding conductors for ground resistance.

.3 Test all wiring devices for correct operation.

.4 Test all receptacles for proper polarity and circuitry.

3.2 Ground Resistance Testing

.1 Measure ground resistance with earth test meter to verify compliance with CSA C22.2 No. 0.4 and Canadian Electrical Code.

3.3 Load Balance Testing

.1 Perform load tests when as many loads as possible, prior to Interim Acceptance of the Work, are operable.

.2 Turn on all possible loads.

.3 Test load balance on all feeders at distribution centres, motor control centre and panelboards.

.4 If load balance exceeds 15%, reconnect circuits to balance loads.

3.4 Power Factor Testing

.1 Record power factor readings at 15 minute intervals for full 24 hour period during normal operation of the facility.

.2 Take reading at following locations on distribution system:

- .1 Main Service
- .2 Motor Control Centre

3.5 Voltage Testing and Adjusting

.1 Test voltage at all panelboards.

.2 Test voltage at motor control centre.

.3 Adjust transformer tap settings to compensate for under-voltage or over-voltage conditions, if directed to do so by Consultant.

END OF SECTION

ELECTRICAL EQUIPMENT AND SYSTEMS DEMONSTRATION AND INSTRUCTION

1. GENERAL

1.1 Intent

.1 Reference Section 01735 – Commissioning

.2 Provide demonstration and instruction sessions to familiarize Owner's operation and maintenance personnel with electrical systems and their operation and maintenance.

.3 Submit system sign off sheets for each system listed prior to substantial completion.

.4 Complete a motor survey sheet for each motor and submit prior to substantial completion. Include a control wiring diagram for each motor neatly drawn in ladder form. Indicate all terminal and wire numbers. Identify all associated control components. Provide typed copies of these lists and diagrams in the operating/maintenance manuals. Include motor overload selection charts for each type and application of overload relay.

.5 All sign off and survey sheets shall be typewritten.

1.2 Manufacturer's Site Services

.1 Arrange and pay for appropriately qualified manufacturers representatives to provide or assist in providing electrical equipment and system demonstration and instruction as specified herein.

1.3 Contractor/Owner Coordination

.1 Owner will chair demonstration and instruction sessions.

.2 Establish agendas for demonstration and instruction sessions in conjunction with Owner. Coordinate scheduling of sessions with Owner.

2. PRODUCTS (NOT APPLICABLE)

3. EXECUTION

3.1 Systems Demonstration

.1 Demonstrate operation of following systems:

- .1 600/347 Volt Electrical System
- .2 208/120 Volt System
- .3 Generator and controls
- .4 Mechanical Equipment Connections and Controls

.5 Grounding System

.6 Telephone

.7 Lighting

.8 Lighting Controls

.9 Future Connection Points and Conduit Stubs.

MOTOR SURVEY SHEET

Motor Name & Number ______________________________

Manufacturer ______________________________

H.P. ______________________ Max. Ambient ____________ °C

R.P.M. ______________________ Service Factor ____________

Volts ________ / ________ / ________ Insulation Class ____________

AMPS ________ / ________ / ________ EEMAC Design ____________

PHASE ______________________ Time Rating ____________

Frame ______________________ Type ____________

Serial #

Model # ______________________________

Starter ______________________ Type ____________

OPERATING CONDITIONS

Full Load Operating Amps ______________ A ________ B ________ C

Full Load Operating Voltage at Motor ______________ A-B ________ B-C ________ C-A

Overload Relay Installed ______________ Adjustable Setting ____________ %

M.C.P. AMPS ______________ Adjustable Setting ____________

Acceleration Time (If over 5 seconds) ______________________

Reduced Voltage Starter Tap Setting ______________________

Reduced Voltage Starter Transition Time Setting ______________________

Special Controls and Remarks (Thermistor and Relay Type, Capacitors and where connected, etc.

____

____

SYSTEM COMPLETION AND COMMISSIONING

SYSTEM: ____________________

The above system is installed as per the drawings and specifications, is complete and has been commissioned.

Electrical Contractor

Signed by: ____________________ Dated: ____________________

General Contractor

Signed by: ____________________ Dated: ____________________

Deficiencies Attached ZD?
@DY

This system has been reviewed by:

The Consultant

Signed by: ____________________ Dated ____________________

The Owner's personnel have been instructed in the operation and maintenance of the above system:

The Owner

Signed by: ____________________ Dated ____________________

The above does not constitute a waiver of any of the requirements of the Contract Documents.

	ELECTRICAL CONTRACTOR	GENERAL CONTRACTOR
	____________________	____________________
Address:	____________________	____________________
	____________________	____________________
	____________________	____________________
Phone:	____________________	____________________

END OF SECTION