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 Site Work: Division 02

.3 Concrete: Division 03

.4 Doors and Windows: Division 08

.5 Finishes: Division 09

.6 Specialties: Division 10

.7 Equipment: Division 11

.8 Mechanical: Division 15

1.3 Quality Assurances

.1 Codes, Rules, Permits & Fees

.1 Comply with all laws, ordinances, rules, regulations, codes and orders of all authorities having jurisdiction relating to this Work.

.2 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.

.3 Quality of Work specified and/or shown on the Drawings shall not be reduced by the foregoing requirements.

.4 Immediately after award of Contract and prior to installation, verify location, arrangement and point of attachment for service and service entrance equipment with supply authority and inspection departments. Failure to do so will render this Division responsible for any corrections necessary without additional compensation.

.5 Give all required notices, submit Drawings, obtain all permits, licenses and certificates and pay all fees required for this Work.

.6 Furnish a Certificate of Final Inspection and approvals from inspection authority to the Contract Administrator.

.2 Standard of Workmanship:

.1 Execute all Work in a competent manner and to present an acceptable appearance when completed.

.2 Employ a competent supervisor and a sufficient number of licensed tradesmen to complete the Work in the required time.

.3 Arrange and install products to fit properly into designated building spaces.

.4 Unless otherwise specified or shown, install products in accordance with recommendations and ratings of manufacturers.

1.4 Submittals

.1 Within 30 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 required construction schedule.

.2 Submit samples as required where specified in Division 16.

.3 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 Section 01300 Submittals. 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 Shop Drawing shall indicate material, methods of construction and attachment of support wiring, diagram, 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 item will be mounted 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 if the Work, state such in writing to the Contract Administrator prior to proceeding with the Work.

.7 Manufacture of products shall conform to revised shop drawings.

.8 Keep one complete set of shop drawings at job site during construction.

1.5 Record Drawings

.1 The Contractor shall keep one complete set of white prints at the site office, including all addenda, change orders, site instructions, clarifications and revisions for the purpose of record drawings. As the work on site proceeds, the Contractor shall clearly record in Red Pencil all as-built conditions which deviate from the original contract documents. Record drawings to include circuiting of all devices, conduit and feeder runs (complete with conductor size and number) and locations of all electrical equipment.

.2 Prior to Substantial Performance, the Contractor shall obtain CAD files of all electrical drawings, using AutoCAD Release 2000, and use the services of a competent CAD operator to transfer all as-built information, including: Addenda, Change Orders, Clarifications, Revisions, Site Instructions and shop drawings. Upon completion, the contractor shall certify, in writing, that the as-built record drawings are complete and that they accurately indicate all electrical services, including exposed as well as concealed items.

.3 Contractor to forward letter of certification and as-built CAD drawings to the Contract Administrator for final review. As-Built drawings to be submitted in the form of one set of CAD files burnt on a CD Disc.

1.6 Operation and Maintenance Manuals

.1 All maintenance manual data shall be submitted in and electronic format in accordance with the requirements of Section 01300 Submittals.

.2 Each section of the manual shall contain the following information:

.1 Systems Descriptions. A brief synopsis of each system typed and inserted at the beginning of each section. Include sketches and diagrams where appropriate.

.2 Descriptive and technical data.

.3 Maintenance and operating instructions for all electrical equipment and controls. (These operating instructions need not be manufacturer's data but may be typewritten instructions in simple language to guide the City in the proper operation and maintenance of his installation.)

.4 Lubricating and servicing intervals recommended.

.5 A copy of all wiring diagrams complete with wire coding.

.6 List of spare parts of all electrical equipment complete with names and addresses of sales, service representatives and suppliers.

.7 Copy of test data

.8 A motor list showing each motor number, name, horsepower, full load amps, overload settings, nameplate, current rating, heater size and type, and current being drawn.

.9 Include type and accuracy of instruments used to obtain test data.

.10 Copy of final inspection certificate.

.11 Copy of the purchase order, showing equipment make and model numbers issued to the manufacturer complete with all addenda. All cost details may be hidden.

.12 Copy of all warranty certificates.

.13 Set of final reviewed Shop Drawings.

.14 Names, addresses, phone numbers and facsimile numbers of Contractor, Contract Administrator, sub-contractors and suppliers used on the Work together with a Specification reference of the portion of the Work they undertook.

1.7 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 Selected Products and Equivalents

.1 Products and materials provided shall be new and free from all defects. Defective products or materials will be rejected, regardless of previous inspections. The Contractor shall be responsible to remove and replace defective products at their expense, and shall be responsible for any resulting delays and associated expenses, which result from defective products being rejected. Related materials shall be of the same manufacturer throughout the Work.

.2 Products and materials referred to in the Specifications by trade names, manufacturer's name and catalogue reference are those which shall be used as the basis for the Tender.

.3 The design has been based on the use of the specified product.

2.2 Quality of Products

.1 All products provided shall be CSA approved, ULC 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.

.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.

2.3 Uniformity of Manufacture

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

2.4 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 on-site.

.3 Touch up all damaged painted finishes with matching lacquer, or, if required by the Contract Administrator, completely repaint damaged surface.

2.5 Use of Products During Construction

.1 Any equipment used for temporary or construction purposes shall be approved by the Contract Administrator and in accordance with the General Conditions. Clean and restore to "as new" condition all equipment prior to the time of Substantial Performance.

2.6 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 effect 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 Substantial Performance listing all equipment and certifying their compliance.

.3 Notwithstanding any other remedy available under this agreement or at law for breach of the Warranty, any Product that is not Date Compliant shall, within twenty-four (24) hours of receipt of notice of the breach, be repaired or replaced at the Contractors sole cost and

expense, including parts, labour, transportation and insurance, so as to correct any failure to meet the Warranty.

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.

.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 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 Structural drawings.

.2 Outlet and equipment locations shown on the drawings are approximate. Locations may be revised up to 3 meters to suit construction and equipment arrangements without additional cost to the City, provided that the Contractor is notified prior to the installation of the outlets, or equipment.

.3 Maintain luminaire locations wherever possible. Notify the Contract Administrator of conflicts with other services.

.4 Unless otherwise specified or shown, install products in accordance with recommendations and ratings of manufacturers.

3.3 Separation of Services

.1 Maintain separation between electrical wiring system and building piping, ductwork, etc. so that 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.

3.4 Equipment Identification

.1 3 mm thick plastic lamacoid nameplates, 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:

.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)

.2 Color 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 metre intervals. Color coding to be as follows:

System	Major Band	Major Band
120/208 V Normal	Lt. Blue	
Telephone	Lt. Green	
Security Systems	Dk. Green	Lt. Brown
Intercom	Purple	Yellow
Computers	Black	Yellow

.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.

.6 Provide permanent, corrosion resistant warning markers, suitable to the local inspection authority, imbedded in the surface of concrete slabs which are directly above high voltage cables and duct banks.

3.5 Wiring to Equipment Supplied by Others Divisions

.1 Equipment supplied by the City or under other Division will be moved to the installation site by others. However, the electrical connection to the equipment shall be done by this Division.

3.6 Testing

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

3.7 Instructions to City's Personnel

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

3.8 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.

.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.

3.9 Mounting Heights

.1 Unless a conflict exists, use the following as mounting heights from finished floors to centre of device.

Receptacles in Mechanical Rooms	1400 mm
Receptacles and Telephone Outlets	1000 mm
Light Switches	1400 mm
Intercom	1400 mm
Thermostats	1400 mm
Panelboards, starters, and disconnects (to top of cover)	2000 mm
Outlets above Counters	175 mm above countertop or backsplash

3.10 Sealing of Wall and Floor Openings

.1 All conduit and cable entering through outside walls of buildings, through partition walls separating electrical rooms from other areas, through fire separation and through floors above and below grade shall be sealed to prevent passage of moisture, dust, gasses, flames or to maintain pressurization.

.2 Openings shall be sealed when all wires entries shown on the Drawings have been completed.

.3 Sealing material shall be fire-resistant and shall not contain any compound, which will chemically affect the wiring jacket of insulating material. Cable penetrations through fire separations to be sealed.

3.11 Housekeeping Pads

.1 All floor mounted electrical equipment installed by this Division shall be mounted on concrete housekeeping pads that, unless otherwise noted, shall be the responsibility of the Contractor.

.2 The Contractor shall determine the extent of the housekeeping pads required and supply all information and details as to size and locations to the Contract Administrator within thirty days after the award of the Contract.

3.12 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.

3.13 Temporary Lighting and Power

.1 Provide grounded extension cords and temporary lights required for electrical work.

.2 Coordinate with General Contractor for obtaining temporary power service.

.3 If 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 least interference with other Work.

3.14 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.

3.15 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.

.2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.

.3 Submit, at completion of work, report listing phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load. State hour and date on which each load was measured, and voltage at time of test.

END OF SECTION

SCOPE OF WORK

1. WORK INCLUDED

1.1 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 Utility connections .

.4 Scaffolding.

.5 Shop Drawings.

.6 Project Record Documents (As-Built Drawings) where specified.

.7 Operating and Maintenance Data, where specified.

1.2 Materials

.1 Provide and install underground conductor from utility point of service to utility meter.

.2 Provide and install 120/240 volt utility meter and conductor to 120/240 volt Distribution Panel A.

.3 Provide and install 120/240 volt Distribution Panel A complete with all breakers as shown in panel schedule on drawing E1.03.

.4 Wire and connect all mechanical equipment.

.5 Wire and connect power and communication for scales as provided by General Contractor.

.6 Wire and connect power and communication for automatic pay systems as provided by General Contractor.

.7 Wire and connect power and communication for CCTV cameras as provided by the City.

.8 Wire and connect power for automatic windows.

.9 Provide and install conduit for future radiation detectors as shown on Drawing E1.02.

.10 Alarm, annunciation and signaling systems, including burglar, fire or smoke detection. Complete, including detection, control, indicating and recording devices.

.11 Conductors, including all types of wires, conductors, cables, which form an integral part of the electrical power system.

SCOPE OF WORK

.12 Cables and bus support systems which are intended to enclose or support all forms of electrical conductors used for any purpose covered by this scope. This includes cable trays, raceways and all forms of rigid, flexible, metallic and non-metallic conduit, and including conduit for communication systems or others, which may be installed at a later date, or buried conduit for wiring work by others, only when such buried conduit is indicated in the Contract Documents.

.13 Control panels associated with any electrical equipment covered under this section of Work.

.14 Circuit breakers of all types and for all applications associated with electrical equipment which receives its power supply from the main, auxiliary or emergency (including battery) system.

.15 Emergency power and lighting systems.

.16 Grounding systems, as required by the Electrical Code, or as otherwise specified in the Contract documents.

.17 Heaters - all types where electricity is the principal source of heat. This includes baseboard heaters, strip and immersion heaters, and strap-on including heating tapes. (Ducted heaters included in Division 15).

.18 Lighting - all forms of electric lighting devices, both individual and packaged types, including complete modular and integrated ceiling together with all associated troffers, deflectors, diffusers, ballasts, lens, tubes and mounting devices, and which are used for all purposes, such as floodlighting exterior parking areas, landscaping lighting, display lighting, operating room lighting, etc.

.19 Electronic data processing and transmission systems, including auxiliary equipment, interface and components.

END OF SECTION

INSTALLATION OF CABLES IN TRENCHES AND IN DUCTS

1. GENERAL

1.1 Related Work

.1 Excavation and Backfilling: Division 2

2. PRODUCTS

2.1 Cable Protection

.1 38 x 140 mm planks pressure treated copper napthenate or 5% pentachlorophenol solution, water repellent preservative.

2.2 Markers

.1 Concrete type cable markers: 600 x 600 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.

3.2 Markers

.1 Mark cable at changes in direction.

.2 Lay red electrical plastic tape marker in able trench above cables.

.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 Pre-acceptance Test

.1 After installing cable but before splicing and terminating, perform insulation resistance test with 1000 V megger on each phase conductor.

.2 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.

.6 Acceptance Tests

.1 Ensure that terminations and accessory equipment are disconnected.

.2 Ground shields, ground wires, metallic armour and conductors not under test.

.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 Provide 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 alternate.

.3 Connectors subjected to moisture interior and exterior: liquid and dust tight with insulated throat, Thomas & Betts "Bullet Hub" 370 Series or approved alternate.

.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 alternate.

2.2 Rigid P.V.C. Conduit

.1 Conduit: rigid non-metallic conduit of unplasticized polyvinyl chloride 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.

2.3 Flexible Conduit

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

2.4 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).

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 metre.

.3 Three phase motor wiring (Teck cable may also be used for this application where shown on the drawings).

3.2 Rigid P.V.C. 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.

3.3 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.

3.4 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.

3.5 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 Polyken #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, pack outlet boxes and cap conduit terminations both in boxes and stub-ups. Apply Polyken #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 structural engineer prior to installing conduits in slabs.

.8 At all recessed panels cap 2 - 25 mm and 4 - 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 meter length of conduit extending from the structure to be Polyken 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 4 - 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 of 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.

.17 Ensure electrical continuity in all conduit systems.

.18 All conduit shown exposed in finished areas is to be free of unnecessary labels and trademarks.

.19 Install a 90 lb. test line in all conduits left empty by this contractor 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, Sceptre, 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 CABLES 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 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.

.2 Copper conductors: size as indicated, with 300V insulation of chemically cross-linked thermosetting polyethylene (XLPE) material rated RW90 or RWU90.

2.2 Teck Cable

.1 Conductors:

.1 Grounding conductor: copper

.2 Circuit conductors: copper, size as indicated.

.2 Insulation:

.1 Chemically cross-linked thermosetting polyethylene rated type RW90, 600 V.

.3 Inner jacket: polyvinyl chloride material.

.4 Armour: interlocking aluminium.

.5 Overall covering: thermoplastic polyvinyl chloride material.

.6 Fastenings:

.1 One hole malleable steel 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 dia. threaded rods to support suspended channels.

.7 Connectors:

.1 Watertight, approved for TECK cable.

2.3 Control Cables

.1 Type LVT: two soft annealed copper conductors, sized as indicated, with thermoplastic insulation, outer covering of thermoplastic jacket, and armour of closely wound aluminum wire.

.2 Low energy 300 V control cable: stranded annealed copper conductors sized as indicated, with PVC insulation type with shielding of wire braid over each pair and over all conductors and overall covering of PVC jackets.

2.4 Luminaire Wire

.1 Type TEW: Copper conductors, #14 AWG, with thermoplastic and asbestos insulation, flame retardant, heat and moisture resistant, rated 600 Volts, 105^{o}C.

3. EXECUTION

3.1 General

.1 Minimum conductor size #12 AWG except for luminaire drops which can be #14 AWG if fed from 15A circuits.

3.2 Installation of Building Wires

.1 Install wiring as follows:

.1 In conduit systems in accordance with Section 16111.

.2 In trenches in accordance with Section 16106.

3.3 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.

.4 Terminate cables in accordance with Section 16151 - Wire and Box Connectors - 0 - 1000 V.

3.4 Installation of Control Cables

.1 Install control cables in conduit.

.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.

.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.

3.7 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 volt 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

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, 1.25 oz/sq. ft. minimum zinc coating.

.2 Surface mounting exposed: Cast ferrous for threaded conduit, with attached lugs, corrosion resistant two coats finish.

.2 Components:

.1 Ceiling outlets, surface mounting, concealed:

.1 101 mm square, depth 54 mm, Iberville 52171 series

.2 119 mm square, depth 54 mm, Iberville 72171 series

.2 Ceiling outlets, concealed mounting in concrete:

.1 101 mm octagonal concrete rings, depth from 38 mm to 152 mm Iberville 54521 series.

.2 Extension ring to change from recessed conduit to exposed conduit, 101 mm octagonal, 38 mm deep square Iberville 53151-1/2 or 38 mm deep octagonal Iberville 51151C or 54 mm deep, Iberville 55171C.

.3 Wall boxes, concealed in concrete or masonry: for one and two gang applications shall be 101 mm square, 54 mm deep, 52171 series complete with suitable 52-C-49 series square cornered raised tile wall cover for proper device and wall surface application. Masonry boxes may be used for line voltage switching.

.4 Wall outlets, concealed non-masonry construction, with plaster finish: For one or two gangs used with switches, receptacles, etc., use 54 mm deep Iberville 52171 series, with matching plaster covers, depth to suit. Alternately, use 119 mm square boxes, Iberville 72171 series and covers as required. (For more than two gangs use solid boxes Iberville GSB series with GBC series cover, or special boxes as required).

.5 Wall outlets, surface, exposed mounting or used for outdoor outlets: One or more gang, Crouse-Hinds FS series or FD series, condulet.

.6 Floor Outlets, concealed: Of a type adjustable after box secured, permanently watertight concrete type, sheet steel, T & B #1963.

.7 Covers: Unless wiring devices and plates are mounted, provide blank, round canopy covers to match boxes.

2.3 Concrete Boxes

.1 Electro-galvanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

2.4 Conduit Boxes

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

2.5 Outlet Boxes for Non-Metallic Sheathed Cable

.1 Electro-galvanized, sectional, screw ganging steel boxes, minimum size 76 x 50 x 63 mm with two double clamps to take non-metallic sheathed cables.

2.6 Fittings - General

.1 Bushing and connectors with nylon insulated throats.

.2 Knock-out fillers to prevent entry of debris.

.3 Conduit outlet bodies for conduit up to 32 mm and pull boxes for larger conduits.

.4 Double locknuts and insulated bushings on sheet metal boxes.

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 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.

.4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.

.5 Install all outlets flush and surface mounted as required for the installation.

.6 Surface mount above suspended ceilings, or in unfinished areas.

.7 Adjust position of outlets in finished masonry walls to suit course lines. Coordinate cutting of masonry walls to achieve neat openings for all boxes.

.8 Do not distort boxes during installation. If boxes are distorted, replace with new boxes.

.9 Use plaster rings to correct depth. Use 30 mm on concrete block.

.10 Do not use sectional boxes.

.11 Provide boxes sized as required by the Canadian Electrical Code.

.12 Install vapour barrier material to surround and seal all outlet boxes located on exterior walls of building. Maintain wall insulation.

.13 Outlets installed in partition walls to be offset by a minimum of one stud space.

.14 Ceiling outlet boxes shall be provided for every surface mounted fixture or row of fixtures installed on suspended "hard" ceilings.

.15 Primary bushings in termination box for cable connection.

.16 Secondary bushings in termination box for bus duct connection.

.17 Control junction box.

.18 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 project.

.2 Manufacturers shall be Hubbell, Smith and Stone, Bryant 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 stainless steel coverplates in all but mechanical areas unless noted otherwise. Use galvanized steel coverplates in mechanical areas and for surface mounted devices.

2.3 Switches

.1 120-277 volt, 20 amp, 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 by 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 ampere, 120 volt, 3 wire, brown, 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 (8) back wired entrances, four (4) side wiring screws.

.4 Break-off links for use as split receptacles.

.5 Triple wipe contacts and rivetted grounding contacts.

.2 Duplex 15 ampere, 120 volt, 3 wire, ivory, U-ground ground fault receptacle, as Hubbell No. GF-5261.

.3 Receptacles located on the exterior of the building to be weather-proof construction.

2.5 Coverplates

.1 Provide coverplates for all wiring devices, including but not limited to telephone, computer.

.2 Use sheet steel utility box cover for wiring devices installed in surface mounted utility boxes.

.3 Use stainless steel 1 mm thick coverplates on all wiring devices mounted in flush-mounted outlet boxes unless otherwise specified.

.4 Weatherproof double lift spring - loaded cast aluminum coverplates, complete with gaskets for single receptacles or switches.

.5 Weatherproof spring - loaded cast aluminum coverplates complete with gaskets for single receptacles or switches.

.6 Use gasketted 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 Protect cover plate finish with paper or plastic film until all painting and other work is finished, then remove paper.

.6 Install suitable common coverplates where wiring devices are grouped. Do not distort plates by tightening screws excessively.

.7 Do not use coverplates meant for flush outlet boxes on surface mounted boxes.

.8 Wherever possible, mount equipment in a straight line at a uniform mounting height, coordinated with other equipment and materials.

.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 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 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 armoured 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.

.2 Thomas & Betts 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 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 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 local Electrical code.

.2 The system to consist of cables, ground rods, 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 Ground rods shall be 20 mm x 3000 mm copper clad.

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, 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 Connect using #3/0 bare copper conductors from the main ground bus to a minimum of 2 ground rods located adjacent to the building. Test the system for ground resistance before connecting the utility ground and install additional ground rods as necessary to meet the minimum requirements.

.5 All main distribution centres and all panels requiring equipment grounds shall contain a ground bus of adequate size, and tapped for lugs for the ground wire required.

.6 All bolted connections must be accessible.

.7 All motors shall be grounded by means of an adequately sized green ground wire contained within the feeder conduit.

.8 Include a separate green ground wire in all power conduits including branch circuit wiring sized to Table 16, Canadian Electrical Code.

.9 Expansion joints and telescoping sections of raceways shall be bonded using jumper cables as per Canadian Electrical Code.

.10 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.

.11 Connect all transformer neutrals to the main building ground wire, using compression terminations.

.12 Install rigid conduit sleeves where ground wires pass through concrete slabs.

.13 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.

.14 Ground all utility services to the electrical system ground.

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 shall employ P1000 Unistrut or equal together with the manufactures connecting components and fasteners for a complete system.

.2 Heavy duty supporting structures to be fabricated and welded from steel structural members and prime painted before installation.

.2 Finishes:

.1 Outdoors, wet locations: Hot dipped galvanized.

.2 Indoors, dry locations: Galvanized when available, prime painted if not available.

.3 Nuts, bolts, machine screws: Cadmium plated.

.3 Unistrut:

.1 Section P1000 or as required for load and span, with mounting screws, or approved. P1000 or equal is a minimum standard for supporting conduits 50 mm and larger.

2.2 Concrete and Masonry Anchors

.1 Materials: Hardened steel inserts, zinc plated for corrosion resistance. All anchor bolts must be galvanized.

.2 Components: non-drilling anchors for use in predrilled holes, sized to safely support the applied load with a minimum safety factor of four.

.3 Manufacturer: Hilti (Canada) Limited or approved equal.

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.

.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, suitable non-ferrous, or approved stainless steel or aluminum clamps shall be used.

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 meter span and 8 mm over a 2 meter 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 solid masonry, tile and plaster surfaces with lead anchors or nylon shields.

.2 Secure equipment to poured concrete with expandable inserts.

.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.

.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 dia threaded rods and spring clips.

.2 Support 2 or more cables or conduits on channels supported by 6 mm dia. 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 1500 mm on centre 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

UNDERGROUND SERVICE

1. GENERAL

1.1 Related Requirements

.1 Electrical General Requirements: Section 16010

1.2 Coordination With Power Supply Authority

.1 Coordinate and meet requirements of power supply authority. Ensure availability of power when required.

1.3 Related Work

.1 Conduits, Conduit Fastenings and Conduit Fittings: Section 16111

2. PRODUCTS

2.1 Components

.1 Conductors: Copper, TECK, size and number of conductors as indicated.

.2 Markers: Markers shall be square with 25 mm letters.

.3 Cable Lugs: Suitable for the application and use as required by the Canadian Electrical Code, approved by the electrical inspection authority and acceptable to the local supply authority.

3. EXECUTION

3.1 Installation

.1 Install cables in trenches and in accordance with Section 16106 - Installation of Cables in Trenches and in Ducts.

.2 Allow adequate conductor length for connection to supply by power supply authority.

.3 Allow adequate conductor length for connection to service equipment.

.4 Service conduit shall terminate in main panel with an approved grounding bushing. From the grounding bushing a #3/0 ground connection shall be made to the distribution centre ground bus.

3.2 Service Installation

.1 General routing to follow that indicated on drawings.

END OF SECTION

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

1. GENERAL

1.1 Description

.1 Provide disconnect switches for 120/240 volt distribution as indicated on the drawings, as manufactured by Cutler Hammer, Schnieder or Square D.

2. PRODUCTS

2.1 Disconnect Switches

.1 Ratings: 240 volts. 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 amperes 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.

3. EXECUTION

3.1 Disconnect Switches

.1 Mounting: Provide 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 Identification: Provide lamacoid plate in accordance with Section 16010 - Electrical General Requirements, on each switch showing voltage, source of supply and load being fed, for example:

Door Controller
120/208 Volts
Fed from PPA

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 Service entrance rated

.3 120/240 V panelboards: bus and breakers rated for 10 kA (symmetrical) interrupting capacity or as indicated.

.4 Integral TVSS.

.5 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.

.6 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.

.7 Two keys for each panelboard and key panelboards alike.

.8 Copper bus with neutral of same ampere rating as mains.

.9 Mains: suitable for bolt-on breakers.

.10 Trim with concealed front bolts and hinges.

.11 Trim and door finish: baked grey enamel.

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 to 30 A breakers installed as indicated. Turn over unused lock-on devices to City.

2.3 TVSS

.1 Approved to UL 1449 second edition.

.2 Integral to panelboard with direct bus bar connection.

.3 Rating: 240kA surge current capacity per phase.

.4 Surge counter.

.5 Integral disconnect.

2.4 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.

2.5 Acceptable Products

.1 Eaton Cutler-Hammer

.2 Schneider Electric

.3 Approved Equal

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 plywood backboards. Where practical, group panelboards on common backboard.

.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.

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.

.2 Common-Trip Breakers: With single handle for multi-pole applications.

.3 Circuit breakers with interchangeable trips as indicated.

2.2 Thermal Magnetic Breakers

.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 Optional Features

.1 Include where indicated on drawings:

.1 Shunt trip
.2 Auxiliary switch
.3 Motor-operated mechanism
.4 Under-voltage release
.5 On-off locking device
.6 Handle mechanism
.7 Keyed interlocks
.8 Non-auto
.9 Solid state trip units.

3. EXECUTION

3.1 Installation

.1 Install circuit breakers as indicated.

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 Section 16010 - Electrical General Requirements.

2. PRODUCTS

2.1 Contactors

.1 Contactors: to EEMAC No.1CS.

.2 Electrically held controlled by pilot devices as indicated and rated for type of load controlled. This rating shall be on the basis of incandescent or non-inductive loading for continuous operation. Half size contactors not accepted. All contactors shall have 120V 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 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 size 4 nameplate indicating name of load controlled.

3. EXECUTION

3.1 Installation

.1 Install contactors and connect auxiliary control devices where indicated on drawings and specified herein.

.2 Contactors shall be mounted separately in suitable CEMA-1 enclosures.

END OF SECTION

GENERAL PROVISIONS FOR INTERIOR LIGHTING

1. GENERAL

1.1 Work Included

.1 Supply and install lighting fixtures complete with lamps, ballasts and all necessary fittings.

1.2 Code Requirements

.1 Installation of lighting equipment to conform to Section 30, Canadian Electric Code, Part 1, and as amended or supplemented by provincial, municipal or other regulatory agencies having jurisdiction.

1.3 Shop Drawings

.1 Submit a complete list of the types of lighting fixtures, lamps, ballasts and accessories with catalogue illustrations, data sheets, etc. for review. Bind in a suitable booklet and keep one copy of this booklet at the job site at all times.

.2 Submit complete photometric data, based on actual fixtures proposed for project. Substantiate brightness and efficiency requirements. Photometric data must be produced by a recognized independent laboratory.

1.4 Lamps Used for Temporary Lighting

.1 Fluorescent or mercury lamps may be used for temporary light and lamps used for this purpose will be accepted when the project or portions of the work are turned over to the City. Spot relamp faulty or burned out lamps prior to this acceptance, without additional cost to City.

.2 Metal halide, sodium, incandescent and quartz lamps are not to be used for temporary lighting, unless all lamps so used are replaced with new lamps immediately prior to completion at no additional cost to City.

2. PRODUCTS

.1 Provide, wherever possible, commercially available stock lighting fixtures meeting specified requirements and as shown on the drawings.

.2 Different fixtures may be supplied by different manufacturers. Similar fixtures shall be supplied by the same manufacturer.

.3 Provide only lighting fixtures which are structurally well designed and constructed and which use new parts and materials of highest commercial grade available. Unless otherwise specifically noted, fixtures shall be of the quality stated in the manufacturer's catalogues and data sheets.

.4 Refer to related sections for details of fixtures and accessories.

3. EXECUTION

3.1 Installation

.1 Install fixtures in accordance with the manufacturer's requirements, code requirements, and as shown on the drawings.

.2 Confirm compatibility and interface of other materials with luminaire and ceiling systems. Examine the room finish schedule and reflected ceiling drawings. Report discrepancies and defer ordering until clarified.

.3 Supply plaster frames, trim rings and backboxes to other trades as the work requires.

.4 Ground lighting equipment to metal raceway, armour of armoured cable, grounding conductor in non-metallic sheathed cable, or to a separate grounding conductor.

.5 Co-ordinate with other trades to avoid conflicts between luminaires, supports and fittings and mechanical and structural equipment.

.6 Provide guards where fixtures are subject to mechanical damage as required by code or shown on the drawings.

3.2 Workmanship

.1 Completely clean all glassware, lamps, and hangers. Polish metal parts before completion.

.2 Provide suitable extension couplings for row mounted fixtures.

.3 Protect fixtures, hangers, supports, fastenings and accessory fittings at the site prior to and during installation. Unless fixtures are erected immediately, after delivery to site, deliver in original cartons or enclosed in air-tight plastic wrapping. Store in a dry and secure space on site. Protect hangers, supports, fastenings and accessory fittings against corrosion. Take care during installation to ensure that insulation and corrosion protection is not damaged.

.4 Fixtures which show evidence of corrosion, rough handling, scratching of finishes, etc. are to be replaced with new fixtures at no additional cost.

.5 Install recessed fixtures to permit removal from below, for access to outlet or prewired fixture box.

.6 Hang and mount fixtures to prevent distorting fixture frame, housing, sides or lens frame, and permit correct alignment of several fixtures in a row.

.7 Support fixtures as shown on drawings, level, plumb and true with structure and other equipment in horizontal or vertical position as intended. Install wall or side bracket mounted fixture housings rigidly and adjust to a neat flush fit with mounting surface.

.8 Adjust length of hangers of suspended fixtures to hang fixture bodies level and in same horizontal plane, unless shown otherwise on drawings.

.9 Install ceiling canopies to cover suspension attachments and fit tightly to ceiling without restricting alignment of hanger.

.10 For recessed fluorescent fixtures mounted in suspended ceiling with exposed tee bar grid system, support by the ceiling tee bar grid structure. Provide any additional support necessary for oversize fixtures, or to meet code requirements.

.11 Metal inserts, expansion bolts or toggle bolts which do not carry wiring shall be accurately located in relation to outlet boxes, for perfect alignment and spacing of suspension stems or other hangers.

.12 For remote mounted ballasts, supply mounting board and space ballasts in accordance with manufacturer's directions. Size wiring from ballasts to remote fixtures to meet manufacturer's requirements.

.13 Remove any noisy ballasts from the fixtures and replace at no additional cost to the City prior to completion.

END OF SECTION

STREET LIGHTING POLES AND LUMINAIRES

1. GENERAL

1.1 Related Work

.1 Electrical General Requirements: Section 16010

.2 Luminaire Schedule (on Drawing No. E1.03)

2. PRODUCTS

2.1 Wood Poles

.1 Wood Poles: To CSA O15.1, CSA O15.2, CSA O15.3, class 1 Western Red cedar and:

.1 Length: 12 m.
.2 Minimum Diameter: At butt 990 mm, at top 686 mm.
.3 Pressure Treated: To CSA O80.

2.2 Luminaire Mounting Brackets

.1 Mounting brackets aluminum for metal halide fixtures and:

.1 2-single brackets as indicated.

.2 Arm extension length: 2.5m.

.3 Type: single bend upsweep with underbrace

.4 Single tapered davit type.

.5 Acceptable material: aluminum

2.3 Luminaires

.1 Luminaire with cast aluminum weatherproof housing and:

.1 One 250W, metal halide lamp per bracket.

.2 Ballast: One lamp, 250 W metal halide.

.3 Optical assembly:

.1 For metal halide lamps:

.1 Reflector: Sheet aluminum with Alzak finish
.2 Refractor: One piece polycarbonate
.3 Gasket: Seal between refractor and housing.

.4 Light Distribution:

.1 IES distribution Type II by adjusting position of lamp socket.

.5 Self-locking latch of stainless steel and aluminum.

.6 Factory wired including integral ballast.

3. EXECUTION

3.1 Installation

.1 Install poles with bottom of base being 1.8 m below grade.

.2 Install brackets on poles as indicated.

.3 Install luminaires on pole brackets, connect to pole wiring and install lamps. Pole wiring to be installed in rigid steel conduit to a height of 3m and a depth of 900mm.

.4 Connect pole wiring to underground street lighting circuit.

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

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 Fixed contact plug-in type: general purpose DPDT. Coil rating: 120 V. Contact rating: 250 VAC/28VDC, 10 A.

.2 LED indicator and varistor surge suppressor.

.3 Silver contacts.

2.2 Solid State Timing Relays

.1 Construction: ac operated electronic timing relay with solid-state timing circuit to operate output contact.

.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: minimum 0.05s, maximum 300 hours.

2.3 Operator Control Stations

.1 Enclosure: CSA Type 1, surface mounting:

2.4 Pushbuttons

.1 Standard. Operator flush type. Black, with 1-NO and 1-NC contacts rated at 5 A, ac, labels as indicated. Stop pushbuttons coloured red.

2.5 Selector Switches

.1 Maintained, spring return to middle, 2 and 3 position labelled as indicated. Standard, operators knob, contact arrangement as indicated, rated 120 VAC, 5 A.

2.6 Indicating Lights

.1 Standard, full voltage, LED type, lens colour: as indicated, supply voltage: 120 V, lamp voltage: 120 V, labels as indicated.

2.7 Control and Relay Panels

.1 CSA Type 1 sheet steel enclosure with hinged padlockable access door, accommodating relays timers, labels, as indicated, factory installed and wired to identified terminals.

2.8 Thermostat (Line Voltage)

.1 Wall mounted.

.2 Full load rating: 8 A at 120 V.

.3 Temperature setting range: 0°C to 30°C.

.4 Thermometer Range: 0°C to 30°C.

.5 Markings in 5° increments.

.6 Differential temperature fixed at 1°C.

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

CONNECTIONS TO MECHANICAL EQUIPMENT

1. GENERAL

1.1 Related Work

.1 Mechanical: Division 15

1.2 Requirements

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

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

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

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

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

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

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

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

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

.10 Refer to Motor Control Equipment Schedule.

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

.1 Condenser Water Pumps, Chilled Water Pumps

.1 Provide all 120V and 240V wiring for this equipment. Provide all 120V control wiring to chiller control panel to provide pump operation and interlocking as shown on the drawings.

.2 Fans

.1 Provide all 120V and 240V power wiring. Except where specifically noted otherwise, all control for fans is to be supplied, installed and wired from the starter control circuits to the equipment under Division 15. Fire alarm and smoke detection systems shall be wired to shut down fans by this Division.

.3 Pumps for Sprinkler System, Domestic Water, Plumbing & Drainage Systems

.1 Provide all 120V and 240V power wiring. Except where specifically noted otherwise, all control for fans is to be supplied, installed and wired from the starter control circuits to the equipment under Division 15. Fire alarm and smoke detection systems shall be wired to shut down fans by this Division.

.4 Pumps for Sprinkler System, Domestic Water, Plumbing & Drainage Systems

.1 Provide all 240V and 120V wiring as shown on the drawings.

.5 Unit Heaters

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

.6 Forced Flow Convectors

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

2. PRODUCTS

2.1 120 Volt, 1 Phase Disconnect Switches

.1 Manual starter without overload relay.

2.2 240 Volt, 1 Phase Motor Disconnect Switches

.1 Manual starter without overload relay.

3. EXECUTION

3.1 Installation

.1 Provide disconnect switches adjacent to all motors.

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

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

END OF SECTION

STARTING OF ELECTRICAL EQUIPMENT AND SYSTEM

1. GENERAL

1.1 Related Work

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

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

1.2 Coordination

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

.1 Electrical equipment and systems specified in Division 16

.2 Mechanical equipment and systems specified in Division 15

.3 Other equipment and systems specified in other Divisions.

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

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 Energizing Main Electrical System

.1 Prior to energizing main electrical system:

.1 Verify supply authority voltage and phase rotation.

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

3.2 Starting Motors

.1 Prior to starting motors:

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

3.3 Energizing Equipment

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

END OF SECTION

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 to 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 Electrical General Requirements: Section 16010

.2 Starting of Electrical Systems and Equipment: Section 16960

1.3 Manufacturer's Production Test Records

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

1.4 Site Testing Reports

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

.2 Submit forms to 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

.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 appropriately qualified manufacturers' representatives where on-site testing, adjusting, or balancing of electrical equipment or systems performed by Manufacturer's representatives is specified, or otherwise required to ensure that electrical equipment and systems are operational in full compliance with the Contract Documents

1.7 Sequencing and Scheduling

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

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

2. PRODUCTS

2.1 Test Equipment

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

3. EXECUTION

3.1 Testing of Wiring and Wiring Devices

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

.2 Test service grounding conductors for ground resistance.

.3 Test all wiring devices for correct operation.

.4 Test all receptacles for proper polarity and circuitry.

3.2 Ground Resistance Testing

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

3.3 Load Balance Testing

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

.2 Turn on all possible loads.

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

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

3.4 Voltage Testing and Adjusting

.1 Test voltage at all panelboards.

END OF SECTION

ELECTRICAL EQUIPMENT AND SYSTEMS DEMONSTRATION AND INSTRUCTION

1. GENERAL

1.1 Intent

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

.2 Submit system 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 operating/maintenance 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 appropriately 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 City will chair demonstration and instruction sessions.

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

2. PRODUCTS (NOT APPLICABLE)

3. EXECUTION

3.1 Systems Demonstration

.1 Demonstrate operation of following systems:

.1 240/120 Volt System Emergency and Normal

.2 Pump Protection Panels

.3 Mechanical Equipment Connections and Controls

.4 Grounding System

.5 Fire Alarm

.6 Telephone

.7 Intercom System

.8 Lighting

.9 Lighting Controls

.10 Future Connection Points and Conduit Stubs

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MOTOR SURVEY SHEET

Motor Name & Number _____

Manufacturer _____

H.P. _____ Max. Ambient _____ °C

R.P.M. _____ Service Factor _____

Volts _____ / _____/_____ Insulation Class _____

AMPS _____ / _____/_____ EEMAC Design _____

PHASE _____ Time Rating _____

Frame _____ Type _____

Serial #

Model # _____

Starter _____ Type _____

OPERATING CONDITIONS

Full Load Operating Amps _____ A _____ B _____ C

Full Load Operating Voltage at Motor _____ A-B _____ B-C _____ C-A

Overload Relay Installed _____ Adjustable Setting _____ %

M.C.P. AMPS _____ Adjustable Setting _____

Acceleration Time (If over 5 seconds) _____

Reduced Voltage Starter Tap Setting _____

Reduced Voltage Starter Transition Time Setting _____

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

_____

_____

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SYSTEM COMPLETION AND COMMISSIONING

SYSTEM: _____

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

Electrical Contractor

Signed by: _____Dated: _____

General Contractor

Signed by: _____Dated: _____

Deficiencies Attached ZD?
@DY

This system has been reviewed by:

The 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 CONTRACTOR	GENERAL CONTRACTOR
	_____	_____
Address:	_____	_____
	_____	_____
	_____	_____
Phone:	_____	_____

END OF SECTION

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