

ELECTRICAL GENERAL REQUIREMENTS

1. GENERAL

1.1 Work Included

- .1 Complete and operational electrical system as required by the Drawings and as herein specified.

1.2 Related Work

- .1 General Requirements: Division 1
- .2 Demolition and Removal: Division 2
- .3 Process: Division 11
- .4 Mechanical: Division 15

1.3 Drawings and Specifications

- .1 Symbols used to represent various electrical devices often occupy more space on the Drawing than the actual device does when installed. In such instances, do not scale locations of devices from electrical symbols. Install these devices with primary regard for usage of wall space, convenience of operation and grouping of devices.

1.4 Quality Assurances

- .1 Codes, Rules, Permits, & Fees
 - .1 Comply with all rules of the Canadian Electrical Code, CSA Standard C22.1 and the applicable building codes.
 - .2 Quality of Work specified and/or shown on the Drawings shall not be reduced by the foregoing requirements.
 - .3 Prior to installation, verify location, arrangement and point of attachment for service and service entrance equipment with supply authority and inspection departments.
 - .4 Furnish a Certificate of Final Inspection and approvals from inspection authority to the Contract Administrator.
- .2 Standard of Workmanship:
 - .1 Arrange and install products to fit properly into designated building spaces.
 - .2 Unless otherwise specified or shown, install products in accordance with recommendations and ratings of manufacturers.

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1.5 Submittals

- .1 Submit samples as required where specified in Division 16.
- .2 Prior to delivery of any products to job Site and sufficiently in advance of requirements to allow ample time for checking, submit shop drawings for review as specified in Division 1. Submit Shop Drawings for all equipment as required in each Section of this Specification.
- .3 Prior to submitting the Shop Drawings to the Contract Administrator, the Contractor shall review the Shop Drawings to determine that the equipment complies with the requirements of the Specifications and Drawings.
- .4 Indicate materials, methods of construction and attachment of support wiring, diagrams, connections, recommended installation details, explanatory notes and other information necessary for completion of Work. Where equipment is connected to other equipment, indicate that such items have been coordinated, regardless of the section under which the adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.

Adjustments made on Shop Drawings by the Contract Administrator are not intended to change the Contract price. If adjustments affect the value of the Work state such in writing to the Contract Administrator prior to proceeding with the Work.

- .5 Manufacture of products shall conform to revised Shop Drawings.
- .6 Keep one (1) complete set of Shop Drawings at Site during construction.

1.6 Product Handling

- .1 Use all means necessary to protect the products of this Division before, during and after installation and to protect products and installed Work of all other trades.
- .2 Immediately make good any damage by repair or replacement at no additional cost to the City and to the approval of the Contract Administrator.
- .3 Remove advertising labels from all electrical equipment. Do not remove identification of certification labels.
- .4 Remove dirt, rubbish, grease, etc. resulting from this work from all surfaces, including the inside of all cabinets, equipment enclosures, panelboard tubs, etc.

2. PRODUCTS

2.1 Quality of Products

- .1 All products provided shall be CSA Approved, UL approved where applicable, and new, unless otherwise specified.

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- .2 If products specified are not CSA approved, obtain special approval from the local regulatory authority. Pay all applicable charges levied and make all modifications required for approval.
- .3 Products provided, if not specified, shall be new, of a quality best suited to the purpose required and their use subject to approval by the Contract Administrator.

2.2 Uniformity of Manufacture

- .1 Unless otherwise specifically called for in the Specifications, uniformity of manufacture shall be maintained for similar products throughout the work.

2.3 Product Finishes

- .1 Finish all cabinets, panelboards, switchboards, equipment cabinets, cable trays, etc. in ANSI 61 grey enamel unless otherwise specified.
- .2 Apply primer on all items which are to be finished as part of the Work.
- .3 Touch up all damaged painted finishes with matching lacquer, or, if required by the Contract Administrator, completely repaint damaged surface.

2.4 Non-Specific Date/Time Compliance

- .1 All equipment, hardware, software and firmware (for the purposes of this clause, the "Product") delivered or deliverables resulting from any services provided are fully Date Compliant and the product will not adversely or materially affect the daily business operations as a result of a date related computer problem (for the purposes of this clause, the "Warranty"). Date Compliant means that the product accurately and correctly processes and stores date/time data (including, but not limited to, calculating, comparing, displaying, recording and sequencing operations) including year, century and leap year calculations.
- .2 Provide documentary proof of Date Compliance prior to Total Performance listing all equipment and certifying their compliance.

3. EXECUTION

3.1 Coordination with Other Divisions

- .1 Examine the Drawings and Specifications of all Divisions and become fully familiar with their Work. Before commencing Work, obtain a ruling from the Contract Administrator if any conflict exists, otherwise no additional compensation will be made for any necessary adjustments.
- .2 Lay out the work and equipment with due regard to architectural, structural, and mechanical features. Architectural and Structural Drawings take precedence over Electrical Drawings regarding locations of walls, doors and equipment.
- .3 Do not cut structural members without approval of the Contract Administrator.

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- .4 Coordinate with all Division installing equipment and services, and ensure that there are no conflicts.
- .5 Install anchors, bolts, pipe sleeves, hanger inserts, etc. in ample time to prevent delays.
- .6 Examine previously constructed work and notify the Contract Administrator of any conditions which prejudice the proper completion of this work. Commencement of this work without such notification shall constitute acceptance of other Work.

3.2 Separation of Services

- .1 Maintain separation between electrical wiring system and building piping, ductwork, etc. so that the wiring system is isolated (except at approved connections to such systems) to prevent galvanic corrosion.
- .2 In particular, contact between dissimilar metals, such as copper and aluminum, in damp or wet locations is not permitted.
- .3 Do not support wiring from pipes, ductwork, etc. Hangers for suspended ceilings may be used for the support of wiring only when approval is obtained from the Contract Administrator and the ceiling installer, and approved clips or hangers are used.

3.3 Equipment Identification

- .1 3 mm thick plastic lamicoïd name plates, black face, white core, mechanically attached with self tapping screws, 6 mm high lettering, to be attached to the front face of the following equipment:

NAMEPLATE SIZES

Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters

- .1 Distribution Centres (Indicate designation, bus capacity, voltage)
- .2 MCC's (Designation, voltage)
- .3 Starters, contactors, Disconnects (Designation, voltage, load controlled)
- .4 Panelboard (Designation, voltage, Bus Capacity)
- .5 Automatic transfer switch (designation, voltage, rating)
- .6 Terminal cabinets and pull boxes (system, voltage)
- .7 Transformers (designation, capacity, primary, and secondary voltage)

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- .2 Colour code exposed conduits (including conduits above T-bar ceilings), junction and pull boxes, and metallic sheathed cables with paint or plastic tape (25 mm wide band) at 15 m intervals. Colour coding to be as follows:

SYSTEM	MAJOR BAND	MAJOR BAND
347/600 V Normal	Dk. Blue	
120/208 V Normal	Lt. Blue	
UPS System	Lt. Blue	White

- .3 Provide neatly typed circuit directories in panelboards to indicate the area or equipment controlled by each branch circuit.
- .4 All conductors shall be identifiable by coloured insulation and permanent markers at every terminal and accessible points throughout its entire run.

Conductors:

- Equipment Grounding – Green
- Neutral Conductor – White

347/600 Volt System	120/208 Volt System
Phase A – Orange	Phase A – Red
Phase B – Brown	Phase B – Black
Phase C – Yellow	Phase C – Blue

- .5 Install yellow plastic warning tape, 300 mm below grade, above all underground ducts.

3.4 Wiring to Equipment Supplied by Others

- .1 Electrical connection to City Supplied Equipment or equipment specified in any Division shall be done by this Division.

3.5 Testing

- .1 Refer to Section 16980 – Testing, Adjusting and Balancing of Electrical Equipment and Systems.

3.6 Instructions to City’s Personnel

- .1 Refer to Section 16990 – Electrical Equipment and Systems Demonstration and Instruction.

3.7 Access Panels

- .1 Where electrical equipment, junction boxes, remote ballasts or the like are concealed, access panels shall be supplied. Panels shall be of adequate size for servicing of the electrical work and complete with necessary frames and hinged doors held closed with captive fasteners. Coordinate type and size of panels with the Contract Administrator.

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- .2 In removable ceiling areas, provide markers on ceiling tile to locate equipment requiring access. Markers shall be of a type approved by the Contract Administrator.

3.8 Sealing of Wall and Floor Openings

- .1 All conduit and cable entries through outside walls of buildings, through partition walls separating electrical rooms from other areas, through fire separations, and through floors above grade shall be sealed to prevent passage of moisture, dust, gasses, flame, or to maintain pressurization.
- .2 Openings shall be sealed when all wiring entries shown on the Drawings have been completed.
- .3 Sealing material shall be fire resistant and shall not contain any compounds which will chemically affect the wiring jacket or insulating material. Cable penetrations through fire separations to be sealed.

3.9 Sleeves

- .1 Provide sleeves of galvanized steel pipe with machine cut ends of ample size to accommodate conduits passing through walls, partitions, ceilings, floors, etc.
- .2 For wall, partitions and ceilings the ends shall be flush with the finish on both sides but for floors they shall extend 4" above finished floor level.
- .3 The space between the sleeve and the conduit shall be filled with Dow Corning silicone RTV foam for fire stop and caulked around the top and bottom with approved permanently resilient, non-flammable and weatherproof silicone base compound and ensure that the seal is compatible with the floor and ceiling finishes.
- .4 Locate and position sleeves exactly prior to construction of walls, floors.
- .5 Failure to comply with the above requirements shall be remedied at this Division's expense.

3.10 Insulation Resistance Testing

- .1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
- .2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
- .3 Check resistance to ground before energizing.
- .4 Carry out tests in presence of Contract Administrator.
- .5 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .6 Submit test results for Contract Administrator's review.

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3.11 Load Balance

- .1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance. Adjust branch circuit connections as required to obtain best balance of current between phases and record changes (maximum deviation of 15%).
- .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
- .3 Submit, by date of Substantial Performance, report listing phase and neutral currents on panelboards, dry-core transformers, and MCC's, operating under normal load. State hour and date at which each load was measured, and voltage at time of test.

END OF SECTION

SCOPE OF WORK

1. GENERAL

- .1 Supply and Install all material, equipment, wiring and labour necessary for the installation of the systems detailed on the drawings in accordance with the latest edition of the Canadian Electrical Code.

2. WORK INCLUDED

2.1 General Requirements

- .1 General Clean-up.
- .2 All inspection and other permits, licenses required by various Inspection Agencies and local regulations related to the portions of the Work specified in this Division.
- .3 Scaffolding.
- .4 Shop Drawings.
- .5 Project Record Documents (As-built Drawings) where specified.
- .6 O&M Data, where specified.

2.2 Specific Requirements Included But Not Limited to Scope of Work

- .1 Terminate new service cables, supplied and installed by Bid Op 498-2006 from Electrical/Generator Building, to existing Schneider Electric 5 kV Vacuum Breaker at east end of Distribution line-up. Tie switch will be open when this procedure is completed. Local generator will be operating to service the building essential electrical loads (To be confirmed with the City).
- .2 Disconnect the existing main incoming breaker (West End of distribution line-up) bus bars and temporary cables. Remove breaker cell and metering cell. Install new 5 kV Vacuum Breaker, set in place and bus connect as indicated on the drawing layout. Terminate new service cables, supplied and installed by Bid Op 498-2006 from Electrical/Generator Building, to new Schneider Electric 5 kV Vacuum Breaker.
- .3 Supply and Install new and existing 4160 V switch gear and motor starters as indicated on the Drawings and hereafter specified.
- .4 Supply and Install 600 V power supplies to motorized valves on inlet piping to each of the UV reactors as indicated on the Drawings and hereafter specified. Provide 600 V 3 pole breakers and install in breaker panel as indicated.
- .5 Supply and Install new or reconnect existing cable from the three (3) 2 speed soft start motor starters for the 900 hp pump motor to the new starters as indicated on the Drawing.

SCOPE OF WORK

- .6 Supply and Install new 5 kV cables from the single speed soft start motor starters to new 450 hp motors (2) as indicated on Drawings
- .7 Supply and Install new cable for flushing water pumps (two) associated with the new 450 hp pumps. Supply 1000 V cables from existing motor control center (Square D). Supply and install suitable motor starter to be installed in existing MCC.
- .8 Supply and Install all miscellaneous bus bars as may be required for inter connection of distribution equipment.
- .9 Terminate two (2) 4/0 insulated ground conductors supplied and installed by Bid Op 498-2006. One cable to each main breaker section in the 4160 V switchgear.

2.3 Demolition

- .1 Disconnect and remove the existing Westinghouse 5 kV vacuum breaker and metering compartment.
- .2 Disconnect the existing Westinghouse Ampgard 5 kV 2 speed motor starters. (total of three)
- .3 Disconnect and remove the existing capacitors associated with the existing 5 kV motor starters.
- .4 Disconnect and make ready for use the existing three 5 kV switches in new distribution equipment line up.

3. UNITS OF MEASUREMENT

3.1 General

- .1 The Contract Documents have been prepared using the modified International System (SI) units of metric measurement. Whenever appropriate, available metric products shall be used unless otherwise specified herein.
- .2 Only metres (m) and millimetres (mm) are used. Generally, metres are used for measurements of 10 m or more, and millimetres for measurements below 10 m.
- .3 All measurements on Drawings are in millimetres unless otherwise indicated.

3.2 Conversions

- .1 The following three conversion methods were used in product and location dimensions:
 - .1 Hard Conversion: Industry available products which are manufactured in metric measurements.

SCOPE OF WORK

- .2 Soft Conversion: Products which are still manufactured in Imperial units and are converted in specifications using arithmetic conversion factors.
- .3 Rationalized Conversion: Dimensions which are soft converted and rounded off for ease of measurements.
- .2 In cases where measurements may be open for interpretation, dual dimensions have been incorporated until hard conversions can be used exclusively.

END OF SECTION

CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS

1. GENERAL

1.1 Work Included

- .1 Supply and Install a complete system of conduit and fittings for installation of wiring.

2. PRODUCTS

2.1 Rigid Steel Conduit

- .1 Galvanized with threaded joints and connections.
- .2 Connections in dry locations: steel or malleable iron locknuts inside and outside enclosures. Insulated bushings Thomas & Betts Series 222 or approved equal.
- .3 Connectors subjected to moisture interior and exterior: liquid and dust tight with insulated throat, Thomas & Betts "Bullet Hub" 370 Series or approved equal.
- .4 Fittings: cast metal "Condulet" as manufactured by Crouse-Hinds Canada Ltd. including gasketted covers in damp locations.
- .5 Expansion joints: cast metal Crouse-Hinds type XJ or approved equal.

2.2 E.M.T. Conduit

- .1 Fittings in dry locations: Steel or zinc set screw connectors with insulated throat. Steel or zinc set screw couplings.
- .2 Fittings in wet locations: steel rain-tite connectors with insulated throat. Steel rain tite couplings.

2.3 Rigid PVC Conduit

- .1 Conduit: rigid non-metallic conduit of unplasticized PVC as manufactured IPEX. "Sceptre" Schedule 40.
- .2 Fittings: threaded male or female solvent weld connectors and solvent weld couplings, as supplied by conduit manufacturer.
- .3 Solvent: as recommended by conduit manufacturer.

2.4 Flexible Conduit

- .1 Connectors: slip-proof, insulated throat or non-metallic bushings, steel, Thomas & Betts Ltd. "Tite-Bite", Series 300.

CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS

2.5 Liquid-Tight Flexible Conduit

- .1 Conduit: flexible metal conduit with liquid-tight PVC jacket. Industrial Wire & Cable "Liquiseal".
- .2 Connectors: captive sealing jacket and ground cone insulated throat, steel (Thomas & Betts Ltd. "Super-Tight", Series 6000).

2.6 Zinc Fittings

- .1 Connectors and couplings to be manufactured of No. 3A alloy conforming to ASTM designation B.240 as manufactured by Regal Manufacturing.

3. EXECUTION

3.1 Rigid Steel Conduit

- .1 Use as raceways for following applications:
 - .1 In all areas exposed to weather.
 - .2 Locations where mechanical damage may occur and in mechanical rooms to a height of 1 m.
 - .3 Three phase motor wiring (Teck cable may also be used for this application where shown on the drawings).

3.2 EMT Conduit

- .1 Use as raceways for following applications:
 - .1 In surface and concealed areas or in poured concrete above ground level.
- .2 It may not be used in damp locations, corrosive atmosphere, underground, outdoors, nor in areas exposed to mechanical damage.

3.3 Rigid PVC Conduit

- .1 Use as raceways for following applications
 - .1 In poured concrete floors and walls and on underground runs exterior to the buildings unless otherwise noted.
 - .2 Wiring installed in areas subject to intermittent or continuous moisture but not surface mounted.
 - .3 Rigid PVC conduit shall not be surface mounted.

CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS

- .2 Use strictly in accordance with the Canadian Electrical Code. Do not use in return air plenums and for exit and fire escape lights.
- .3 Provide insulated ground wire in all rigid PVC conduits in accordance with the Canadian Electrical Code.
- .4 Where rigid PVC conduit is set in poured concrete, solvent joints must be completed and allowed to set as per manufacturer's instructions.
- .5 Bend rigid conduit in strict accordance with manufacturer's directions. Distorted bends will not be accepted.

3.4 Flexible Conduit

- .1 Use as raceways for following applications:
 - .1 Connections to f.h.p. motors in dry locations.
 - .2 Flexible connections to luminaires.
- .2 Provide a separate insulated ground wire in all flexible conduits.

3.5 Liquid-Tight Flexible Conduit

- .1 Use as raceways for following applications:
 - .1 At all motors, pipe mounted control devices, and other devices subject to movement or water.
 - .2 At all motors provide a short length before connecting to the motor terminal box. Minimum length shall be 450 mm plus 4 times the conduit diameter.
 - .3 Provide a separate ground wire within flexible conduit, bonded to motor frames and system ground.

3.6 Corrosion Control (Special Application)

- .1 In wet locations as pool and pool mechanical rooms and pool service tunnel fittings, outlet boxes, junction boxes, rack members, clamps and fasteners shall be zinc or cadmium plated. All threads shall be completely coated.
- .2 In the pool and basement areas all exposed conduit, couplings and straps shall be corrosion resistant epoxy-polyester coated Columbex Green Guard II or equal.
- .3 Use a different colour of coating for control, power and lighting.

CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS

3.7 Workmanship

- .1 Install all conduit and wiring concealed, unless otherwise shown on the Drawings. Do not recess conduit in columns, except as noted, without permission.
- .2 Where conduit is run exposed, run parallel to building lines. Where conduits are grouped (two or more), space evenly, make bends concentric and mount on Unistrut racks.
- .3 Lay out conduit to avoid interference with other Work. Maintain a minimum clearance of 150 mm from steam or hot water piping, vents, etc.
- .4 Slabs on grade: Install rigid PVC conduit in the gravel base below concrete slabs. Provide mechanical protection around stub-ups through slab and extend 150 mm beyond concrete. When rigid steel conduit is installed in contact with earth it shall be protected by Polykin #940 tape. Extend taping 300 mm above finished grade.
- .5 Metal conduit installations in concrete pours: Tie down conduit to prevent shifting. All joints are to be made up tight to ensure ground continuity. To prevent concrete entry, seal EMT set screw fittings with tape, pack outlet boxes and cap conduit terminations both in boxes and stub-ups. Apply Polykin #940 tape to the conduit 152 mm both sides of the point of leaving slab.
- .6 Where steel conduit is required to be bent, do not heat, and do not bend conduit in such a way as to reduce pipe cross section area at any point. Radii of bends shall be as per Canadian Electrical Code.
- .7 For all runs of conduits, do not include more than equivalent of four - quarter bends. Provide conduit fittings, pullboxes and junction boxes where necessary. Pulling elbows shall not be used except by special permission.
- .8 Where possible, install conduits so that they are not trapped, cap turned up conduits to prevent the entrance of dirt or moisture during construction. Swab out conduit and thoroughly clean internally before wires and cables are pulled.
- .9 Take extreme care in reaming ends of all conduit to ensure a smooth interior finish that will not damage the insulation of the wires.
- .10 Use insulated non-metallic bushings on all conduit terminations.
- .11 Ensure electrical continuity in all conduit systems.
- .12 All conduit shown exposed in finished areas is to be free of unnecessary labels and trade marks.
- .13 Install a 40 kg test line in all conduits left under the Contract including those which others will pull cables, wires, etc.

CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS

- .14 Conduits and ducts crossing building expansion joints shall have conduit expansion fittings to suit the type of conduit used, and shall be Crouse-Hinds, Scepter, or approved fitting.
- .15 Seal conduits with duct seal where conduits are run between heated and unheated areas. Where conduits, cables, or cable trays pierce fire separations, seal openings fire separation assembly suitably rated for the type of penetration. Submit assembly detail to Contract Administrator prior to installation.
- .16 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. Review size and quantity of conduit sleeves with the Contract Administrator.
- .17 Where drawings show conduit designations, these conduits shall be identified at each point of termination with Thomas & Betts "Ty-Rap" No. TY532M labels.
- .18 Where conduit finish is damaged, repair or replace.
- .19 Use "Condulet" fittings for power and telephone type conduit terminations in lieu of boxes where support is not provided.
- .20 All branch circuit wiring, home-runs, communication and data to be minimum 20 mm diameter unless otherwise stated.
- .21 Provide necessary flashing and pitch pockets, making watertight joints where conduits pass through roof or watertight membranes.
- .22 Where panelboard branch circuit conduits are amalgamated, size shall not exceed 25 mm diameter.

END OF SECTION

CABLE TRAYS

1. GENERAL

1.1 Description

- .1 Supply and Install a complete system of cable trays as shown on the Drawings complete with all supports and hangers and seismic bracing necessary for the installation.
- .2 Coordinate the location of the support channels so as not to interfere with other services.

1.2 Shop Drawings and Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 01300 – Submittals.
- .2 Indicate various types of cabletroughs with terminology used in Part 2.
- .3 Prior to construction, submit design drawings and calculations indicating all tray loading and seismic support designs have been reviewed by and bear the stamp of a Professional Engineer registered in the Province of Manitoba.

2. PRODUCTS

2.1 Cabletray

- .1 All cable trays for 347 V and above shall be galvanized steel ladder type, Class E to CSA C22.2 No. 126 with 300 mm rung spacing, 150 mm side rails and width as required to maintain 100% cable spacing and no cable derating.
- .2 All cable trays for 120 V and below to be galvanized steel ventilated, Class E to CSA C22.2 No. 126, 150 mm side rails and width required to maintain less than 20% cable fill.
- .3 Horizontal elbows, end plates, drop outs, vertical risers and drops, tees, wyes, expansion joints, reducers and other fittings where required. Field fabricate only those fittings not available from manufacturer.
- .4 Supply and Install stainless steel rod hanger clamps, rod hangers, wall mounting support brackets and all necessary accessories for complete installation.
- .5 Barriers where different voltage systems or electrical systems are in the same cabletrough, or as indicated.
- .6 Approved manufacturers: Pilgrim, Unitray, B-Line, Comtray, Canstrut, ElectroTray.
- .7 Unless otherwise approved by the Contract Administrator, provide cabletrays of the same manufacturer throughout the Work.

CABLE TRAYS

2.2 Supports

- .1 Supply and Install stainless steel rod hangers, rod hanger clamps and accessories as required.
- .2 Wall mounted support brackets: Provide aluminum channel strut supports mounted vertically in concrete wall complete with mounting brackets sized to suit cabletray width and loading.

3. EXECUTION

3.1 Installation

- .1 Suspend cabletrays on rod hangers and hanger clamps or channels spaced as required by loading classification rating and not more than 3000 mm on centers. Fasten hangers to channels securely mounted to the structure.
- .2 Install trays and raceways generally as indicated on Drawings. Coordinate this Work with the other trades to ensure adequate horizontal and vertical clearances.
- .3 Provide minimum vertical clearance above the trays as indicated on the Drawings.
- .4 Provide minimum 600 mm horizontal clearance on one side of cabletray throughout.
- .5 All trays are shown diagrammatically on the Drawings. Determine the exact location in the field. Install tray runs to prevent interference with process or service piping and ducting and to maintain clearance for tray access. Coordinate the exact location of tray supports and runs with the work of other Divisions. The electrical building crawl space requires extensive cable trays. Refer to the Drawings and isometric views to identify the multiple vertical layer of trays required.
- .6 Do not install tray routes and tray supports until the location of same has been reviewed by the Contract Administrator.
- .7 Install tray systems in such a manner as to conserve head-room and minimize the use of free space through which they pass. Maintain a minimum 2100 mm clear head-room wherever possible.
- .8 Run trays parallel to building lines unless otherwise shown on the Drawings. A tray in tunnel areas to run parallel with the ceiling lines as the floor is graded for drainage. Where two or more trays run the same route, make parallel and ensure offsets and bends are uniform.
- .9 When the ends on Unistrut type shelf brackets are below 2100 mm AFF in a walking area, cut flush with tray. Permanently cap the end of Unistruts, etc. with plastic caps. Suitably protect sharp corners and edges of tray to prevent personal hazard.
- .10 Use beam clamps to fasten support systems to structural steel. Do not weld, drill or cut structural steel without approval by the Contract Administrator.

CABLE TRAYS

- .11 Where hanger rods are used, use stainless steel and not be smaller than 12 mm in diameter.
- .12 Extend a stranded #2/0 tin plated bare, or green insulated, copper ground conductor the length of each tray route, and solidly connect sections of tray runs to the ground bus of the electrical room. Connect ground conductor to the tray every 15 m with approved grounding clamps suitable for connecting aluminum tray with copper conductor.
- .13 Generally run cables of different voltage classes in separate trays. Where a common tray is shown on Drawings, separate the cables for different voltage classes from each other by metal barriers as supplied by the tray Manufacturer.
- .14 Check all trays for surface smoothness prior to installation and remove all burrs, ridges, etc. on tray surfaces facing cables.
- .15 Size cabletrays as indicated on Drawings. If any discrepancies are found or changes in tray size are required, advise the Contract Administrator before installing the tray.

3.2 Cables in Cabletray

- .1 Install cables individually.
- .2 Lay cables into cabletray. Use rollers when necessary to pull cables.
- .3 Secure cables in cabletrough at 5 m centers, with nylon ties.
- .4 Identify cables with nameplates in accordance with Section 16010 – Electrical General Requirements.
- .5 Mark power and communication runs in accordance with colour coding outlined in Section 16010 – Electrical General Requirements.

END OF SECTION

HV POWER CABLES & 8 KV SHIELDED CABLE TERMINATIONS

1. GENERAL

1.1 Description

- .1 Complete supply, installation and termination of 4160 V shielded power cables with 5 kV 133% insulation rating

1.2 Codes and Standards

- .1 Insulated cables to CSA C22.2 No. 38, CSA C68.3, ICEA T-29-520, and ICEA T-30-520

2. PRODUCTS

- .1 Armoured Cables.

- .1 The Armoured Cables shall have the following characteristics:

- .1 Approved by CSA or other recognized Certification Organization in Canada.
- .2 Three soft drawn, bare, Class B compact or compressed stranded copper conductors sized as indicated per ASTM.
- .3 Conductor Shield: Extruded thermosetting semiconducting shield which is free stripping from the conductor and bonded to the insulation.
- .4 Insulation Rating: 90°C rating, 133% insulation level.
- .5 Insulation Shield: Extruded thermosetting semiconducting shield with controlled adhesion to the insulation providing the required balance between electrical integrity and ease of stripping.
- .6 Metallic Shield: Helically applied non-magnetic uncoated copper tape over the insulation shield with a maximum 15% gap.
- .7 Assembly: Three conductors shall be twisted together with fillers and soft drawn, bare copper bonding conductors and covered with a binder tape.
- .8 Sunlight resistant PVC jacket tightly applied over the binder tape.
- .9 Flexible AIA applied over the inner jacket for mechanical protection.
- .10 Low-temperature, sunlight-resistant PVC jacket applied over the armour.
- .11 Short circuit rating 60 kA, 1 cycle; 14 kA, 30 cycles.
- .12 90°C normal, 130°C emergency rating, 250°C short circuit rating.

- .2 The Armoured Cables shall be Prysmian 5 kV 3/C Armortek or approved equal.

HV POWER CABLES & 8 KV SHIELDED CABLE TERMINATIONS

2.2 Termination

- .1 Coldapplied, silicone rubber termination qualified to IEEE 48-1996, designed for indoor and outdoor applications.
- .2 Use silicone molded skirts on outdoor applications.
- .3 Prysmain Elasticfit, or approved equal.

3. EXECUTION

3.1 Cables General

- .1 Do not splice cables. A continuous length is required for all feeds.
- .2 Submit certified Manufacturer's data sheets.

3.2 Receiving/Handling Cable

- .1 Visually inspect cable reels for any damage that may have occurred in transit.
- .2 Visually check each reel to insure that it has the proper tags and labels as described in the Specifications.
- .3 Handling of Cable Reels. When moving cable reels, care should be taken to insure that material handling equipment does not come in contact with cable surfaces or with protective covering on the reel. Under no circumstances should cable reels be dropped from any height, or be allowed to roll uncontrolled.
- .4 Storage of Cable Reels. Where possible, cable reels are to be stored indoors on a hard, dry surface to prevent deterioration of the reels and possible ingress of moisture into the cables. Cable reels stored outdoors must be supported off the ground and covered with a suitable weatherproof material.

3.3 Installation

- .1 Install in accordance with Manufacturer's recommendations, observing requirements for minimum bending radius and pulling tensions.
- .2 Rack/Trays. Check the entire path that the cable will follow during pulling to make sure that the cable will ride free and clear of all obstructions, sharp edges or projections which might cause it to jam or be damaged in passage.
- .3 Cable Pulling and Cable Guides. To avoid abrasion and damage of the cable jacket when guiding the cable from the reel to the duct mouth or trench, all guides shall be in the form of large diameter, smooth-surfaced, free-turning sheaves or rollers.
- .4 Maximum Pulling Tensions. Pulling tensions for installing electrical cables should be maintained as low as possible to prevent damage to the cable. Follow Manufacturer recommendation.

HV POWER CABLES & 8 KV SHIELDED CABLE TERMINATIONS

- .5 Consideration for Metallic Armoured Cables. Cable armours and concentrically applied grounding conductors shall be bonded and grounded at the supply end only and thereafter isolated from ground and each other. Installing cables in individual ducts of insulating material, by using cables jacketed with PVC or other insulating material, or mounting cables on insulated supports, may attain isolation.

3.4 Terminations

- .1 Follow Manufacture's recommended installation procedures.
- .2 Remove the insulation to fit the connector. Avoid nicking the conductor strands. Remove enough insulation to allow crimp connectors to "grow" without pushing into insulation. Follow connector Manufacturer's instructions for use of oxide inhibiting compounds, crimp tools, dies, etc.
- .3 Thoroughly read Manufacturer's instructions before beginning installation, taking note of any special requirements. Make sure that the dimensions for cable prep are for the appropriate voltage class. Make sure that the connectors used are appropriate for the application (suitable for use on copper, sealed lugs if outdoor, length, tapered, if required, etc.) and that the proper crimp tool (and dies, if needed) is available.
- .4 Clean the cable jackets to the specified distance. To eliminate the risk of damaging the underlying metallic shield, do not cut completely through the jacket. Instead, ring cut through at least 50% of the material and tear off the remainder.
- .5 Metallic Shields. Remove the metallic shield to the specified distance. Consult instructions prior to bundling.
- .6 Semiconductive Layer. Remove the extruded semiconductive layer. Any nick through this layer into the insulation shall be sanded out or discharge will occur and could lead to failure.
- .7 Cleaning Solvents. Solvents should be used with lint-free cloths. Do not pour solvents directly onto cable insulation. Read solvent manufacturer's instructions thoroughly.
- .8 Install compression connectors using tools provided by the connector Manufacturer in accordance with the Manufacturer's recommendations.

3.5 Tests

- .1 The Contractor is to test cables prior to energization, as follows:
 - .1 Megger
 - .2 Highpot
 - .3 25 kV DC ICEA

END OF SECTION

WIRES AND CABLE 0-1000 V

1. GENERAL

1.1 Work Included

- .1 Provide a complete system of wiring, making all connections necessary for the installation shown on Drawings.

1.2 References, Codes and Standards

- .1 CSA C22.2 No. 0.3, Test Methods for Electrical Wires and Cables.
- .2 Install and rate power cables in accordance with the Canadian Electrical Code requirements or in accordance with ICEA requirements where permissible.

1.3 Product Data

- .1 Submit product data in accordance with Section 16010 – Electrical General Requirements.

2. PRODUCTS

2.1 Building Wires

- .1 Minimum conductor size #12 AWG
- .2 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.
- .3 Copper conductors: size as indicated, with 600 V insulation of chemically XLPE material rated RW90.

2.2 Teck Cable

- .1 Minimum conductor size #12 AWG
- .2 Conductors:
 - .1 Grounding conductor: copper.
 - .2 Circuit conductors: copper, size as indicated.
- .3 Insulation:
 - .1 Chemically cross-linked thermosetting polyethylene rated type RW90, 600 V.
- .4 Inner jacket: PVC material.
- .5 Armour: interlocking aluminum.
- .6 Overall covering: thermoplastic PVC material.

WIRES AND CABLE 0-1000 V

- .7 Fastenings:
 - .1 One hole malleable iron straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.
 - .2 Channel type supports for two or more cables at 1500 mm centers.
 - .3 Six mm diameter threaded rods to support suspended channels.
- .8 Connectors:
 - .1 Watertight approved for TECK cable.

2.3 Control Cables

- .1 Type LVT: 2 soft annealed copper conductors, sized as indicated, with thermoplastic insulation, and outer covering of thermoplastic jacket.
- .2 Low energy 300 V control cable: solid stranded annealed copper conductors sized as indicated, with PVC insulation type TW with shielding of wire braid over each pair and overall covering of PVC jackets.
- .3 600 V type: stranded annealed copper conductors, sizes as indicated with PVC insulation type R90, XLPE type with shielding of wire braid each pair of conductors and overall covering of thermoplastic jacket interlocked armour and jacket over sheath of PVC.

3. EXECUTION

3.1 Installation of Building Wires

- .1 Install wiring as follows:
 - .1 In conduit systems in accordance with Section 16111 – Conduits, Conduit Fastenings and Conduit Fittings.
 - .2 In trenches in accordance with Section 16106 – Installation of Cables in Trenches and in Ducts.

3.2 Installation of Teck Cable 0 - 1000 V

- .1 Install cables.
- .2 Group cables wherever possible on channels.
- .3 Install cable in trenches in accordance with Section 16106 – Installation of Cables in Trenches and in Ducts.
- .4 Terminate cables in accordance with Section 16151 – Wire and Box Connectors.

WIRES AND CABLE 0-1000 V

3.3 Installation of Aluminum Sheathed Cable

- .1 Group cables wherever possible on channels.
- .2 Install cable in trenches in accordance with Section 16106 – Installation of Cables in Trenches and in Ducts.
- .3 Lay cable in cabletroughs in accordance with Section 16114 – Cable Trays.
- .4 Terminate cables in accordance with Section 16151 – Wire and Box Connectors.

3.4 Installation of Control Cables

- .1 Install control cables in conduit, underground ducts or by direct burial.
- .2 Ground control cable shield.

3.5 Workmanship

- .1 Before pulling wire, ensure conduit is dry and clean. If moisture is present, thoroughly dry out conduits; vacuum if necessary. To facilitate pulling, recognized specially manufactured wire pulling lubricants may be used. Do not use grease. Employ suitable techniques to prevent damage to wire when ambient temperature is below the minimum permitted for each insulation type. Do not pull wires into incomplete conduit runs.
- .2 Installation to be free of opens and grounds. Before energization, measure insulation resistance and comply with the Canadian Electrical Code. Submit data sheet with values measured.
- .3 Do not install any conductor smaller than #12 AWG, except where specifically indicated otherwise, i.e. for fire alarm system station circuits, P.A. wiring, etc.
- .4 Provide sizes of conductors as shown on Drawings. Voltage drop from lighting panels to farthest outlet must not exceed 2% at full load in any case. Advise Contract Administrator if problem is foreseen.
- .5 Exercise care in stripping insulation from wire. Do not nick conductors.

3.6 Identification, Coding and Balancing

- .1 For branch circuit wiring, follow identification system shown on the Drawings and as specified in Section 16010 – Electrical General Requirements.
- .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, motor control centres, etc. Use two wraps of 3M #471 plastic film tape 48 mm wide.

WIRES AND CABLE 0-1000 V

- .4 Conductors sized No. 10 and smaller are required to be factory coloured, not taped on Site.
- .5 For direct current wiring use red for positive and black for negative.

3.7 Testing

- .1 All power and control wiring shall be tested for insulation resistance value with a 1000 V megger. 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 Contract Administrator.

END OF SECTION

SPLITTERS, JUNCTION BOXES, PULL BOXES AND CABINETS

1. GENERAL

1.1 Work Included

- .1 Supply and Install a complete system of splitters, junction boxes, pull boxes and cabinets for the installation of wiring and equipment.

1.2 Shop Drawings and Product Data

- .1 Submit Shop Drawings and product data for cabinets in accordance with Section 16010 – Electrical General Requirements.

2. PRODUCTS

2.1 Junction Boxes and Pull Boxes, Weatherproof

- .1 Materials:
 - .1 Cast steel, Crouse Hinds, WBJ Series.

2.2 Junction Boxes and Pull Boxes, Indoor Dry Locations

- .1 Materials:
 - .1 Code gauge sheet steel, welded construction, phosphatized and factory paint finish.
- .2 Components:
 - .1 For flush mounting, covers to overlap box by 25 mm minimum all around with flush head cover retaining screws.
 - .2 Use rolled edges for surface boxes.
- .3 Junction boxes mounted in exterior walls shall be complete with box vapour barriers.

2.3 Cabinets

- .1 Materials:
 - .1 Cabinets: Code gauge sheet steel, welded construction, phosphatized and factory paint finish, suitable for field painting.
 - .2 Locks: to match panelboards.
 - .3 Mounting: Galvanized U channel, secured to structure and cabinet, at top and bottom of cabinet.

SPLITTERS, JUNCTION BOXES, PULL BOXES AND CABINETS

- .2 Components:
 - .1 With hinged door and return flange overlapping sides, with handle, lock and catch for surface mounting, size as indicated or to suit.
 - .2 Surface or flush with trim and hinged door, latch and lock and two keys, size as indicated or to suit. Keyed to match panelboard keys.

3. EXECUTION

3.1 Installation

- .1 Junction Boxes and Pull Boxes:
 - .1 Supply all pull boxes and junction boxes shown on the Drawings or required for the installation.
 - .2 Identify with system name and circuit designation as applicable.
 - .3 Size in accordance with the Canadian Electrical Code, as a minimum.
- .2 Cabinets:
 - .1 Mount cabinets with top not greater than 1980 mm above finished floor, coordinated with masonry, panelboards, fire hose cabinets and similar items. Securely fasten backboards to cabinet interiors.
 - .2 Install terminal block where indicated.
- .3 Identification
 - .1 Provide equipment identification in accordance with Section 16010 – Electrical General Requirements.

END OF SECTION

OUTLET BOXES, CONDUIT BOXES AND FITTINGS

1. GENERAL

1.1 Work Included

- .1 Provide a complete system of boxes for the installation of wiring and equipment.

1.2 References

- .1 CSA C22.1-Canadian Electrical Codes, Part 1.

2. PRODUCTS

2.1 Outlet and Conduit Boxes General

- .1 Size boxes in accordance with CSA C22.1.
- .2 102 mm² or larger outlet boxes as required for special devices.
- .3 Gang boxes where wiring devices are grouped.
- .4 Blank cover plates for boxes without wiring devices.
- .5 Combination boxes with barriers where outlets for more than one system are grouped.

2.2 Outlet Boxes for Metal Conduit

- .1 Materials:
 - .1 Surface or recessed concealed type: Die formed steel, hot dip galvanized, 3.95g/m² minimum zinc coating.
 - .2 Surface mounting exposed: Cast ferrous for threaded conduit, with attached lugs, corrosion resistant two coats finish.
- .2 Components:
 - .1 Outlets boxes, mounted on concrete:
 - .1 Wall outlets, surface, exposed mounting or used for outdoor outlets: One or more gang, Crouse-Hinds FS series or FD series, conduit.
 - .2 Covers: Unless wiring devices and plates are mounted, provide blank canopy covers to match boxes.

2.3 Outlet Boxes for Rigid PVC Conduit

- .1 Materials:
 - .1 Rigid PVC boxes and fittings: Unplasticized PVC.

OUTLET BOXES, CONDUIT BOXES AND FITTINGS

2.4 Conduit Boxes

- .1 Cast FS or FD Feraloy boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacle.

2.5 Fittings - General

- .1 Bushing and connectors with nylon insulated throats.
- .2 Conduit outlet bodies for conduit up to 32 mm and pull boxes for larger conduits.

3. EXECUTION

3.1 Installation

- .1 Support boxes independently of connecting conduits.
- .2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
- .3 Provide correct size of openings in boxes for conduit, and armoured cable connections. Reducing washers are not allowed.
- .4 Install all outlets surface mounted as required for the installation.
- .5 Surface mount on unfinished areas.
- .6 Do not distort boxes during installation. If boxes are distorted, replace with new boxes.
- .7 Do not use sectional boxes.
- .8 Provide boxes sized as required by the Canadian Electrical Code.
- .9 Ceiling outlet boxes shall be provided for every surface mounted fixture or row of fixtures installed on suspended "hard" ceilings.
- .10 Primary bushings in termination box for cable connection.
- .11 Secondary bushings in termination box for bus duct connection.
- .12 Control junction box.
- .13 Stainless steel nameplate and connection diagram.

END OF SECTION

WIRE AND BOX CONNECTORS

1. GENERAL

1.1 Work Included

- .1 Supply and Install a complete system of wiring, making all connections necessary for the installation shown on Drawings.

1.2 Special Codes

- .1 Install and rate power cables in accordance with the Canadian Electrical Code requirements, or in accordance with IPCEA requirements where permissible.

1.3 References

- .1 CSA C22.2 No. 65 Wire Connectors.
- .2 EEMAC 1Y-2, Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).

2. PRODUCTS

2.1 Materials

- .1 Pressure type wire connectors: with current carrying parts same material as conductors sized to fit the conductors as required.
- .2 Fixture type splicing connectors: with current carrying parts same material as conductors sized to fit the conductors 10 AWG or less.
- .3 Bushing stud connectors: to EEMAC 1Y-2 to consist of:
 - .1 Connector body and stud clamp for stranded copper conductors.
 - .2 Clamp for stranded copper conductors.
 - .3 Stud clamp bolts.
 - .4 Bolts for copper conductors.
 - .5 Sized for conductors as indicated.
- .4 Clamps or connectors for aluminum sheathed cable, flexible conduit, as required.

2.2 Wire Connectors

- .1 Use 3M "Scotchlock", self-insulated connectors for hand twist wire joints for lighting, small power, and control wiring.

WIRE AND BOX CONNECTORS

- .2 Use Thomas & Betts non-insulated ring type compression lugs for terminating #10 AWG and smaller motor connections. Lugs to accept ten (10) 32 x ³/₈" machine bolts.
- .3 Terminate conductors #8 AWG and larger with Thomas & Betts Colour-Keyed compression connectors Series 54000, or on lugs provided with equipment.
- .4 Thomas & Betts "KOPR-SHIELD" compound Series CP8 on all terminations for compression connectors.

3. EXECUTION

3.1 Installation

- .1 Remove insulation carefully from ends of conductors and:
 - .1 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by the Manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2 No. 65.
 - .2 Install fixture type connectors and tighten. Replace insulating cap.
 - .3 Install bushing stud connectors in accordance with EEMAC 1Y-2.

3.2 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 the Manufacturer.
- .3 Install compression connectors using methods and tools recommended by the Manufacturer.
- .4 Do not install stranded conductors under screw terminals unless compression lugs are installed.

END OF SECTION

CONNECTORS AND TERMINATIONS

1. GENERAL

1.1 Inspection

- .1 Obtain inspection certificate of compliance covering high voltage stress coning from Consultant and include it with as-built drawings and maintenance manuals.

1.2 Product Data

- .1 Submit product data sheets in accordance with Section 16010 – Electrical General Requirements.

2. PRODUCTS

2.1 Connectors and Terminations

- .1 Copper long barrel compression connectors as required and sized for conductors.
- .2 Contact aid for aluminum cables where applicable.

3. EXECUTION

3.1 Installation

- .1 Install stress cones, terminations, and splices in accordance with Manufacturer's instructions.
- .2 Bond and ground as required.

END OF SECTION

GROUNDING

1. GENERAL

1.1 Description

- .1 Supply and install a complete grounding system. Securely and adequately ground all components of the electrical system in accordance with the requirements of all related sections in the latest Canadian Electrical Code and the local Electrical Inspection Branch.
- .2 The extension to existing system to consist of cables, supports, and all necessary materials and inter-connections to provide a complete system. Measured resistance to ground of the network shall not exceed 5 ohms.
- .3 All ground conductors shall be run in conduit.

2. PRODUCTS

- .1 Cables 3/0 and smaller to be connected to ground bars via Burndy Quiklug Type QA-2B connectors. Connections for cables larger than 3/0 shall be brazed.
- .2 All ground wires to be stranded copper TWH complete with a green jacket unless otherwise shown.
- .3 Cable to pipe connectors to be made with Burndy GAR connectors.

3. EXECUTION

3.1 Grounding - General

- .1 All frames and metallic enclosures of all electrical equipment and electrically operated equipment shall be grounded via a ground wire.
- .2 All transformers, switchgear, motor control centres, panelboards and splitters fed from the main distribution centre shall be grounded by grounding conductors sized in accordance with the Canadian Electrical Code. The ground wire shall be terminated at each end with an appropriate grounding lug, which shall be connected to the equipment ground bus. Ground wire to be green TWH.
- .3 All sub panels such as lighting panels, local distribution panels, etc., shall be grounded with a green ground wire run back to the panel from which it is fed. The ground conductor shall be sized according to the Canadian Electrical Code.
- .4 All main distribution centres, motor control centres, switchgear, and all panels requiring equipment grounds shall contain a ground bus of adequate size, and tapped for lugs for the ground wire required.

GROUNDING

- .5 All bolted connections must be accessible.
- .6 All motors shall be grounded by means of an adequately sized green ground wire contained within the feeder conduit.
- .7 Include a separate green ground wire in all power conduits including branch circuit wiring sized to Table 16, Canadian Electrical Code.
- .8 Expansion joints and telescoping sections of raceways shall be bonded using jumper cables as per Canadian Electrical Code.
- .9 Use Burndy compression connectors or approved equal for all grounding splices and terminations unless otherwise shown on the Drawings. For bolted ground connections use Burndy Engineering Company's "Durium" or approved equal hardware.
- .10 Connect all transformer neutrals to the main building ground wire, using compression terminations.
- .11 Install rigid conduit sleeves where ground wires pass through concrete slabs.
- .12 Conduit installed buried in earth or installed in or under grade floor slabs shall have separate ground wire installed, whether the conduits are metal or not.
- .13 Ground all utility services to the electrical system ground.
- .14 Ground control cable shields at one end only. Ensure that shields are continuous over the entire circuit run.

END OF SECTION

FASTENINGS AND SUPPORTS

1. GENERAL

1.1 Work Included

- .1 Supply and Install all hangers, supports and inserts for the installation shown on the Drawings and specified herein, as necessary to fasten electrical equipment securely to the building structure.

2. PRODUCT

2.1 Framing and Support System

- .1 Materials:
 - .1 Intermediate duty supporting structures: Galvanized steel strut channel together with the manufactures connecting components and fasteners for a complete system.
 - .2 Heavy duty supporting structures: fabricated from welded steel structural members and hot dipped galvanized before installation.
 - .3 Nuts, bolts, machine screws: stainless steel.

2.2 Concrete and Masonry Anchors

- .1 Materials: Hardened steel inserts, zinc plated for corrosion resistance. Epoxy adhesive type.
- .2 Components: non-drilling anchors for use in predrilled holes, sized to safely support the applied load with a minimum safety factor of 4.
- .3 Manufacturer: Hilti (Canada) Limited.

2.3 Non-Metallic Anchors

- .1 Material: Plastic anchors for sheet metal screws.
- .2 Manufacturer: Fischer.

2.4 Conduit Supports

- .1 General: Malleable iron one-hole conduit straps where exposed to weather. Stamped steel two-hole straps indoors.
- .2 Structural Steel: Crouse-Hinds "Wedgetite" supports or equal manufactured by Appleton.
- .3 Masonry, concrete, stone, etc.: Anchors.

FASTENINGS AND SUPPORTS

- .4 Title: Toggle bolts.
- .5 Metal studs, ceiling hangers, etc.: “Caddy-Clips”.
- .6 Unistrut: Unistrut conduit clamps.

2.5 Cable Supports and Clamps

- .1 General: As per conduit supports, except that for single conductor cables, use suitable non-ferrous, or approved stainless steel or aluminum clamps.

3. EXECUTION

3.1 General

- .1 Do not cut or drill beams, joists or structural steel unless written permission of the Contract Administrator is obtained.
- .2 Distance between conduit or cable supports not to exceed code requirements.
- .3 Supports to be suitable for the real loads imposed by equipment.
- .4 Supports to be securely fastened, free from vibration and excessive deflection or rotation. Maximum deflections are 4 mm over a 1 m span and 8 mm over a 2 m span.
- .5 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with Manufacturer’s installation recommendations.
- .6 Supply and Install conduit rack with 25% spare capacity for multiple runs.
- .7 Supply and Install channel support with fittings for vertical runs of conduit and cables.

3.2 Installation

- .1 Secure equipment to tile and plaster surfaces with lead anchors.
- .2 Secure equipment to poured concrete and concrete masonry with adhesive anchors.
- .3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
- .4 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .5 Fasten exposed conduit or cables to building construction or support system using straps.
 - .1 One-hole malleable iron or steel straps to secure surface conduits and cables 50 mm and smaller.

FASTENINGS AND SUPPORTS

- .2 Two-hole steel straps for conduits and cables larger than 50 mm.
- .3 Beam clamps to secure conduit to exposed steel work.
- .6 Suspended support systems.
 - .1 Support individual cable or conduit runs with 6 mm diameter threaded rods and spring clips.
 - .2 Support two or more cables or conduits on channels supported by 6 mm diameter threaded rod hangers where direct fastening to building construction is impractical.
- .7 Use plastic anchors for light loads only. Use metal anchors for all other loads.
- .8 Shot driven pins may only be used with written approval of the Contract Administrator.
- .9 Use round or pan head screws for fastening straps, boxes, etc.
- .10 Do not support heavy loads from the bottom chord of open web steel joists.
- .11 Support outlet boxes, junction boxes, panel tubs, etc., independent of conduits running to them. Support conduits within 600 mm of outlet boxes. Support surface mounted panel tubs with a minimum of four 6 mm fasteners.
- .12 For surface mounting of two or more conduits use channels at 1.5 m oc spacing.
- .13 Supply and Install metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .14 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .15 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .16 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of the Contract Administrator.

END OF SECTION

CIRCUIT BREAKERS

1. GENERAL

1.1 Product Data

- .1 Submit product data in accordance with Section 16010 – Electrical General Requirements.

2. PRODUCTS

2.1 Circuit Breakers

- .1 Indoor vacuum circuit breaker, 3 pole, single break, power operated, draw out breaker element, sized as indicated.
- .2 Circuit breaker shall be operated by a motor-charged spring stored energy mechanism. The spring may be charged manually in an emergency or during maintenance procedures.
- .3 Circuit breakers shall have three (3) vacuum interrupter assemblies that are separately mounted on 5 kV class insulators. The breaker front panel shall be removable when the compartment door is open for ease of inspection and maintenance of mechanism.
- .4 Breaker shall be electrically operated by 115 VAC close and AC capacitor trip.
- .5 Breaker shall be complete with control switchgear and red and green indicating lights to indicate breaker contact position.
- .6 Control voltage shall be derived from within equipment.

2.2 Rating – Switch Gear, Switch and Circuit Breaker

- .1 The 5 kV switchgear assembly rating shall be as follows:
 - .1 Maximum voltage 4.76 kV
 - .2 Basic impulse level 60 kV
 - .3 Interrupting capacity 350 MVA
 - .4 Nominal system voltage 4.16 kV 3 phase 3 wire resistance grounded
 - .5 Main cross bus continuous current rating 1200 A
- .2 The 5 kV breaker rating shall be as follows:
 - .1 Circuit breaker nominal 3 phase MVA class 350
 - .2 Frame size 1200 A

CIRCUIT BREAKERS

2.3 Construction

- .1 The switchgear assembly shall consist of deadfront, completely metal – enclosed vertical section with drawout vacuum circuit breaker.

2.4 Bus Bars

- .1 3 phase insulated bus bars, continuous current rating of 1200 A at 5 kV, extending full width of multi-cubicle switchboard suitably supported on insulators.
- .2 Bus bar insulation shall be epoxy flame-retardant and track-resistant. Bus supports shall be flame-retardant and track-resistant glass polyester.
- .3 Ground bus conductor shall be silver plated copper.
- .4 Bus supports to be high strength and high creep, finned supports providing a minimum of 356 mm of creep between phase and ground.

2.5 Trip Unit

- .1 Microprocessor three phase protection relay.
- .2 Relay for phase time over current, instantaneous overcurrent and ground fault protection, ANSI 50/51, 50/51G shall be incorporated into a single device to be Schneider Electric SEPAM 1000 S40

2.6 Equipment Identification

- .1 Provide equipment identification in accordance with Section 16010 – Electrical General Requirements.
- .2 Label Size: 7

2.7 Approved Manufacturer

- .1 Schnieder

3. EXECUTION

3.1 Factory Testing

- .1 Standard factory tests shall be performed on circuit breaker elements in accordance with the latest version of ANSI, CSA, and NEMA standards.

CIRCUIT BREAKERS

3.2 Field Quality Control

- .1 Provide services of a quality factory-trained Manufacturer's Representative to assist the Contractor in installation and Performance Verification of equipment specified under this Section.
- .2 Perform test in accordance with Section 16980 – Testing, Adjusting and Balancing of Electrical Equipment and Systems.

3.3 Installation

- .1 Set and secure cubicle in place, rigid, plumb and square, on channel base.
- .2 Interconnect cubicles to adjacent equipment as indicated.
- .3 Check factory-made connectors for mechanical security and electrical continuity.
- .4 After finishing work, remove foreign material, including dust, before energizing substation.

END OF SECTION

INTERLOCKING SYSTEM

1. GENERAL

1.1 Shop Drawings and Product Data

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

2. PRODUCTS

2.1 Interlock Systems

- .1 Kirk key interlocks, Type F for load interrupter switch and Type D for switchgear cubicle door to prevent:
 - .1 Opening cubicle door for access to fuses while load interrupter is in closed position.
 - .2 Closing load interrupter while cubicle door is open.
- .2 Key interlocks mounted in switchgear so that interlocks can not be removed when operating switch or breaker is in closed position.
- .3 Key interlocks shall match existing interlocks.

2.2 Manufacturer

- .1 Kirk Interlocks and Schneider Canada Service.

3. EXECUTION

- .1 Install interlocks on switch or breakers cubicle as indicated on drawings.

END OF SECTION

INSTRUMENT TRANSFORMERS

1. GENERAL

1.1 References

- .1 CAN3-C13, Instrument Transformers.

1.2 Product Data

- .1 Submit product data in accordance with Section 16010 – Electrical General Requirements.
- .2 Indicate dimensions and connection details.

2. PRODUCTS

2.1 Potential Transformers

- .1 Potential Transformers: To CAN3-C13, dry type for indoor use, with following characteristics:
 - .1 Nominal Voltage Class: as indicated
 - .2 Rated Frequency: 60 Hz
 - .3 Basic Impulse Level: 10 kV
 - .4 Voltage Ratio: as required
 - .5 Accuracy Rating: 0.3B2.0.
- .2 Potential Transformers fused with separate fuse block, Fuses: as required.

2.2 Current Transformers

- .1 Current Transformers: To CAN3-C13, dry type for indoor use with following characteristics:
 - .1 Nominal Voltage Class: as indicated
 - .2 Rated Frequency: 60 Hz
 - .3 Basic Impulse Level: 60 kV
 - .4 Metering Accuracy Ratio: 0.3B2.0
 - .5 Relay Accuracy Rating: 2.5H100
 - .6 Rated Primary and Secondary Current: as indicated

INSTRUMENT TRANSFORMERS

- .7 Continuous-Current Rating Factor: 150%
- .8 Short-Time Mechanical Current Rating: 1.5 times primary rating
- .9 Short-Time Thermal Current Rating: 1.5 times primary rating.
- .2 Positive action automatic short-circuiting device in secondary terminals.

2.3 Mounting Brackets

- .1 Potential transformers with brackets as required.
- .2 Fabricate brackets and channels from electrogalvanized code gauge painted steel.

3. EXECUTION

3.1 Installation

- .1 Install instrument transformers and ensure accessibility.

END OF SECTION

DISCONNECT SWITCHES FUSED AND NON-FUSED UP TO 600 V - PRIMARY

1. GENERAL

1.1 Description

- .1 Supply and Install disconnect switches for the Branch 1 Cooling Water Supply Pumps, as manufactured by Cutler Hammer, Schnieder Electric.

2. PRODUCTS

2.1 Disconnect Switches

- .1 Ratings: 600 V for 347/600 V distribution, 240 V for 120/208 V distribution. Unless otherwise shown, 3 pole for 3 phase, 3 wire distribution, 3 pole and solid neutral for 3 phase 4 wire distribution. Ampere ratings as shown on the drawings or to suit load requirements. For motors, use disconnect switches with HP ratings at least equal to motor HP.
- .2 Enclosures: CSA code gauge galvanized steel, hinged doors, external operating handles. Disconnect switches in dry locations shall be EEMAC-1 and EEMAC-3 where exposed to weather. Provide ON-OFF switch position indication on switch enclosure cover.
- .3 Finish: One primer coat and one finish coat on all metal surfaces, colours as per Section 16010 – Electrical General Requirements.
- .4 Switch mechanisms: Quick make and quick break action with self wiping contacts, solderless pressure lug connectors. For switches 100 A and over, provide non-tracking arc shrouds. All switch poles to operate together from a common operating bar. Provide for padlocking disconnect switches in "Off" position. Doors to be interlocked and complete with defeat mechanism, to prevent opening when handle in ON position.
- .5 Neutral Bars: Where distribution system has grounded neutral conductor, provide neutral bar where required with ampere rating equal to switch rating, in enclosure. Provide ground bar for terminating ground conductors.
- .6 Fuse Holders: Supply and Install fuse holders (relocatable and suitable without adapters) on load side of switches, ampere rating equal to switch ratings, suitable for fuses specified.

2.2 Fuses

- .1 All fuses to be 100,000 A (minimum) interrupting capacity of the current limited type. In addition, fuses feeding motors to be of the time delay type. Provide one full set of spare fuses, three (3) for each different ampere rating used, stored in suitable enclosure.

DISCONNECT SWITCHES FUSED AND NON-FUSED UP TO 600 V - PRIMARY

3. EXECUTION

3.1 Disconnect Switches

- .1 Mounting: Supply and Install supports independent of conduits. Wall mount where possible, otherwise provide Unistrut frame support. Where switches are grouped mount in uniform arrangement.
- .2 Wiring: Connect line and load cable to all switches.
- .3 Fuse Rating: Install so that rating is visible.
- .4 Identification: Supply and Install lamacoid plate in accordance with Section 16010 – Electrical General Requirements, on each switch showing voltage, source of supply and load being fed, for example:

UPS

120/208 V

Fed from DP-G101-31,33,35

END OF SECTION

PANELBOARDS - BREAKER TYPE

1. GENERAL

1.1 Shop Drawings

- .1 Submit shop drawings in accordance with Section 16010 - Electrical General Requirements.
- .2 Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

2. PRODUCTS

2.1 Panelboards

- .1 Panelboards: product of one manufacturer.
 - .1 Install circuit breakers in panelboards before shipment.
 - .2 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.
- .2 Panelboards: bus and breakers rated for 250V to be 10 KA, 600V to be 14 KA (symmetrical interrupting capacity or as indicated).
- .3 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.
- .4 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.
- .5 Two keys for each panelboard and key panelboards alike.
- .6 Copper bus with neutral of same ampere rating as mains.
- .7 Mains: suitable for bolt-on breakers.
- .8 Trim with concealed front bolts and hinges.
- .9 Trim and door finish: baked grey enamel.

2.2 Breakers

- .1 Breakers: Refer to Section 16477 - Moulded Case Circuit Breakers.
- .2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.

PANELBOARDS - BREAKER TYPE

- .3 Main breaker: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.

2.3 Equipment Identification

- .1 Provide equipment identification in accordance with Section 16010 - Electrical General Requirements.
- .2 Nameplate for each panelboard size 4 engraved as indicated.
- .3 Nameplate for each circuit in distribution panelboards size 2 engraved as indicated.
- .4 Complete circuit directory with typewritten legend showing location and load of each circuit.

2.4 Acceptable Products

- .1 Cutler Hammer
- .2 Schneider

3. EXECUTION

3.1 Installation

- .1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.
- .2 Mount panelboards to height specified in Section 16010 - Electrical General Requirements or as indicated.
- .3 Connect loads to circuits.
- .4 Connect neutral conductors to common neutral bus with respective neutral identified.

END OF SECTION

MOULDED CASE CIRCUIT BREAKERS

1. GENERAL

1.1 Product Data

- .1 Submit product data in accordance with Section 16010 – Electrical General Requirements.
- .2 Include time-current characteristic curves for breakers with interrupting capacity of 22,000 A symmetrical (rms) and over at system voltage.

2. PRODUCTS

2.1 Breakers General

- .1 Bolt-On Moulded Case Circuit Breaker: Quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40°C ambient.
- .2 Common-Trip Breakers: With single handle for multi-pole applications.
- .3 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting. Trip settings on breakers with adjustable trips to range from 3 to 8 times current rating.
- .4 Circuit breakers with interchangeable trips as indicated.

2.2 Thermal Magnetic Breakers [Design A]

- .1 Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.

2.3 Magnetic Breakers [Design B]

- .1 Moulded case circuit breaker to operate automatically by means of magnetic tripping devices to provide instantaneous tripping for short circuit protection

2.4 Enclosure for Individually Mounted Breakers

- .1 Enclosure shall be CSA code gauge galvanized steel, hinged door, front mounted external operating handle, lockable in “off” position, EEMAC-1 unless shown otherwise. Use EEMAC-12, for industrial application, enclosure for wet environment or as shown “WP” on drawings. Increase enclosure size above standard for large cables.
- .2 Where distribution system has grounded neutral conductor, provide neutral bar, with ampere rating equal to breaker/switch rating in enclosure.

MOULDED CASE CIRCUIT BREAKERS

3. EXECUTION

3.1 Installation

- .1 Install circuit breakers as indicated.
- .2 Identification: Provide lamicoid plate on each breaker showing voltage, source of supply and load being fed - 120/208 V, 3 phase, 4W fed from LDP No.1 to Splitter Trough No. 1.

END OF SECTION

POWER SURGE PROTECTORS

1. GENERAL

1.1 Related Work

- .1 Section 16010 – General Electrical Requirements
- .2 Section 16471 – Panelboards - Breaker Type

1.2 System Description

- .1 A transient voltage surge suppressor for the protection of downstream electronic equipment connected to the building power supply. The specified unit shall be compatible with non-linear loads and shall provide effective high-energy transient voltage suppression, surge current diversion and high-frequency electrical noise filtering while connected in parallel with a facility's distribution system. The filtering unit shall utilize non-linear voltage dependent metal oxide varistors or selenium cells. The suppression system's components shall not utilize gas tubes, spark gaps, or silicon avalanche diodes. The device shall be referred to as a TVSS filter for the purpose of this document and drawings.

2. PRODUCT

2.1 Operation and Environment

- .1 Voltage: The TVSS devices shall be suitable for the voltage and systems configuration as indicated on the single line diagram(s).
- .2 Maximum Continuous Operating Voltage (MCOV): The MCOV of the suppressor unit shall be greater than 125% for 120/208 V systems and 115% for 347/600 V systems.
- .3 Protection Modes: Transient voltage surge suppression paths shall be provided for all possible common and normal modes (between each line and ground, neutral and ground, line to line and each line and neutral). The primary suppression path shall not be to ground.

2.2 Suppression Component

- | | | | |
|----|------------------------------|------------------------------------|---|
| .1 | Peak surge Current per Phase | 240,000 Amps | (Main entrance panel applications) |
| | | 120,000 Amps | (Branch Panel Applications) |
| | | 30,000 Amps | (Plug-in / Cord -- connected individual equipment protection) |
| .2 | Let Through Voltage (L-N) | 120 V (individual equipment units) | 330 V |
| | | 208 V Units | 500 V |
| | | 600 V Units | 1200 V |

POWER SURGE PROTECTORS

- .3 TVSS clamping components response time < 1 nanosecond

2.3 Filtering

- .1 TVSS shall contain a high frequency extended range tracking filter.
- .2 Noise attenuation ≥ 45 dB @ 100 kHz.
- .3 Main entrance panel application effective filtering bandwidth - 180 Hz to 50 Mhz. Branch panel application effective filtering bandwidth - 1 kHz to 50 Mhz. Plug-in/Cord - Connected Individual Equipment application effective filtering bandwidth - 100 kHz to 100 Mhz.

2.4 Panelboard Component (Integrated TVSS Panel)

- .1 Main Bus: The device shall have a copper, tin plated main bus.
- .2 Circuit Breakers: Are to be of the over center toggle mechanism type which use bolt-on connectors to line side panelboard connectors.
- .3 Panelboard Enclosure: The panelboard shall be provided in an EEMAC 1 enclosure. The TVSS/filter status indicators shall be visible without the need to open the panelboard door. A lockable door shall be provided to limit access to authorized personnel only. Trim assembly shall be tamper proof. The trim (doors) shall be finished in grey ASA61 paint.
- .4 Neutral Bus: The unit shall be equipped with a copper 100% rated neutral bus, which shall include a sufficient quantity of solderless type lugs to service the total unit circuit capacity.
- .5 Wiring Gutters: The integrated TVSS filtering panel shall be equipped with a complete perimeter wiring gutter with a cross-sectional dimensions of not less than 12,200 mm².
- .6 Safety and Insulated/Isolated Ground Bus: The integrated filter panel shall have a safety and insulated/isolated ground bus equipped with solderless type lugs of quantity to sufficiently service the circuit loads.

2.5 General Features

- .1 The integrated TVSS panel shall be factory installed and connected to the bus bar.
- .2 Connectors: Terminals shall be provided for all the necessary input and output power and ground connections on the TVSS.
- .3 Enclosure: The specified system shall be provided in a heavy duty NEMA 12 dust tight enclosure with no ventilation openings for maintenance and branch panel applications. Indication of surge current module status shall be visible without opening the door.
- .4 Internal Connections: All surge current diversion connections shall be by way of low impedance wiring. Surge current diversion components shall be wired for reliable low

POWER SURGE PROTECTORS

impedance connections. No plug-in component modules, quick disconnect terminals or printed circuit boards shall be used in surge suppression paths.

- .5 Unit Status Indicators: Red status indicators shall be provided on the hinged front cover to indicate unit phase status. The absence of the red light shall reliably indicate that one or more surge current diversion phases have failed and that service is needed to restore full operation.
- .6 Fuses: The unit shall utilize internal fuses rated with a minimum interrupting capability of 200,000 A or greater.
- .7 Identification: The unit shall include manufacturer's nameplate, UL rating, and a CSA approval on the exterior enclosure.
- .8 Testing: Testing at each unit shall include assurance checks, "Hi-Pot" test at two times rated voltage plus 1000 V per UL requirements, and operation and calibration tests.

2.6 Approved Manufacturers

- | | | |
|----|--|-----------|
| .1 | Current Technologies
-- Integrated TVSS panel | Model EGP |
| .2 | Liebert Corporation
-- Integrated TVSS panel | Model LPG |
| .3 | Square D
-- Integrated TVSS panel board | |

3. EXECUTION

3.1 Installation

- .1 Install with Manufacturer's recommended conductors tapped from the electrical service switchboard conductor system. Conductors are to be as short and straight as possible. Input conductors to the TVSS shall be twisted together to reduce impedance during high frequency filtering.
- .2 An appropriately sized manual safety disconnect shall be supplied and installed before and in line with the TVSS from the electrical service for the purpose of electrically isolating the device from the system should service be required without interrupting the main service. Coordinate required disconnect ampacity with TVSS manufacturer.
- .3 The TVSS should be following the Manufacturer's recommended practices as outlined in the manufacturer's installation and Maintenance Manual and in compliance with all applicable electrical codes.

END OF SECTION

MOTOR STARTERS TO 600 V

1. GENERAL

1.1 References

- .1 NEMA Contactors and Motor Starters.

1.2 Related Work

- .1 Connections to Mechanical Equipment: Section 16950 – Connections to Mechanical Equipment.

1.3 Starter Requirements

- .1 In general, there are categories of starting equipment for three phase motors.
 - .1 Integral Mounted Starters: Some items of mechanical equipment such as boilers, have the starter mounted as part of the equipment. For this equipment, supply disconnects and wire to the terminals of the equipment.
 - .2 Separately Mounted Starters: For motors without integral mounted starters, supply separately mounted starters as indicated on the Drawings and wire the equipment.
 - .3 Starters in MCC: For motors fed from MCCs, wire from the equipment to the MCCs.
- .2 Provide manual starters for all single phase motors unless otherwise indicated on the Drawings.
- .3 Supply and Install interlocking between starters where required.
- .4 All starter accessories such as pilot lights, Hand-Off-Auto, Start-Stop, etc. whether integrally or remote mounted shall be heavy duty oil tight, unless otherwise specified.

1.4 Shop Drawings and Product Data

- .1 Submit Shop Drawings in accordance with Section 16010 – Electrical General Requirements.
- .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

MOTOR STARTERS TO 600 V

1.5 Operation and Maintenance Data

- .1 Provide operation and maintenance data for motor starters for incorporation into manual specified in Section 16010 – Electrical General requirements.
- .2 Include operation and maintenance data for each type and style of starter.

1.6 Maintenance Materials

- .1 Provide maintenance materials and listed spare parts for each different size and type of starter:
 - .1 Three (3) contacts, stationary
 - .2 Three (3) contacts, movable
 - .3 One (1) contacts, auxiliary
 - .4 One (1) control transformer
 - .5 One (1) operating coil
 - .6 Two (2) fuses
 - .7 10% indicating lamp bulbs used

2. PRODUCTS

2.1 Materials

- .1 Starters: to NEMA Standards

2.2 Enclosure

- .1 All individually mounted motor starters shall be enclosed in a general purpose sheet steel enclosure unless in wet areas where they shall be watertight EEMAC 4.
- .2 For all motors 22.4 kW and above, the starters shall contain thermistor control relay and accessories.

2.3 Manual Motor Starters

- .1 Manual motor starters of size, type, rating, and enclosure type as indicated, with components as follows:
 - .1 Switching mechanism, quick make and break
 - .2 Overload heaters, manual reset, trip indicating handle
 - .3 Rated volts and poles to suit application

MOTOR STARTERS TO 600 V

- .2 Accessories:
 - .1 Push-button: oil-tight labelled as indicated.
 - .2 Indicating lights: oil tight type and colour as indicated, LED lamps.
 - .3 Locking tab to permit padlocking in "ON" or "OFF" position.

2.4 Full Voltage Non Reversing (FVNR) Magnetic Starters

- .1 Magnetic and combination magnetic starters of size, type, rating and enclosure type as indicated with components as follows:
 - .1 Contactor solenoid operated, rapid action type.
 - .2 Motor overload protective device in each phase, manually reset from outside enclosure.
 - .3 Wiring and schematic diagram inside starter enclosure in visible location.
 - .4 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
- .2 Combination type starters to include motor circuit interrupter with operating lever on outside of enclosure to control motor circuit interrupter, and provision for:
 - .1 Locking in "OFF" position with up to 3 padlocks.
 - .2 Independent locking of enclosure door.
 - .3 Provision for preventing switching to "ON" position while enclosure door open.
- .3 Accessories:
 - .1 Pushbuttons and selector switches: oil tight labelled as indicated.
 - .2 Indicating lights: oil tight type and red pilot light to indicate energized motor circuit and where called for, green pilot light to indicate de-energized motor circuit. Pilot lights to be push-to-test transformer type. Lamps shall be LED type.
 - .3 In addition to standard, 1-N/O and 1-N/C spare auxiliary contacts unless otherwise indicated.
 - .4 For all starters and components, provide interconnection wiring to WTP SCADA system. Monitored status includes the following:
 - .1 COA control switch position
 - .2 Motor running status
 - .3 Fault status

MOTOR STARTERS TO 600 V

2.5 Full Voltage Reversing (FVR) Magnetic Starters

- .1 FVR magnetic starters of size, type, rating and enclosure type as indicated with components as follows:
 - .1 Two (2) 3 pole magnetic contactors mounted on common base.
 - .2 Mechanical and electrical interlocks to prevent both contactors from operating at same time.
 - .3 Three smart overload relays with adjustable settings, manual reset.
- .2 Accessories:
 - .1 Pushbuttons and selector switches: oil-tight labelled as indicated.
 - .2 Indicating lights: oil-tight type and color as indicated, LED type lamp.
 - .3 Auxiliary control devices as indicated.

2.6 Multi-Speed Starters

- .1 2 speed starters of size, type, rating and enclosure type as indicated. Starter suitable for constant torque, variable torque, or constant kW type motor (as required) and with components as follows:
 - .1 One (1) 3 pole contactor for each winding for separate winding motors.
 - .2 One (1) 3 pole and one (1) 5 pole contactor for each reconnectable winding for consequent pole type motors.
 - .3 Three overload relays with three heater elements and manual reset for each speed.
- .2 Accessories:
 - .1 Pushbuttons and selector switches: oil-tight labelled as indicated.
 - .2 Indicating lights: oil-tight, type and color as indicated, LED type lamp.
 - .3 Auxiliary control devices as indicated.
 - .4 Automatic sequence accelerating and decelerating relays for each speed.

2.7 Control Transformer

- .1 A control transformer of sufficient VA capacity, dry type, with primary voltage as indicated and 120 V secondary, complete with primary and secondary fuses (HRC Form J), installed in with starter as indicated.
- .2 Size control transformer for control circuit load plus 20% spare capacity.

MOTOR STARTERS TO 600 V

2.8 Finishes

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

2.9 Equipment Identification

- .1 Provide equipment identification in accordance with Section 16010 – Electrical General Requirements.
- .2 Manual starter designation label, white plate, black letters, size 1, engraved as indicated.
- .3 Magnetic starter designation label, white plate, black letters, engraved as indicated.

3. EXECUTION

3.1 Installation

- .1 Install starters, connect power and control as indicated.
- .2 Ensure correct fuses and overload devices elements installed.

3.2 Starter Verification

- .1 Field check motor starters supplied prior to Performance Verification. 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 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,

MOTOR STARTERS TO 600 V

temperature differences between motor and starter locations. Monitor motor operation during running test 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 application. 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, equipment, control devices, operate as indicated.

END OF SECTION

MEDIUM VOLTAGE SOFT STARTERS 4160 V

1. GENERAL

1.1 Scope of Work

- .1 This Specification describes the requirements for the supply, factory testing and installation of medium voltage soft starters for 3 phase, squirrel cage induction motors as required by various process and mechanical equipment required for this Contract.
- .2 A total of five (5) MVSS shall be provided. Two MVSS shall be capable of controlling single speed motors; three MVSS shall be capable of controlling dual speed motors.
- .3 Soft starters and their associated over-current protection devices shall be connected as detailed on the References.
- .4 Use medium voltage starters manufactured and tested to conform to the following industry standards and specifications:
 - .1 ANSI
 - .2 CSA
 - .3 IEEE
 - .4 UL
 - .5 EEMAC
 - .6 NEMA

1.2 Shop Drawings and Product Data

- .1 Submit Shop Drawings in accordance with Section 01300 – Submittals
- .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

MEDIUM VOLTAGE SOFT STARTERS 4160 V

1.3 Operation and Maintenance Data

- .1 Provide O&M data for motor starters for incorporation into manual specified in Section 01730 – Operation and Maintenance Manuals.
- .2 Include O&M data for each type and style of starter.

1.4 Maintenance Materials

- .1 Provide maintenance materials in accordance with manufacturer recommendation.
- .2 Provide listed spare parts for each different size and type of starter:
 - .1 Three (3) contacts, stationary.
 - .2 Three (3) contacts, movable.
 - .3 One (1) contacts, auxiliary.
 - .4 One (1) control transformer.
 - .5 One (1) operating coil.
 - .6 Two (2) fuses.
 - .7 10% indicating lamp bulbs used.

2. PRODUCTS

2.1 Medium Voltage Soft Starter

- .1 The MVSS shall be installed in a 4160 V switchgear enclosure complete with horizontal bus bar and low and medium voltage sections.
- .2 Supply each MVSS with a vacuum bypass contactor, which is utilized to provide bypass of the SCR power poles once the motor is up to full speed. When a stop is commanded, the bypass contactor opens while the SCR poles are operating so that it does not have to open under full voltage. The vacuum bypass contactor shall be rated for across-the-line starting.
- .3 Supply each MVSS with a GE M60 Motor Management Relay for motor protection.
- .4 Brace the horizontal busswork and the cabling/bus from the main power cell and test in accordance with NEMA/EEMAC ICS 2-324 through ICS 2.325, and UL 347. The short circuit ratings - 350 MVA at 4160 V, as defined by NEMA/EEMAC and UL.
- .5 Provide the starter containing a 12 or 18 SCR power section with 4 or 6 SCRs per phase connected inverse parallel for variable AC output voltage with minimal motor and starter

MEDIUM VOLTAGE SOFT STARTERS 4160 V

heating. Design the power section to be capable of providing maximum torque per amp throughout the motor's speed-torque curve.

- .6 Provide Normal/ByPass selector switch to allow for across the line starting in the case of a soft start failure.
- .7 Furnish the logic control to perform all of the necessary starter functions.
- .8 In the logic control, incorporate a microcomputer, which consists of all of the circuitry required to drive the power semiconductors that are located in the power section. Configure the logic to provide the following standard features:
 - .1 Electronic motor overload,
 - .2 Adjustable up-to-speed motor protection (off; 0 to 300 seconds)
 - .3 Adjustable over/under voltage protection
 - .4 Adjustable line to average current imbalance
 - .5 Adjustable high and low frequency protection
 - .6 Single phase protection
 - .7 Adjustable starts per hour (off or 1 to 20 starts)
 - .8 Adjustable time between starts (off or 1 to 600 minutes)
 - .9 Backspin timer (off or 1 to 200 minutes)
 - .10 Programmable over current detection level (off or 50 to 800%) and delay time (0.1 to 90.0 seconds)
 - .11 Programmable undercurrent detection level (off or 10 to 100% and delay time (0.1 to 90.0 seconds)
 - .12 Programmable residual ground fault detection level (off or 1 to 100 amps) and delay time (0.1 to 90.0 seconds)
 - .13 All faults can each be set to either trip the starter or activate a relay
 - .14 Instantaneous electronic over-current trip
 - .15 Shorted SCR detection
 - .16 Phase rotation selectable ABC, CBA, or Ins (insensitive)
 - .17 Emergency restart capability

MEDIUM VOLTAGE SOFT STARTERS 4160 V

- .18 Two programmable ramp profiles selectable at any time via a 120 V input
- .19 Initial current, maximum current, and ramp time adjustments for each ramp
- .20 Tru-torque ramp profile (kW ramp profile)
- .21 Kick current and time adjustments for each ramp
- .22 Adjustable deceleration profile
- .23 Local start/stop controls
- .24 Remote start/stop; maintained type of control; for the two speed starter assume two external dry contacts (start command points); one for low speed, one for high speed.
- .25 Running status dry contact; for the two speed starter provide one contact “running low speed” and one contact “running high speed”.
- .26 Adjustable Ramp Time (0 to 120 seconds)
- .27 Adjustable Initial Current (50 to 400%)
- .28 Adjustable Max Current (100 to 600%)
- .29 Motor Deceleration and S-Curve Deceleration Control (0 to 60 sec.)
- .30 Line Phase Loss Detection
- .31 Line Current Imbalance Detection (10 to 40%)
- .32 Over/Under Line Voltage Protection (10 to 30%)
- .33 Up to speed indication
- .34 Plain English operation via back lit LCD display interface
- .35 LCD and LED status and diagnostics (full fault annunciation)
- .36 Programmable automatic fault reset capability
- .37 Programmable metering
- .38 Programmable relay outputs
- .39 Latched fault relay output
- .40 External trip input
- .41 Zero-speed switch input

MEDIUM VOLTAGE SOFT STARTERS 4160 V

- .42 Real time clock
- .43 Time stamped event recorder (99 events)
- .44 Password protection
- .45 Battery backed-up starter parameters and lockout times
- .9 MVSS shall switch between two separate parameters sets based on low or high speed for the two speed motors.
- .10 Provide each motor starter with the capability to display the following information:
 - .1 Each phase current
 - .2 Average current
 - .3 Phase 1 current
 - .4 Phase 2 current
 - .5 Phase 3 current
 - .6 Each phase voltage
 - .7 Average voltage
 - .8 Phase 1 voltage
 - .9 Phase 2 voltage
 - .10 Phase 3 voltage
 - .11 Frequency
 - .12 Thermal overload in percentage from 0 to 100% (100% = Trip)
 - .13 Motor power factor
 - .14 The elapsed running time in tenths of an hour (non-resettable)
 - .15 The elapsed running time in hours (non-resettable)
 - .16 The user re-settable elapsed running time
 - .17 The user re-settable motor starts counter
 - .18 Motor real power consumption
 - .19 Kilo-watt-hours used by the motor
 - .20 Mega-watt-hours used by the motor

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- .21 Motor reactive power consumption
- .22 Motor apparent power consumption
- .23 Ground fault current in amps
- .24 Motor starts counter
- .25 Motor current imbalance in percentage
- .11 Supply the starter with the ability to provide switching control for Power factor capacitors. Configure so that the capacitors are disconnected when the starter is stopped, accelerating or decelerating and the capacitors are connected when motor is running full speed, and the bypass contactor is closed.
- .12 The selection, sizing, internal connection and the control of the Power Factor capacitors shall take into consideration possible interference between already running pumps and accelerating pumps. Detuned power factor correction shall be provided if the harmonics generated adversely affect the capacitors.
- .13 Supply each starter with a Medium Voltage Transient Voltage Surge Suppression (MVTVSS) unit to protect each soft starter. The MVTVSS shall comply with the latest revision of ANSI/IEEE C62.11 "IEEE Standard for Metal Oxide Surge Arresters for AC Power Circuits.

2.2 PORT

- .1 Provide each motor starter with PORT functionality.
- .2 Provide and configure the control logic to provide the following parameters:
 - .1 Fault Delay
 - .2 Sense Time
 - .3 Bypass Delay
 - .4 Forward #2 Ramp Profile
- .3 Provide each motor starter with a properly sized UPS unit to supply control power to each motor starter for the PORT function.

2.3 Enclosure

- .1 Indoor NEMA 1 enclosure.
- .2 The switchgear assembly shall consist of individual vertical sections housing MVSS, bolted to form a rigid metal-clad switchgear assembly. Metal side sheets shall provide grounded barriers between adjacent structures and solid removable metal barriers shall isolate the major primary sections of each circuit. Two (2) rear covers shall be furnished for each

MEDIUM VOLTAGE SOFT STARTERS 4160 V

vertical section for circuit isolation and ease of handling. Hinged rear doors, complete with provisions for padlocking, shall be provided.

- .3 Use non-corrosive bolts and hardware.
- .4 100 mm steel channel sills for base mounting in single length common to multi-cubicle switchboard.
- .5 Provide 100 mm infrared sightglass, suitable for both short and long wave infrared, in front of each MVSS.

2.4 Bus Bars

- .1 3 phase insulated bus bars, continuous current rating of 1200 A at 5 kV, extending full width of multi-cubicle switchboard suitably supported on insulators.
- .2 Bus bar insulation shall be epoxy flame-retardant and track-resistant. Bus supports shall be flame-retardant and track-resistant glass polyester.
- .3 Main connections between bus bars, major switching components of continuous current rating to match major switching components.
- .4 High conductivity copper for bus bars and main connections.
- .5 Brace bus bar system including ground bus to withstand stresses resulting from short circuit currents specified.
- .6 Tin surfaced joints, secured with non-corrosive bolts and washers, tightened with torque wrench in accordance with Manufacturer's recommendations.
- .7 Identify phases of bus bars by suitable marking.
- .8 Provide bus bar connectors when switchgear shipped in more than one (1) section.
- .9 Transitions to allow connection to existing Schneider sections as outlined in the Drawings

2.5 Grounding

- .1 Copper ground bus not smaller than 50 x 6 mm extending full width of multi-cubicle switchboard and situated at bottom.
- .2 Lugs at each end for size #2/0 to #4/0 AWG grounding cable.
- .3 Bond non-current carrying parts, including switchgear framework, enclosure and bases to ground bus.

MEDIUM VOLTAGE SOFT STARTERS 4160 V

2.6 Equipment Identification

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

2.7 Acceptable Manufacturers

- .1 Benshaw MVRSM Micro II.

3. EXECUTION

3.1 Installation

- .1 Install starters, connect power and control as required.
- .2 Ensure correct fuses and overload devices elements installed.

3.2 Starter Verification

- .1 Field check motor starters supplied prior to testing 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 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 Motor Protection

- .1 Select and configure all motor protection parameters in GE M60 protection relays in accordance with motor Manufacturers' recommendations, considering motor service factors, ambient temperature, and temperature differences between motor and starter locations. Monitor motor operation during Performance Verification to ensure motor operation is satisfactory and relays provide proper protection.

MEDIUM VOLTAGE SOFT STARTERS 4160 V

3.4 Field Quality Control

- .1 Operate switches, contactors to verify correct functioning.
- .2 Perform starting and stopping sequences of contactors and relays.
- .3 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

3.5 Training

- .1 Provide demonstration and training on equipment operation and maintenance in accordance with Section 01664 – Training and 16990 – Electrical Equipment and Systems Demonstration and Instruction.

END OF SECTION

CONTROL DEVICES

1. GENERAL

1.1 Work Included

- .1 Control equipment such as (a) pushbutton stations, indicating lights, control and relay panels, are provided under this specification to form complete control system in conjunction with (b) such items as motor control centre, starters, and (c) items provided under Division 15 for example, pressure flow, float, solenoid valves, panels, pneumatic electric switches, transducers, duct and space thermostats [except heating systems]. Some or all of preceding items are interconnected under Part 3 of this specification. Specify control components and assemblies, relative work and interface between Divisions 15 and 16. Ensure work required to be performed is indicated on layout drawings, diagrams and motor starter and control list.

1.2 Shop Drawings

- .1 Submit Shop Drawings in accordance with Section 16010 – Electrical General Requirements.
- .2 Include schematic, wiring, interconnection diagrams.

2. PRODUCTS

2.1 AC Control Relays

- .1 Convertible contact type: contacts field convertible from NO to NC, electrically held with sliding barrier to permit access to contacts only or coil only, 3-4 poles. Coil rating: 120 V. Contact rating: 120 V, min 3 A.
- .2 Sealed contact type: electrically held with 3-4 poles and front mounted contact block. Coil rating: 120 V. Contact rating: 120 V, min 3 A.
- .3 Universal pole type: electrically held with 3-4 poles, convertible from NO to NC by changing wiring connections. Coil rating: 120 V. Contact rating: 120 V, min 3 A.
- .4 Fixed contact type: heavy duty with 3-4 poles. Coil rating: 120 V. Contact rating: 120 V, min 3 A.

2.2 Relay Accessories

- .1 Standard contact cartridges: normally-open - convertible to normally-closed in field.

2.3 Sealed Contact Oiltight Limit Switches

- .1 Lever type switches: roller operated, double pole, double throw. Contact rating: EEMAC B-600.

CONTROL DEVICES

- .2 Push type switches: actuated by rod located on tip or side of operating head, spring return double pole, double throw. Contact rating: EEMAC B-600.
- .3 Wobble stick cat whisker type switches: actuated by rod or stick extending from tip of operating head. Moving rod in any direction operates contacts. Double pole, double throw. Contact rating: EEMAC B-600.
- .4 Lever operated: time delay switch: adjustable time delay from $\frac{1}{2}$ s to 15 s plus 25%. Contact rating: EEMAC B-600.
- .5 Plug-in construction switches: CSA Type 4, lever or push type, contact rating: EEMAC A-600.

2.4 Solid State Timing Relays

- .1 Construction: AC operated electronic timing relay with solid-state timing circuit to operate output contact. Timing circuit and output contact completely encapsulated to protect against vibration, humidity and atmospheric contaminants.
- .2 Operation: on-delay or off-delay.
- .3 Potentiometer: self contained to provide time interval adjustment.
- .4 Supply voltage: 120 V, ac, 60 Hz.
- .5 Temperature range: minus 20°C to 60°C.
- .6 Output contact rating: maximum voltage 300 V AC or DC. Current: EEMAC B300.
- .7 Timing ranges: as required.

2.5 Instantaneous Trip Current Relays

- .1 Enclosure: CSA Type 1
- .2 Contacts: NO, NC automatic reset with adjustable tripping point.
- .3 Control: 3 wire, with provision for shorting contacts during accelerating period of motor.
- .4 Contact rating: EEMAC B600.

2.6 Operator Control Stations

- .1 Enclosure: CSA Type 1, surface mounting:

CONTROL DEVICES

2.7 Pushbuttons

- .1 Oil tight, operator recessed, or flush, or mushroom type, as required. Black, with 1-NO and 1-NC contacts rated as required. Stop pushbuttons coloured red, provision for padlocking in depressed position.

2.8 Selector Switches

- .1 Maintained or spring return to center position, as required, oil tight, operators standard wing lever, contact arrangement as required, rated 120 V, min 3 A, ac.

2.9 Indicating Lights

- .1 Oil tight, full voltage, LED type, push-to-test, lens colour: as required, supply voltage: 24 V, labels as required.

3. EXECUTION

3.1 Installation

- .1 Install pushbutton stations, control and relay panels, control devices and interconnect.

3.2 Field Quality Control

- .1 Perform tests in accordance with Section 16980 – Testing, Adjusting and Balancing of Electrical Equipment and Systems.
- .2 Depending upon magnitude and complexity, divide control system into convenient sections, energize one section at a time and check out operation of section.
- .3 Upon completion of sectional test, undertake group testing.
- .4 Check out complete system for operational sequencing.
- .5 Submit to Contract Administrator one copy of test results.

END OF SECTION

MOTOR POWER FACTOR CORRECTION

1. GENERAL

1.1 Related Work

- .1 Section 16010 – Electrical General Requirements
- .2 Section 16813 – Medium Voltage Soft Starter 4160 V

1.2 Starter Requirements

- .1 Provide power factor correction for 3 phase squirrel cage induction motors larger than 15 HP.

1.3 Regulatory Requirements

- .1 The design, construction, and assembly of the power factor correction assembly shall conform to CSA 22.1 and CSA No. 190.

2. PRODUCTS

2.1 Capacitors

- .1 Constructed of metallized polypropylene impregnated with non PCB oil.
- .2 One piece extruded aluminum housing.
- .3 Built-in overpressure fuse - self healing type.
- .4 Temperature range of -40°C to +50°C.
- .5 Losses shall be less than .5 watts per KVAR.
- .6 Supply and Install discharge resistor to decrease terminal voltage to 50 V one minute after disconnection.

2.2 Enclosure

- .1 CEMA 1 enclosure finished in acrylic enamel to match MCC.
- .2 Modular mounting of capacitors on rack assembly.
- .3 Wall mounted.

MOTOR POWER FACTOR CORRECTION

3. EXECUTION

3.1 Installation

- .1 Adjust overload relay sizes to correspond to reduced line currents.
- .2 Install capacitor unit adjacent to 4160 V switchgear.
 - .1 Connect capacitor at the motor starter on load side of capacitor contactor.

END OF SECTION

STARTING OF ELECTRICAL EQUIPMENT AND SYSTEMS

1. GENERAL

1.1 Related Work

- .1 Section 16980 – Testing, Adjusting and Balancing of Electrical Equipment and Systems
- .2 Section 16990 – Electrical Equipment and Systems Demonstration and Instruction

1.2 Coordination

- .1 Coordinate 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 Other equipment and systems specified in other Divisions.
 - .3 City supplied pumps for Branch 1.
 - .4 City supplied motorized actuators.
 - .5 City supplied flow meters.
- .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 New Electrical System

- .1 Prior to energizing the new electrical system:
 - .1 Verify supply authority voltage and phase rotation.
 - .2 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.

STARTING OF ELECTRICAL EQUIPMENT AND SYSTEMS

3.3 Energizing Equipment

- .1 Prior to energizing equipment provided under other Sections and equipment provided by the City, confirm equipment nameplate 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 City, who shall also sign the test documentation.
- .5 Submit procedures proposed in writing for approval two (2) weeks prior to test.

1.2 Related Work

- .1 Section 16010 – Electrical General Requirements.
- .2 Section 16960 – Starting of Electrical Equipment Systems.

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 Contract Administrator 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.

TESTING, ADJUSTING AND BALANCING OF ELECTRICAL EQUIPMENT AND SYSTEMS

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

1.6 Manufacturer's Site Services

- .1 Arrange and pay for the site services of qualified Manufacturers' Representatives where Site testing, adjusting, or balancing of electrical equipment or systems' performed by Manufacturer's Representatives are:
 - .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 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 V 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.

**TESTING, ADJUSTING AND BALANCING
OF ELECTRICAL EQUIPMENT AND SYSTEMS**

3.3 Load Balance Testing

- .1 Perform load tests when as many loads as possible, prior to acceptance of the Work, are operable.
- .2 Turn on all possible loads.
- .3 Test load balance on all feeders at distribution centres, MCC, and panelboards.
- .4 If load balance exceeds 15%, reconnect circuits to balance loads.

3.4 Voltage Testing and Adjusting

- .1 Test voltage at all panelboards.
- .2 Adjust transformer tap settings to compensate for under-voltage or over-voltage conditions, if directed to do so by Contract Administrator.

END OF SECTION

ELECTRICAL EQUIPMENT AND SYSTEMS DEMONSTRATION AND INSTRUCTION

1. GENERAL

1.1 Intent

- .1 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.
- .2 All sign off and survey sheets shall be typewritten.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 Demonstration Test

- .1 Refer to Division 1.
- .2 Demonstrate operation of following systems:
 - .1 5 kV breaker
 - .2 Medium voltage softstators
 - .3 600/347 V Electrical System
 - .4 208/120 V System

ELECTRICAL EQUIPMENT AND SYSTEMS DEMONSTRATION AND INSTRUCTION

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 _____ A-B _____ B-C _____ C-A _____
at Motor

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.)

ELECTRICAL EQUIPMENT AND SYSTEMS DEMONSTRATION AND INSTRUCTION

SYSTEM COMPLETION AND COMMISSIONING

SYSTEM: _____

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

Electrical Subcontractor

Signed by: _____ Dated: _____

Contractor

Signed by: _____ Dated: _____

Deficiencies Attached

This system has been reviewed by:

The Contract Administrator

Signed by: _____ Dated _____

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

The City

Signed by: _____ Dated _____

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

ELECTRICAL
SUBCONTRACTOR

CONTRACTOR

Address:

_____	_____
_____	_____
_____	_____
_____	_____

Phone:

_____	_____
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END OF SECTION