

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 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.

1.3 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. Do Overhead Lines in accordance with CAN/CSA-C22.3 No. 1 and Underground Systems in accordance with CAN/CSA-C22.3 No. 7 except where specified otherwise.
 - .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.

1.4 Submittals

- .1 Within thirty (30) Calendar Days of award of Contract, the Contractor shall submit a completed equipment procurement schedule which lists the manufacturer and model of equipment, indicating the projected ordering, shop drawing submittal date and delivery dates of all products to meet the Contract Work Schedule.
- .2 Submit samples as required where specified in Division 16.

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- .3 Prior to delivery of any products to 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.
- .4 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.
- .5 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.
- .6 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.
- .7 Manufacture of products shall conform to Shop Drawings.
- .8 Keep one (1) complete set of Shop Drawings at Site during construction.

1.5 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.
- .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.

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- .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.

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 and civil features. Architectural and Civil Drawings take precedence over Electrical Drawings regarding locations of roads and parking.
- .3 Coordinate with all Divisions installing equipment and services, and ensure that there are no conflicts.
- .4 Install anchors, bolts, pipe sleeves, hanger inserts, etc., in ample time to prevent delays.
- .5 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 Location of Outlets and Luminaires

- .1 Electrical Drawings are, unless otherwise indicated, drawn to scale and approximate distances and dimensions may be obtained by scaling. Figured dimensions shall govern over scaled dimensions. Where exact dimensions and details are required, refer to Architectural and Civil Drawings.

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- .2 Maintain luminaire locations wherever possible. Notify the Contract Administrator of conflicts with other services.
- .3 Unless otherwise specified or shown, install products in accordance with recommendations and ratings of manufacturers.

3.3 Equipment Identification

- .1 3 mm thick plastic lamoid 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	Dimensions	Lines	Letter Height
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 Starters, contactors, Disconnects (Designation, voltage, load controlled)
- .3 Panelboard (Designation, voltage, Bus Capacity)
- .4 Terminal cabinets and pull boxes (system, voltage)
- .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	

- .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.
- .5 Conductors:
 - .1 Equipment Grounding – Green
 - .2 Neutral Conductor – White

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

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

3.4 Testing

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

3.5 Instructions to City's Personnel

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

3.6 Temporary Lighting and Power

- .1 Provide grounded extension cords and temporary lights required for electrical work.
- .2 Provide temporary power service as specified in E3.
- .3 If the City's operations will be affected by any power outage required for this work, give adequate notice to the City and do not interrupt power until approval has been obtained.
- .4 Give adequate notice to Contractor of any power outage required for this work. Schedule outages to provide the least interference with other Work.

3.7 Insulation Resistance Testing

- .1 Megger circuits, feeders, and equipment up to 350 V with a 500 V instrument.
- .2 Megger 350 to 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.

3.8 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%).

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- .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 ELECTRICAL WORK

1. GENERAL

- .1 Supply and Install all material, equipment, wiring, and labour necessary for the installation of the systems detailed on the Drawings and included in the Specifications 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 Electrical Trade.
- .3 Special testing or inspection, additional to the above as required.
- .4 Scaffolding.
- .5 Shop Drawings.
- .6 Project Record Documents (As-Built Drawings) where specified.
- .7 O&M Data, where specified.

2.2 Specific Requirements

- .1 Supply and Install roadway lighting as indicated on the Drawings.
- .2 Supply and Install parking pedestals and electrical distribution as indicated on the Drawings.
- .3 Supply and Install all lighting, lighting controls, and general power as specified herein and indicated on the Drawings.
- .4 Provide all cabling, trenching, and conduit required to make a complete and operational facility.
- .5 Grounding systems, as required by the Manitoba Electrical Code, or as otherwise specified.

END OF SECTION

INSTALLATION OF CABLES IN TRENCHES AND IN DUCTS

1. GENERAL

1.1 Related Work

- .1 None.

2. PRODUCTS

2.1 Cable Protection

- .1 38 x 140 mm planks pressure treated with clear, copper naphthenate or 5% pentachlorophenol solution, water repellent preservative.

2.2 Markers

- .1 Concrete type cable markers: 600 mm x 600 mm x 100 mm with words: "cable", "joint" or "conduit" impressed in top surface, with arrows to indicate change in direction of cable and duct runs.

3. EXECUTION

3.1 Direct Burial of Cables

- .1 After sand bed is in place, lay cables maintaining 75 mm clearance from each side of trench to nearest cable. Do not pull cable into trench.
- .2 Provide offsets for thermal action and minor earth movements. Offset cables 150 mm for each 60 m run, maintaining minimum cable separation and bending radius requirements.
- .3 Underground cable splices not acceptable.
- .4 Minimum permitted radius at cable bends for rubber, plastic or lead covered cables, 8 times diameter of cable; for metallic armoured cables, 12 times diameter of cables or in accordance with Manufacturer's instructions.
- .5 Maintain 75 mm minimum separation between cables of different circuits. Maintain 300 mm horizontal separation between low and high voltage cables. When low voltage cables cross high voltage cables maintain 300 mm vertical separation with low voltage cables in upper position. At crossover, maintain 75 mm minimum vertical separation between low voltage cables and 150 mm between high voltage cables. Maintain 300 mm minimum lateral and vertical separation for fire alarm and control, cables when crossing other cables, with fire alarm and control cables in upper position. Install treated planks on lower cables 0.6 m in each direction at crossings.
- .6 After sand protective cover is in place, install treated planking as indicated to cover width and length of run.

INSTALLATION OF CABLES IN TRENCHES AND IN DUCTS

3.2 Markers

- .1 Mark cable every 150 m along cable or duct runs and changes in direction.
- .2 Where markers are removed to permit installation of additional cables, reinstall existing markers.
- .3 Lay concrete markers flat and centered over cable with top flush with finish grade.

3.3 Field Quality Control

- .1 Perform tests in accordance with Section 16980 – Testing, Adjusting and Balancing of Electrical Equipment and Systems.
- .2 Perform tests using qualified personnel. Provide necessary instruments and equipment.
- .3 Check phase rotation and identify each phase conductor of each feeder.
- .4 Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 50 megohms.
- .5 Acceptance Tests
 - .1 After installing cable but before splicing and terminating, perform insulation resistance tests on each phase conductor.
 - .2 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.
 - .3 Provide Contract Administrator with list of test results showing location at which each test was made, circuit tested and result of each test.
 - .4 Remove and replace entire length of cable if cable fails to meet any of test criteria.

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 gasketed 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 Rigid PVC Duct

- .1 Duct: Rigid non-metallic conduit of unplasticized PVC Type DB-2, conforming to CSA Standard.
- .2 Accessories: Bell ends, couplings, adapters, bends and other fittings of same material as duct. Use solvent recommended by Manufacturer. Horizontal, vertical and foundation spacers as manufactured by Pilgrim Products Ltd.

2.6 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).

2.7 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 E.M.T. 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.

CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS

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.
- .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 fhp motors in dry locations.
 - .2 Flexible connections to luminaires.
- .2 Provide a separate insulated ground wire in all flexible conduits.

3.5 Rigid PVC Duct

- .1 Provide a separate green insulated copper ground wire in all ducts sized as required by the Code.
- .2 Arrange ducts in a horizontal layer separated by plastic spacers to provide spacing between duct centres, as shown on the Drawings.
- .3 Support duct bank on plastic spacers to maintain 190 mm center to center spacing of ducts. Foundation spacers to maintain at least 200 mm clearance between ducts and exterior coverage.
- .4 Make joints with tapered couplings to provide a secure watertight connection. Stagger all joints to provide 200 mm vertical and horizontal clearance between adjacent couplings. Where needed, use factory bends to provide bends of radius required.

CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS

- .5 When all ducts are installed, brace whole assembly at each spacer group to prevent duct floating when concrete is placed.
- .6 Terminate ducts with standard bell ends where ducts enter cable pits, junction boxes, and building interiors.
- .7 Cap ends of unused ducts with plug ends of same material as ducts.
- .8 Seal all joints in ducts with solvent cement.
- .9 Install Roxtek seals inside conduits where ducts enter cable pits, junction boxes and building interiors

3.6 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.

3.7 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 equivalent.
- .3 Use a different colour of coating for control, power and lighting.

3.8 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.

CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS

- .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 tapping 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 Do not place conduit in concrete slabs in which slab thickness is less than four times conduit diameter. Place conduits larger than this size under floor. Conduits to have minimum 25 mm concrete cover.
- .7 Organize conduit in slabs to minimize crossovers. Obtain approval and minimum concrete cover required from the Contract Administrator prior to installing conduits in slabs.
- .8 At all recessed panels cap 2 to 25 mm and 4 to 19 mm empty conduits from panel into ceiling above and below for future use.
- .9 Provide Brady underground warning tapes 300 mm below grade above all underground conduits. Tape shall be yellow warning tape, 150 mm wide.
- .10 Where conduits or ducts enter or exit concrete structures below grade provide 16 mm x 1500 mm steel reinforcing dowels to prevent shearing. Extend dowel 1000 mm beyond concrete and band conduit to dowel. The first 3 m length of conduit extending from the structure to be Polykin wrapped rigid steel.
- .11 Where conduit is installed in floor slabs to run up at equipment or motors, carefully check all conduit locations. Verify conduit locations for mechanical equipment from shop drawings or detail drawings. Brace all stub-ups. Stub-ups shall be rigid steel.
- .12 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.
- .13 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.
- .14 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.
- .15 Take extreme care in reaming ends of all conduit to ensure a smooth interior finish that will not damage the insulation of the wires.
- .16 Use insulated non-metallic bushings on all conduit terminations.

CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS

- .17 Ensure electrical continuity in all conduit systems.
- .18 All conduit shown exposed in finished areas is to be free of unnecessary labels and trade marks.
- .19 Install a 40 kg test line in all conduits left under the Contract including those which others will pull cables, wires, etc.
- .20 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.
- .21 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 with Dow Corning 3-6548 sealant or approved equal.
- .22 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.
- .23 Where drawings show conduit designations, these conduits shall be identified at each point of termination with Thomas & Betts "Ty-Rap" No. TY532M labels.
- .24 Where conduit finish is damaged, repair or replace.
- .25 Use "Condulet" fittings for power and telephone type conduit terminations in lieu of boxes where support is not provided.
- .26 All branch circuit wiring, home-runs, communication and data to be minimum 20 mm diameter unless otherwise stated.
- .27 Provide necessary flashing and pitch pockets, making watertight joints where conduits pass through roof or watertight membranes.
- .28 Where panelboard branch circuit conduits are amalgamated, size shall not exceed 25 mm diameter.

END OF SECTION

WIRES AND CABLE 0-1000V

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.

WIRES AND CABLE 0-1000V

- .6 Overall covering: thermoplastic PVC material.
- .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.

2.4 Luminaire Wire

- .1 Type TEW: Copper conductors, #14 AWG, with thermoplastic and asbestos insulation, flame retardant, heat and moisture resistant, rated 600 V, 105°C.

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.

WIRES AND CABLE 0-1000V

- .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.

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 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 Installation of Luminaire Wire

- .1 Run wires from outlet boxes through luminaire raceways, splice and connect in raceways. Connect continuous rows of luminaires to circuit without breaking conductors.

3.6 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.

WIRES AND CABLE 0-1000V

3.7 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.
- .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.

3.8 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 Provide 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.

2.4 Splitters

.1 Materials:

- .1 Code gauge sheet steel, welded construction, phosphatized, and factory paint finish.

.2 Components:

- .1 Formed hinged cover suitable for locking in the closed position.
- .2 Main and branch lugs to match required size and number of incoming and outgoing conductors as indicated.
- .3 At least three spare terminals on each set of lugs in splitters less than 400 A.

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 Splitters

- .1 Install splitters and mount plumb, true and square to the building lines.
- .2 Extend splitters full length of equipment arrangement except where indicated otherwise.

SPLITTERS, JUNCTION BOXES, PULL BOXES AND CABINETS

.4 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 mm square 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

WIRING DEVICES

1. GENERAL

1.1 Work Included

- .1 Provide and connect all wiring devices for the complete installation.

2. PRODUCTS

2.1 Manufacturer

- .1 Wiring devices to be of one manufacture throughout the Work.
- .2 Manufacturers shall be Hubbell, Leviton, or Pass & Seymour.

2.2 Devices

- .1 The catalogue numbers shown below are for the particular manufacturer's series and all necessary suffixes shall be added for the requirements as stated. All devices shall be specification grade minimum and wherever possible shall be of the same manufacture.
- .2 Devices to be brown with galvanized steel coverplates for surface mounted devices.

2.3 Switches

- .1 120-277 V, 20 A, single and double pole, three and four-way: As Hubbell No. 1221, 1222, 1223 and 1224.
- .2 Manually - operated general purpose AC switches shall have the following features:
 - .1 Terminal holes approved with AWG #10 wire.
 - .2 Silver alloy contacts.
 - .3 Urea or melamine molding for parts subject to carbon tracking.
 - .4 Suitable for back and/or side wiring.

2.4 Receptacles

- .1 Duplex 15 A, 120 V, 3 wire, ivory, U-ground, as Hubbell No. 5252, with the following features:
 - .1 Brown urea molded housing.
 - .2 Suitable for #10 AWG for back and side wiring.
 - .3 Eight back wired entrances, four side wiring screws.

WIRING DEVICES

- .4 Break-off links for use as split receptacles.
- .5 Triple wipe contacts and rivetted grounding contacts.
- .2 Duplex 15 A, 120 V, 3 wire, ivory, U-ground ground fault receptacle, as Hubbell No. GF-5261.

2.5 Coverplates

- .1 Provide coverplates for all wiring devices
- .2 For exterior locations use weatherproof double lift spring - loaded cast aluminum coverplates, complete with gaskets for single receptacles or switches.
- .3 For ordinary locations use sheet steel utility box cover for wiring devices installed in surface mounted utility boxes.
- .4 For ordinary locations use stainless steel 1 mm thick coverplates on all wiring devices mounted in flush-mounted outlet boxes unless otherwise specified.
- .5 Use gasketed DS cast covers on FS and FD type boxes.

3. EXECUTION

3.1 Installation

- .1 Install single throw switches with handle in the "UP" position when switch closed.
- .2 Install switches vertically in gang type outlet box when more than one switch is required in one location.
- .3 Mount switches on the latch side of the doorway as close as possible to door frame unless otherwise indicated on drawings.
- .4 Install receptacles vertically in gang type outlet box when more than one receptacle is required in one location.
- .5 Where split receptacle has one portion switched, mount vertically and switch upper portion.
- .6 Protect cover plate finish with paper or plastic film until all painting and other work is finished, then remove paper.
- .7 Install suitable common coverplates where wiring devices are grouped. Do not distort plates by tightening screws excessively.
- .8 Wherever possible, mount equipment in a straight line at a uniform mounting height, coordinated with other equipment and materials.

WIRING DEVICES

- .9 Mounting dimensions are to the centre of the devices. Final instructions on mounting heights shall be given by the Contract Administrator. The above shall be used as a guide, but shall be subject to final verification prior to installation.

END OF SECTION

WIRE AND BOX CONNECTORS

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 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 A 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 T & B Marrette set-screw two piece pressure type connector for terminating #10 AWG and smaller motor connections.
- .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

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 system to consist of cables, ground rods, supports, and all necessary materials and inter-connections to provide a complete system. Ensure measured resistance to ground of the network does not exceed 3 ohms.
- .3 Run all above ground grounding conductors in conduit as per Drawings.

2. PRODUCTS

- .1 Cables 2/0 and larger to be connected to ground bars via Cadweld exothermic weld.
- .2 All ground wires: stranded copper TWH complete with a green jacket.
- .3 Ground rods: 20 x 3000 mm copper clad steel.
- .4 Cable to pipe connectors: made with Burndy GAR connectors.
- .5 Supply and Install ground bars as indicated on Drawings.

3. EXECUTION

3.1 Grounding - General

- .1 Ground all frames and metallic enclosures of all electrical equipment and electrically operated equipment through the conduit system via a ground wire.
- .2 Ground all lighting poles, parking pedestals and panel boards by grounding conductors sized as specified on Drawings and in accordance with the Canadian Electrical Code. Ground wire shall be run back to the panel from which the device is fed. Terminate the ground wire at each end with an appropriate grounding lug and connect to the equipment ground bus. Ground wire to be green TWH.
- .3 Ground all sub panels such as lighting panels, local distribution panels, etc. with a green ground wire run back to the panel from which it is fed. Size the ground conductor according to the Canadian Electrical Code.
- .4 Ensure all bolted connections are accessible.

GROUNDING

- .5 Include a separate green ground wire in all power conduits including branch circuit wiring sized to Table 16, Canadian Electrical Code.
- .6 Bond expansion joints and telescoping sections of raceways using jumper cables as per Canadian Electrical Code.
- .7 Use Burndy compression connectors for all grounding splices and terminations unless otherwise shown on the Drawings. For bolted ground connections use Burndy Engineering Company's "Durium".
- .8 Install rigid conduit sleeves where ground wires pass through concrete slabs.
- .9 Provide conduit installed buried in earth or installed in or under grade floor slabs with separate ground wire installed, whether the conduits are metal or not.
- .10 Ground all utility services to the electrical system ground.
- .11 Ground all metal fences and gates
- .12 Selected ground rods shall be accessible with ground wells as shown on Drawings

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: Aluminum strut channel together with the Manufacturers 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 equivalent 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 Provide conduit rack with 25% spare capacity for multiple runs.
- .7 Provide 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 Provide 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

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.
- .2 250 V panelboards: bus and breakers rated for 10 kA (symmetrical) interrupting capacity or as indicated.
- .3 600 V panelboards: bus and breakers rated for 14 kA (symmetrical) interrupting capacity or as indicated.
- .4 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.
- .5 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.
- .6 Two (2) keys for each panelboard and key panelboards alike.
- .7 Copper bus with neutral of same ampere rating as mains.
- .8 Mains: suitable for bolt-on breakers.
- .9 Trim with concealed front bolts and hinges.
- .10 Trim and door finish: baked grey enamel.
- .11 Integral TVSS as per Section 16480 – Power Surge Protectors.

PANELBOARDS – BREAKER TYPE

2.2 Breakers

- .1 Breakers: to Section 16477 – Moulded Case Circuit Breakers.
- .2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.
- .3 Main breaker: Separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.
- .4 Lock-on devices for 10% of 15 A breakers installed as indicated. Turn over unused lock-on devices to City.

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 Complete circuit directory with typewritten legend showing location and load of each circuit.

3. EXECUTION

3.1 Installation

- .1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.
- .2 Install surface mounted panelboards on 40mm galvanized U channel. Where practical, group panelboards.
- .3 Mount panelboards to height specified in Section 16010 – Electrical General Requirements or as indicated.
- .4 Connect loads to circuits.
- .5 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 | 347/600V Panelboards |
| | | 120,000 Amps | 120/208V Panelboards |
| | | 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 | |
| .4 | Cutler - Hammer
-- Integrated TVSS panel board | Clipper Power System
– Visor Series |

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

POWER SURGE PROTECTORS

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

CONTACTORS

1. GENERAL

1.1 Description

- .1 Supply and Install contactors as indicated on drawings and specified herein to ensure a complete operational system.
- .2 This Specification covers contactors for voltages up to 600 V. Refer to drawings for voltage, amperage, number of poles, and auxiliary contacts.

1.2 Product Data

- .1 Submit product data in accordance with 01300 – Submittals.

2. PRODUCTS

2.1 Contactors

- .1 Contactors: to EEMAC No.1CS.
- .2 Mechanically held controlled by pilot devices as indicated and rated for type of load controlled. Base this rating on incandescent or non-inductive loading for continuous operation. Half size contactors not accepted. For all contactors use 120 V operating coils.
- .3 Breaker combination contactor as indicated.
- .4 Complete with 2 normally open and 2 normally closed auxiliary contacts unless indicated otherwise.
- .5 Mount in CSA Enclosure 1 unless otherwise indicated.
- .6 Include the following options in cover:
 - .1 Red indicating lamp
 - .2 Stop-Start push-button
 - .3 Hand-Off-Auto selector switch
- .7 Control transformer: To Section 16825 - Control Devices, in contactor enclosure.

2.2 Equipment Identification

- .1 Provide equipment identification in accordance with Section 16010 – Electrical General Requirements.
- .2 Provide a nameplate indicating name of load controlled.

CONTACTORS

3. EXECUTION

3.1 Installation

- .1 Install contactors and connect auxiliary control devices where indicated on drawings and specified herein.
- .2 Mount contactors separately in suitable enclosures rated for the area in which they are to be installed.

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 MCCs, starters, and (c) items provided under Division 15 i.e., 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

STARTING OF ELECTRICAL EQUIPMENT SYSTEMS

1. GENERAL

1.1 Related Work

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

1.2 Coordination

- .1 Coordinates starting of electrical equipment and systems with testing, adjusting and balancing, and demonstration and instruction of:
 - .1 Electrical equipment and systems specified in Division 16
 - .2 Other equipment and systems specified in other Divisions
- .2 Where any equipment or system requires testing, adjusting or balancing prior to starting, ensure that such work has been completed prior to starting of electrical equipment and systems.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 Energizing Main Electrical System

- .1 Prior to energizing main electrical system:
 - .1 Verify supply voltage and phase rotation.
 - .2 Close and open all devices to ensure proper mechanical operation.

3.2 Energizing Equipment

- .1 Prior to energizing equipment provided under other Sections and equipment provided by the City, confirm equipment nameplate data with characteristics of power supply.

END OF SECTION

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

1. GENERAL

1.1 Intent

- .1 Except where otherwise specified, arrange and pay for testing, adjusting, balancing, and related requirements specified herein.
- .2 If test results do not conform with applicable requirements, repair, replace, adjust or balance equipment and systems. Repeat testing as necessary until acceptable results are achieved.
- .3 Provide all labour, materials, instruments and equipment necessary to perform the tests specified.
- .4 All tests shall be witnessed by persons designated by the 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 DEMONSTRATIONS AND INSTRUCTION

1. GENERAL

1.1 Intent

- .1 Provide demonstration and instruction sessions to familiarize City's O&M personnel with electrical systems and their O&M.
- .2 Submit sign off sheets for each system listed prior to Substantial Performance.
- .3 Complete a motor survey sheet for each motor and submit prior to Substantial Performance. 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 O&M manuals. Include motor overload selection charts for each type and application of overload relay.
- .4 All sign off and survey sheets shall be typewritten.

1.2 Manufacturer's Site Services

- .1 Arrange and pay for qualified Manufacturers' Representatives to provide or assist in providing electrical equipment and system demonstration and instruction as specified herein.

1.3 Contractor/City Coordination

- .1 The Contract Administrator will chair demonstration and instruction sessions.
- .2 The Contractor shall establish agendas for demonstration and instruction sessions in conjunction with the Contract Administrator.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 Systems Demonstration

- .1 Demonstrate operation of following systems:
 - .1 208/120 V System
 - .2 Grounding System
 - .3 Future Connection Points and Conduit Stubs

ELECTRICAL EQUIPMENT AND SYSTEMS DEMONSTRATIONS 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.)

END OF SECTION