1.0 General

.1 Supply and installation of a complete system of conduits, ducts and fittings for installation of all wiring, as specified herein and indicated on drawings.

1.1 CONDUIT AND RACEWAY SIZE CONVERSION TABLE

.1 Use the following conversion table in determining the equivalent metric size of all conduits and raceways:

Metric Size (mm) (Nominal)	Imperial Size (inches) (Nominal)
12	1/2
20	3/4
25	1
30	1 1/4
38	1 1/2
50	2
65	2 1/2
75	3
90	3 1/2
100	4
150	6

2.0 Products

2.1 MATERIALS

.1 Rigid Metallic Conduit: Galvanized steel with reamed ends, in accordance with CSA C22.2 No.45; complete with galvanized steel bushings, threaded couplings and connectors, expansion joint fittings and accessories; insulating and/or grounding type where required. Running threads are not acceptable.

.2 Flexible Conduit: Interlocking galvanized steel type, liquid tight, in accordance with CSA C22.2 No.56, minimum 12 mm size, PVC jacketed; complete with liquid tight couplings and connectors with "O" ring gasket and retainer; approved type galvanized steel connectors and couplings; nylon insulated throat.

.3 Rigid PVC Conduit: Unplasticized polyvinyl chloride (PVC); in accordance with CSA C22.2 No.136; rigid schedule 40, complete with appropriate approved fittings; watertight connectors and couplings where required and/or indicated.

.4 19 mm diameter nylon tubing for thermistors on intake pipes.

.5 19 mm copper type L tubing for heating cables on intake pipes.

3.0 Execution

3.1 CONDUIT INSTALLATION

.1 Size and install all conduit in accordance with the Canadian Electrical Code requirements, unless otherwise specified on drawings or herein.

.2 Do not change conduit size or location without Engineer's permission.

.3 Use of rigid steel conduit shall be made in all installations unless indicated otherwise.

.4 Adequately support conduit, surface mounted, as follows:

.1	12 mm to 20 mm sizes	- every 1,500 mm.
.2	25 mm to 32 mm sizes	- every 2,000 mm.
.3	38 mm and larger	- every 3,000 mm.

.5 Use single hole malleable iron or heavy formed conduit straps to support single conduit runs.

.6 Use galvanized formed steel channel sections complete with interlocking pipe clamps to support multiple conduit runs.

.7 Use galvanized formed steel channel sections with galvanized hanger rods and connectors to permit horizontal runs below beams. Perforated steel strapping or field made hangers and fittings are not permitted.

.8 Co-ordinate multiple runs of conduit with parallel multiple mechanical pipe runs.

.9 Install conduit to avoid interference with work of other trades.

.10 Install exposed conduit neat in appearance and in straight runs parallel to building lines. Bends of multiple runs are to be concentric.

.11 Alter routing to avoid structural obstructions keeping crossovers to a minimum.

.12 Install all necessary conduit required for other sections of work.

.13 Make connections to mechanical motors and equipment with PVC jacketed flexible liquid tight conduit and connectors. Minimum size 12 mm. All flexible conduit of sufficient length to avoid transmission of vibration.

.14 Provide CSA approved expansion fittings complete with grounding jumper where conduit crosses building expansion joint.

.15 Provide approved lock nuts and insulated grounding bushings at ends of conduit entering outlet boxes, pull boxes, panel switchboards, or any other metallic enclosures.

.16 Seal conduit with duct seal where conduits leave heated area and enter unheated area.

.17 Provide necessary flashing and pitchpockets, making watertight joints where conduit passes through roof or waterproofing membranes.

.18 Install conduit with long bends free from dents and bruises. Plug ends to prevent entry of dirt or moisture.

.19 Caulk around all conduits installed through walls to provide watertight installation.

.20 All conduit, below vehicle traffic shall be in a reinforced concrete envelope. Continue envelope 3 m perpendicular to either side of traffic area. Provide minimum 50 mm concrete cover around conduit.

.21 Where conduit is installed below floor subs- to run up at equipment or motors, carefully check all conduit locations. Verify conduit locations for mechanical equipment from shop drawings or detail drawings. Brace all stub-ups.

.22 For all runs of conduit, do not include more than equivalent of 3 - 90 degree bends. Provide pulling elbows, pull boxes and junction boxes where necessary.

.23 Where conduits pass through walls, they shall be grouped and installed through openings. After all conduits shown on the drawings are installed, wall openings shall be closed with material compatible with the wall construction.

.24 Use an approved pulling lubricant if required. Provide fish lines in all empty conduits. Fish lines are to be polypropylene rope or nylon line.

.25 Provide a separate green insulated copper groundwire in all conduits as specified or as required by the CEC.

END OF SECTION

PART 1 - GENERAL

1.1 Shop Drawings and Product Data

.1 Submit Shop Drawings and product data in accordance with Section 01340.

PART 2 - PRODUCTS

2.1 Switches

.1 15 or 20A, 120 or 208V, single pole or three-way, switches as indicated on drawings.

.2 Manually-operated heavy-duty commercial specification grade ac switches with following features:
- .1 Terminal holes approved for No. 10 AWG wire
- .2 Silver alloy contacts
- .3 Urea or melamine molding for parts subject to carbon tracking
- .4 Suitable for back and side wiring
- .5 Ivory for finished areas, brown for unfinished areas toggle.

.3 Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.

.4 Switches of one manufacturer throughout project.

.5 Acceptable materials:
- .1 Hubbell 1201.
- .2 Bryant CS115 Series.
- .3 Pass & Seymour 371510.

2.2 Receptacles

.1 Duplex receptacles commercial specification grade, CSA type 5-15 R, 125V, 15A, U ground, with following features:
- .1 Ivory for finished areas, brown for unfinished areas urea molded housing
- .2 Suitable for No. 10 AWG for back and side wiring
- .3 Break-off links for use as split receptacles
- .4 Eight back wired entrances, four side wiring screws
- .5 Triple wipe contacts and rivetted grounding contacts
- .6 IOMA ground fault circuit interrupter.

.2 Acceptable materials:
- .1 Hubbell GF5262
- .2 Bryant GF5262
- .3 Pass & Seymour GF5252.

.3 Other receptacles with ampacity and voltage as indicated.

.4 Receptacles of one manufacturer throughout project.

2.3 Special Wiring Devices

.1 Special wiring devices:

2.4 Cover Plates

.1 Cover plates for wiring devices.

.2 Cover plates from one manufacturer throughout project.

.3 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.

.4 Stainless steel, vertically brushed, 1 mm thick cover plates for wiring devices mounted in flush-mounted outlet box.

.5 Sheet metal cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.

.6 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles as indicated.

.7 Weatherproof spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches.

PART 3 - EXECUTION

3.1 Installation

.1 Switches:
- .1 Install single throw switches with handle in "UP" position when switch closed.
- .2 Install switches in gang type outlet box when more than one switch is required in one location.
- .3 Mount toggle switches at height specified in Section 16010 or as indicated.

.2 Receptacles:
- .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
- .2 Mount receptacles at height specified in Section 16010 or as indicated.
- .3 Where split receptacle has one portion switched, mount vertically and switch upper portion.
- .4 Wire receptacles using side screw terminals. Do not use push-in terminals.

.3 Cover plates:
- .1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.

.2 Install suitable common cover plates where wiring devices are grouped.
.3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

END OF SECTION

1.0 General

.1 Provide necessary wiring for all components of project, making all connections necessary for the installation shown on the drawings.

1.1 INSPECTION

.1 Installations may be inspected by the Engineer prior to connecting equipment.

2.0 Products

2.1 WIRE

.1 Building Wire: Copper conductors sized as indicated with 600 volt insulation of cross-linked polyethylene rated for minus -40°C installation. Maximum conductor temperature 90°C. Wire Type RW-90 XLPE.

.2 Control Cables:

.1 Type LVT: 2 soft annealed copper conductors, sized as indicated, with thermoplastic insulation, outer covering of thermoplastic jacket.

.2 Low energy 300 V control cable: stranded annealed copper conductors, sized as indicated, with PVC insulation with shielding of aluminum polyester shield and overall covering of PVC jackets.

.3 Instrumentation cables.

2.2 WIRE CONNECTORS

.1 Solderless, self-insulated connectors for hand twist wire joints for lighting, small power, heating and associated control devices. Use Ideal wingnut connectors.

.2 Terminate conductors #8 A.W.G. and larger with Thomas & Betts "COLOUR-KEYED" compression connectors Series 54100, or Burndy "Hylug" Type YA-L, or on lugs provided with equipment.

.3 Thomas & Betts "KOPR-SHIELD" compound or approved equal on all terminations suitable for compression connectors which are to be buried, or as recommended by the connector manufacturer.

2.3 TERMINALS

.1 All terminal blocks supplied by this Division shall be of the tubular screw type with pressure plates. Weidmuller feed through modular type, or as noted on the drawings.

.2 Use correct size spade lugs equal to Thomas & Betts "STA-KON" on all wiring terminating on screw terminals.

3.0 Execution

3.1 GENERAL

.1 Use RW-90 (XLPE) 600 V rated insulation for all wiring except as otherwise noted.

.2 Use RWU-90 (XLPE) 600 V rated insulation in underground ducts, duct banks and for direct burial.

.3 Branch Circuits: Minimum #12 AWG; branch circuit runs exceeding 30 m to be minimum #10 AWG; size conductors for maximum 2% voltage drop.

.4 Conductors to fixtures, outlets and motor circuits to be minimum #12 AWG.

.5 All control wiring to be minimum #16 stranded copper.

.6 Wire sizes of #10 AWG and larger to be stranded.

3.2 INSTALLATION

.1 Circuiting to be as indicated on drawings.

.2 Do not combine runs, other than that indicated on drawings, without due regard for derating and without approval of Engineer.

.3 Conductor length for parallel feeders to be identical.

.4 Lace or clip groups of feeder conductors at all distribution centres, pullboxes, wireways, etc.

.5 Do not pull into conduit until rough building construction operations have been completed.

.6 Install all wiring in conduit with number of wires per conduit and size of conduit, as indicated on drawings.

.7 Do not pull conductors through any section of the raceway system that is not complete or through any section of the system that is not fully protected from weather.

.8 When pulling cable or wire, keep conductors free from twisting and maintain parallel in the raceway.

.9 When power conductors are to be installed in circuit at a future time, install in conduit a No. 9 gauge galvanized pull wire to permit future conductor installation.

.10 Install strain relief grips to flexible multiple conductor cords as per manufacturer's recommendations.

.11 Install conductor connections in a workmanship like manner. Twist conductor connections and apply pressure type D solderless connectors, of type recommended for conductor gauge and application.

.12 Provide feed connections at starters with approved Burndy "Hylug" Type YA-L Series high pressure crimped type lugs. After installation, insulate crimped portion of lugs with two (2) half-lapped layers of PVC tape in the corresponding phase colour. Continue PVC tape onto the cable or wire insulation for a minimum of 50 mm, to provide continuous insulation.

.13 Do not utilize common neutral or ground conductors in ungrounded power supply system wiring.

.14 Provide all necessary wiring or cable required for other sections of work.

3.3 WIRE CONNECTORS

.1 Select hand twist connectors for wire size and install tightly on conductors.

.2 Brush "KOPR-SHIELD" compound on terminations for compression connectors as recommended by manufacturer.

.3 Install compression connectors using methods and tools recommended by manufacturer.

.4 All connectors to be CSA approved and of type to suit conductor size and application.

3.4 WORKMANSHIP

.1 Before pulling wire, ensure conduit is dry and clean. If moisture is present, thoroughly dry out conduits. To facilitate pulling, recognized specially manufactured wire pulling lubricants may be used. Do not install wire when ambient temperature is below the minimum permitted for the insulation type.

.2 Do not install any conduit conductor smaller than #12 A.W.G., except where specifically indicated otherwise, i.e. for instrumentation wiring, etc.

.3 Provide sizes of conductors as shown on the drawings. Voltage drop from lighting panels to farthest outlet must not exceed 2% at full load in any case. Advise Engineer if problem is foreseen.

.4 Exercise care in stripping insulation from wire. Do not nick conductors.

3.5 IDENTIFICATION, CODING AND BALANCING

.1 For branch circuit wiring, follow panel and circuit identification system shown on the drawings.

.2 Connect single phase equipment to minimize imbalance on feeders. Adjust branch circuiting shown as required for optimum balancing. Record all changes on record drawings.

.3 Colour code all feeders at all terminations, at all points where taps are made, and at all panelboards, switchboards, starters, etc. by means of coloured insulation or permanent markers. Use markers of a type not subject to ageing or deterioration. Adhesive type markers are not acceptable.

.4 Colour coding to be as follows:

.1 Equipment grounding conductor - green, or green with yellow tracer.

.2 Neutral conductor - white.

.3 Standard 120/208 volt phase wires - red, black or blue.

.5 Switch legs to be the same colour as their respective phase conductors with a white tracer.

.6 All conductors #10 AWG and smaller to have colour code impregnated into the insulation at time of manufacture.

.7 For control wiring, identify each conductor with a wire number using Thomas & Betts Series SM tubular markers. Record all wire numbers on applicable drawings.

3.6 TESTING

.1 All power and control wiring shall be tested for insulation resistance value with a megger rated for 1,000V. Resistance values shall be as recommended by the cable manufacturer.

.2 All wire test results shall be properly tabulated, signed, dated and submitted to the Engineer within three (3) working days of testing.

END OF SECTION

PART 1 - GENERAL

1.1 References

.1 Canadian Standards Association (CSA)
- .1 CSA C22.2 No. 100-95, Motors and Generators.
- .2 CSA C22,2 No. 145-M1986(R1992), Motors and Generators for Use in Hazardous Locations.

.2 Electrical and Electronic Manufacturer's' Association of Canada
- .1 EEMAC M1061978
- .2 EEMAC M1-1.

1.2 Shop Drawings and Product Data

.1 Submit shop drawings and product data in accordance with Section 01340.

1.3 Maintenance Data

.1 Provide maintenance data for fractional horsepower motors for incorporation into manual specified in Section 01730.

PART 2 - PRODUCTS

2.1 Rating

.1 Motors with ratings and operating characteristics to suit driven equipment.

.2 Motor for non-hazardous locations: to CSA C22 No. 100-M1985 and EEMAC M1-6.

.3 Motors for hazardous locations: to CSA C22.2-94. 145-MA86 and EEMAC MI-1.

.4 Motors with internal overload protection, manual reset.

.5 Capacitor start, induction run-type, unless other characteristics are necessary for the application.

PART 3 - EXECUTION

3.1 Installation

.1 Install wiring, flexible connections and grounding.

.2 Check rotation before coupling to driven equipment.

1.0 General

.1 Supply and installation of all motor starters as illustrated on drawings and specified herein.

1.1 STARTER REQUIREMENTS

.1 Provide starters in EEMAC 12 enclosures.

.2 All starter accessories such as pilot lights, Hand-Off-Auto, selector switches, start-stop push buttons etc., shall be heavy duty, oil-tight, and installed on the starter doors. Pilot lights are to be push to test.

.3 Elapsed time meters shall be installed on the doors where indicated.

1.2 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings and product data in accordance with Section 01340 - Shop Drawings, Samples and Mock-ups.

.2 Indicate:

.1 Mounting method and dimensions.

.2 Starter size and type.

.3 Layout of identified internal and front panel components.

.4 Enclosure types.

.5 Wiring diagram for each type of starter.

.6 Interconnection diagrams complete with wire and terminal numbers.

.3 Obtain wiring diagrams and information from other trades on control systems. Co-ordinate and incorporate information on shop drawings.

1.3 OPERATION AND MAINTENANCE DATA

.1 Submit operation and maintenance data in accordance with Section 16010.

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

1.4 MAINTENANCE MATERIALS

.1 Provide maintenance material in accordance with Section 01730 - Operations and Maintenance Manual.

2.0 Products

2.1 MATERIALS

.1 Starters: to IEC 947-4 with AC4 utilization category.

.1 Half size starters not acceptable.

.2 Control Transformers: of sufficient VA capacity, dry type, with primary voltage as indicated and 120V secondary, complete with primary and secondary fuses (HRC form J) installed in with starter.

2.2 MOTOR STARTERS

.1 Except where specifically noted otherwise, supply and install all motor starters.

.2 Three phase starters, magnetic air break, three pole, 208 volts with three overload relays. Breakers are to be three pole, type MCP, moulded case, mechanically trip free with 10,000 amp symmetrical interrupting capacity minimum.

.3 Three phase motor starters to be across-the-line circuit breaker type magnetic starters where indicated on drawings. Each FVNR starter shall contain within it's enclosure:

.1 Contactor with block type 3 pole, ambient compensated, bimetallic overload device. Overload trip contacts shall be wired to the line side of the contactor coil such that the neutral side of the coil is wired directly to the grounded circuit. Overload device to be manual reset style with reset button in starter cover.

.2 For the submersible intake pump, the combination magnetic starter shall be with 3 leg protection overload relays, having ambient compensated quick trip heater elements and lightning protection as approved by pump manufacturer.

.3 Intake pump starter to be c/w 30 mA GFI Protection to trip breaker on ground leakage. GFI Function to be by-passed during start cycle.

.4 Dry contacts for status to PCL and control relays for control from PLC where required.

.5 Standard of Acceptance: Cutler Hammer, 4 Plex, Advantage Starters.

3.0 Execution

3.1 INSTAILATION

.1 Install starters, connect power and control.

.2 Ensure correct fuse and overload device elements installed.

END OF SECTION

PART 1 - GENERAL

1.1 Related Work

.1 Section 16010 - Electrical General Requirements.
.2 Section 16412 - Moulded Case Circuit Breakers
.3 Section 16223 - Motor Starters

1.2 References

.1 Canadian Standards Association (CSA)
  .1 CAN/CSA-Q9000-92, Quality Management and Quality Assurance Standards - Guidelines for Selection and Use.

1.3 Product Data

.1 Submit product data in accordance with Section 01340.

.2 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01340. WHMIS acceptable to Labour Canada, and Health and Welfare Canada.

.3 Submit product data sheets for sills, busbars and compartments. Include product characteristics, physical size and finish.

.4 Manufacturer's Instructions: Provide to indicate special handling criteria, installation sequence, cleaning procedures, operation testing and training.

1.4 Shop Drawings

.1 Submit shop drawings in accordance with Section 01340.

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

1.5 Closeout Submittals

.1 Provide operation and maintenance data for motor control centre for incorporation into manual specified in Section 01730.

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

1.6 Extra Materials

.1 Provide maintenance materials in accordance with Section 01730.

.2 Include: 4 overload devices.

PART 2 - PRODUCTS

2.1 Supply Characteristics

.1 208 V, 60Hz, wyeconnected, 3 phase, four wire, grounded neutral.

2.2 General Description

.1 Compartmentalized vertical sections with common power busbars.

.2 Floor mounting, free standing, rear access enclosed dead front.

.3 Indoor CSA 1 gasketted enclosure, front mounting.

.4 Class I Type B.

.5 Accommodating combination magnetic starters, moulded case circuit breakers, and motor circuit protectors, as indicated.

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 busbars 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 bottom 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 one end of motor control centre including busbars without need for further drilling, cutting or preparation in field.

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

2.4 Sills

.1 Continuous 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 and neutral high conductivity tin plated copper busbars in separate compartment insulated self-cooled, extending entire width and height of motor control centre, supported on insulators and rated:
- .1 Main horizontal busbars: 600 A as indicated.
- .2 Branch vertical busbars: 300 A or as indicated.

.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 25 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, located at bottom.

2.7 Motor Starters and Devices

.1 Combination magnetic starters: Refer to Section 16223 - Motor Starters to 208V.

.2 Controls to section 16900.

2.8 Starter Unit Compartments

.1 Units EEMAC size 4 and smaller, circuit breaker units 225A 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 3 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 Selector switches, 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 as indicated.
- .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.

2.12 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 Contract Administrator 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.

2.13 Acceptable Manufacturers

.1 Allen Bradley
.2 Schneider - Square D
.3 Cutler Hammer

PART 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 relays are installed.

3.2 Field Quality Control

.1 Perform tests in accordance with Section 16010 - Electrical General Requirements.

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

.3 Operate starters in sequence to prove satisfactory performance of motor control centre during 8 hours period.

END OF SECTION