

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 The General Conditions, Supplementary Conditions, and Division 1 are a part of this Specification and apply to this Division.
- .2 The intent of the Drawings and Specifications is to include all labour, products, and services necessary for complete Work, tested and ready for operation.
- .3 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.
- .4 Consider these Specifications and the Drawings and Specifications of all other Divisions as an integral part of the accompanying Drawings. Any item or subject omitted from either the Specifications, or the Drawings, but which is mentioned or reasonably specified in and by the others, shall be considered as properly and sufficiently specified and shall be provided.
- .5 Provide all minor items and work not shown or specified but which are reasonably necessary to complete the Work.
- .6 Responsibility to determine which Division provides various products and work rests with the Contractor. Additional compensation will not be considered because of differences in interpretation of specifications.

1.3 Quality Assurances

- .1 Codes, Rules, Permits and 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 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 Give all required notices, submit Drawings, obtain all permits, licenses and certificates and pay all fees required for this Work.
 - .5 Furnish a Certificate of Final Inspection and approvals from inspection authority to the Contract Administrator.

ELECTRICAL GENERAL REQUIREMENTS

.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 See Section 01300 – Submittals.

1.5 Operation and Maintenance Manuals

- .1 Refer to Section 01730 – Operation and Maintenance Manuals

1.6 Product Handling

- .1 Use all means necessary to protect the products of this Division before, during and after installation and to protect products and installed work of all other trades.
- .2 Immediately make good any damage by repair or replacement at no additional cost to the City and to the approval of the Contract Administrator.
- .3 Remove advertising labels from all electrical equipment. Do not remove identification or 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, ULC approved where applicable, 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 supplied, 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.

ELECTRICAL GENERAL REQUIREMENTS

2.2 Uniformity of Manufacture

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

2.3 Product Finishes

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

2.4 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, "USE OF PREMISES". Clean and restore to "as new" condition all equipment prior to the time of substantial completion.

3. EXECUTION

3.1 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 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 m 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.

3.2 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.

ELECTRICAL GENERAL REQUIREMENTS

- .3 Do not support wiring from pipes, ductwork, etc. Hangers for suspended ceilings may be used for the support of wiring only when approval is obtained from the Contract Administrator and the ceiling installer, and approved clips or hangers are used.

3.3 Equipment Identification

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

NAMEPLATE SIZES

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

- .1 Distribution Centres (Indicate designation, bus capacity, voltage)
- .2 MCCs (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 m intervals. Color coding to be as follows:

SYSTEM	MAJOR BAND	MAJOR BAND
347/600 V Normal	Dk. Blue	
120/208 V Normal	Lt. Blue	
UPS System	Lt. Blue	White
Fire Alarm System	Red	
Telephone	Lt. Green	
Building Alarm	Pink	
Intercom Systems	Purple	Green
Security Systems	Dk. Green	Lt. Brown
Door Intercom/Video	Purple	Yellow

ELECTRICAL GENERAL REQUIREMENTS

- .3 Provide neatly typed circuit directories in panelboards to indicate the area or equipment controlled by each branch circuit.
- .4 Identify all conductors by coloured insulation and permanent markers at every terminal and accessible points throughout its entire run, as per the Canadian Electrical Code.
- .5 Conductors:
 - .1 Equipment Grounding – Green
 - .2 Neutral Conductor – White

Fire Alarm System

Neutrals	White
Switch Legs	Phase Colour with White Tracer
Speaker Cct.	Blue with Yellow Tracer
Box Circuit	Black with Yellow Tracer
Annunciator	Brown with Yellow Tracer

- .6 Place cable metal identification markers bearing the equipment tag number on all Teck cables on both ends and all locations where the cable leaves the cable tray or penetrates a concrete wall
- .7 Install red plastic warning tape, 300 mm below grade, above all underground ducts.
- .8 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.

3.4 Wiring to Equipment Supplied by Others

- .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.

3.5 Testing

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

3.6 Instructions to Owner's Personnel

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

3.7 Access Panels

- .1 Where electrical equipment, junction boxes, remote ballasts or the like are concealed, supply access panels. Use panels of adequate size for servicing of the electrical Work and complete

ELECTRICAL GENERAL REQUIREMENTS

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. Use markers of a type approved by the Contract Administrator.

3.8 Mounting Heights

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

Receptacles in Mechanical Rooms and Process Areas	1000 mm
Receptacles and Telephone Outlets in offices and control rooms	300 mm
Light Switches	1400 mm
Fire Alarm Manual Stations	1400 mm
Fire Alarm Bells	2100 mm
Clocks	2100 mm
Television and Computer Outlets	300 mm
Intercom	1400 mm
Thermostats	1400 mm
Door Entry Push-Buttons	1400 mm
Wall-mounted speakers	2100 mm
Panelboards, starters, and disconnects (to top of cover)	2000 mm
End of Line Resistors	1800 mm
Outlets above Counters	175 mm above countertop or backsplash

3.9 Sealing of Wall and Floor Openings

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

ELECTRICAL GENERAL REQUIREMENTS

3.10 Housekeeping Pads

- .1 Mount all floor mounted electrical equipment installed by this Division on concrete housekeeping pads, which, unless otherwise noted, shall be the responsibility of this Division.
- .2 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 (30) days after the Contract Notice to Proceed.

3.11 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 ensure the ends are flush with the finish on both sides, but for floors extend 100 mm above finished floor level.
- .3 Fire stop opening with ULC approved assembly for the installation conditions. Mount lamacoid indicating assembly requirements by penetration. Include assembly details in O&M Manuals.
- .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.

3.12 Temporary Lighting and Power

- .1 Provide grounded extension cords and temporary lights required for electrical Work.
- .2 Coordinate with Contractor for obtaining temporary power service.
- .3 If City 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 other Divisions of any power outage required for this Work. Schedule outages to provide least interference with other Work.

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 Scaffolding.
- .4 Shop Drawings.
- .5 O&M Data, where specified.

2.2 Specific Requirements Included But Not Limited to the Scope of Work

- .1 Supply and Install two (2) 4160 V direct buried cables from 5 kV switch gear located in DBPS building to the distribution panel.
- .2 Supply and install outdoor power distribution panel (DP-L11) complete with two (2) 4160/600 V transformers, one (1) automatic transfer switch, 600 V panel board and breakers, 600/120-240 V transformer, 120/240 panel board and breakers, panel heater, pump control panel (LCP-L11), and WTP Network Communication panel (LCP-L11A).
- .3 Supply and install heater, power and lights in metering chamber.
- .4 Connect submersible pumps power and control cables.
- .5 Supply and install exterior lighting.
- .6 The Metering Chamber is classified as a Category 1 location. Construction methods and materials shall be suitable for the environment.
- .7 The Dewatering Pump Station is classified as a Category 2, Class 1, Zone 2 location. Construction methods and materials shall be suitable for the environment.
- .8 Supply and install direct buried cables to the 600V receptacles mounted on the Decant structures. The receptacles are supplied and installed by others.

SCOPE OF ELECTRICAL WORK

- .9 Supply and install direct buried power and control cables to the DBPS sanitary pumping station from DBPS.
- .10 The DBPS sanitary pumping station is classified as a Category 2, Class 1, Zone 2 location. Construction methods and materials shall be suitable for the environment.

END OF SECTION

INSTALLATION OF CABLES IN TRENCHES AND IN DUCTS

1. GENERAL (NOT USED)

2. PRODUCTS

2.1 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 specified on drawings 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 Make termination and splice only as indicated leaving 0.6 m of surplus cable in each direction.
 - .1 Make splices and terminations in accordance with Manufacturer's instructions using approved splicing kits.
- .4 Underground cable splices not acceptable.
- .5 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.
- .6 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.

3.2 Cable Installation in Ducts

- .1 If cables require installation into ducts the following sections shall apply.
- .2 Do not pull spliced cables inside ducts.

INSTALLATION OF CABLES IN TRENCHES AND IN DUCTS

- .3 Install multiple cables in duct simultaneously.
- .4 Use CSA approved lubricants of type compatible with cable jacket to reduce pulling tension.
- .5 To facilitate matching of colour coded multiconductor control cables reel off in same direction during installation.
- .6 Before pulling cable into ducts and until cables properly terminated, seal ends of lead covered cable with wiping solder; seal ends of non-leaded cables with moisture seal tape.
- .7 After installation of cables, seal duct ends with duct sealing compound.

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 for cables under 1000 V:
 - .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 Pre-acceptance test for cables over 1000 V:
 - .1 After installing cable but before splicing and terminating, perform insulation resistance test with 5000 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.
- .7 Acceptance Tests:
 - .1 Ensure that terminations and accessory equipment are disconnected.
 - .2 Ground shields, ground wires, metallic armour and conductors not under test.
- .8 Acceptance Tests for cables over 1000 V
 - .1 High Potential (Hipot) Testing:
 - .1 Conduct Hipot testing at 200% of original factory test voltage in accordance with Manufacturer's or IPCEA recommendations.

INSTALLATION OF CABLES IN TRENCHES AND IN DUCTS

- .2 Leakage Current Testing.
 - .1 Raise voltage in steps from zero to maximum values as specified by IPCEA Manufacturer for type of cable being tested.
 - .2 Hold maximum voltage for specified time period by IPCEA or Manufacturer.
 - .3 Record leakage current at each step.
- .9 Provide Contract Administrator with list of test results showing location at which each test was made, circuit tested and result of each test.
- .10 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.
- .3 Connectors subjected to moisture interior and exterior: liquid and dust tight with insulated throat, Thomas & Betts "Bullet Hub" 370 Series.
- .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 alternate.

2.2 EMT Conduit

- .1 Conduit: galvanized electrical metallic tubing.
- .2 Fittings: 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 C.G.E. "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.
- .4 Use rigid steel epoxy coated elbows where exiting the slab

2.4 Flexible Conduit (Open Air)

- .1 Conduit: spiral wound, interlocking flexible metal conduit.
- .2 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 Flexible Conduit (Embedded in Slab)

- .1 Plastic conduit ENT may be used in the slab
- .2 For conduit slab exit, use rigid steel, epoxy coated elbows

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 Rigid Aluminum Conduit

- .1 Conduit: rigid extruded aluminum with threaded joints and connections and interior silicone coating to meet requirements of CSA C22.2 No. 45. Rigid metal conduit.
- .2 Fittings: copper free cast aluminum conduit fittings for indoor and outdoor installations.

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).
 - .4 In hazardous classified areas.

3.2 EM.T Conduit

- .1 Use as raceways for following applications:
 - .1 For housing digital communications cables.
 - .2 In dry finished areas such as offices, and control rooms.
- .2 It may not be used in any other areas.

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 Category 2 locations.
 - .4 Do not surface mount rigid PVC conduit.
- .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. Tie PVC conduit securely to prevent movement and broken joints from concrete pour and vibration.
- .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 luminaries, in dry areas such as offices, control rooms and similar finished locations.
- .2 Provide a separate insulated ground wire in all flexible conduits.

3.5 Liquid-Tight Flexible Conduit

- .1 Use as raceways for following applications:
 - .1 At all motors, pipe mounted control devices, luminaries in non classified plant process areas, and other devices subject to movement or vibration in non classified process areas.
 - .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.

CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS

- .3 Provide a separate ground wire within flexible conduit, bonded to motor frames and system ground.

3.6 Aluminum Conduit

- .1 Use as a raceway for the following applications and as indicated on Drawings.
 - .1 In wet areas for surface conduit runs.
 - .2 Surface mounted in tank areas and exterior.
- .2 Follow Manufacturer's recommendations for cutting, threading, reaming and bending.
- .3 Use thread compound to prevent thread damage and ensure watertight connections. Do not use red or white lead paint.
- .4 Do not install in poured concrete.

3.7 Workmanship

- .1 Install all conduit and wiring concealed, unless otherwise shown on the drawings. Do not recess conduit in columns, except as noted, without permission.
- .2 Where conduit is run exposed, run parallel to building lines. Where conduits are grouped (two or more), space evenly, make bends concentric and mount on Unistrut racks.
- .3 Lay out conduit to avoid interference with other Work. Maintain a minimum clearance of 150 mm from steam or hot water piping, vents, etc.
- .4 Slabs on grade: Install rigid PVC conduit in the gravel base below concrete slabs. Provide mechanical protection around stub-ups through slab and extend 150 mm beyond concrete. When rigid steel conduit is installed in contact with earth it shall be protected by Polykin #940 tape. Extend taping 300 mm above finished grade.
- .5 Metal conduit installations in concrete pours: Tie down conduit to prevent shifting. All joints are to be made up tight to ensure ground continuity. To prevent concrete entry, seal EMT set screw fittings with tape, pack outlet boxes and cap conduit terminations both in boxes and stub-ups. Apply Polykin #940 tape to the conduit 152 mm both sides of the point of leaving slab.
- .6 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.

CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS

- .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.
- .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.
- .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.

CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS

- .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

**POWER CABLES AND
OVERHEAD CONDUCTORS 1001-15000 V**

1. GENERAL

1.1 Related Work

- .1 Section 16153 – Connectors and Terminations.

2. PRODUCTS

2.1 Teck Power Cable 1001 - 15000 V

- .1 Bare copper grounding conductor, size as indicated.
- .2 Copper circuit conductors, size and number as indicated.
- .3 Strand shielding.
- .4 Insulation: chemically cross-linked thermosetting polyethylene rated RW90 8 kV to ICEA S-66-524.
- .5 Insulation shielding: semi-conducting non-metallic tape over insulation and served wire shield over tape to ICEA S-19-81.
- .6 Separator tape over conductor assembly.
- .7 Inner jacket of PVC.
- .8 Interlocked galvanized steel armour.
- .9 Overall PVC jacket rated minus 40°C.

3. EXECUTION

3.1 Installation

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

END OF SECTION

WIRES AND CABLE 0-1000 V

1. GENERAL

1.1 Work Included

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

1.2 References, Codes and Standards

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

1.3 Product Data

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

2. PRODUCTS

2.1 Building Wires

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

2.2 Teck Cable

- .1 Conductors:
 - .1 Grounding conductor: copper.
 - .2 Circuit conductors: copper, size as indicated.
- .2 Insulation:
 - .1 Chemically XLPE rated type RW90, 1000 V.
- .3 Inner jacket: PVC material.
- .4 Armour: interlocking aluminum.
- .5 Overall covering: thermoplastic PVC material.

WIRES AND CABLE 0-1000 V

.6 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 6 mm diameter. threaded rods to support suspended channels.

.7 Connectors:

- .1 Watertight approved for TECK cable.

2.3 Control Cables

- .1 Type LVT: two (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 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 – Conduits, Conduit Fastenings and Conduit Fittings.
 - .2 In trenches in accordance with Section 16106 – Installation of Cables in Trenches and in Ducts.

WIRES AND CABLE 0-1000 V

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 – Installation of Cables in Trenches and in Ducts.
- .4 Terminate cables in accordance with Section 16151 – Wire and Box Connectors - 0 – 1000 V.

3.4 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 - 0 – 1000 V.

3.5 Installation of Control Cables

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

3.6 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.

3.7 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.

WIRES AND CABLE 0-1000 V

- .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.

3.8 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.

3.9 Testing

- .1 All power and control wiring shall be tested for insulation resistance value with a 1000 V megger. Resistance values shall be as recommended by the cable Manufacturer.
- .2 All wire test results shall be properly tabulated, signed, dated, and submitted to the Contract Administrator.

END OF SECTION

SPLITTERS, JUNCTION BOXES, PULL BOXES AND CABINETS

1. GENERAL

1.1 Work Included

- .1 Supply and Install a complete system of splitters 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 01300 – Submittals and 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 For junction boxes mounted in exterior walls, provide complete with box vapour barriers.

2.3 Junction Boxes in Hazardous Classified Areas

- .1 Junction boxes in hazardous classified areas to be rated and marked for hazardous classification of location in which they are to be installed.

2.4 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.

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 Install a back mounting plate for DIN rail mounted terminal blocks. Plate to be painted white enamel.
 - .3 Install metal divider in cabinets with more than one voltage.
 - .4 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 19 mm.

2.5 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 Boxes installed in party walls to be offset by a minimum of one stud space.
 - .3 Install in inconspicuous but accessible locations, above removable ceilings or in electrical rooms, utility rooms or storage areas.
 - .4 Identify with system name and circuit designation as applicable.
 - .5 Size in accordance with the Canadian Electrical Code, as a minimum.

SPLITTERS, JUNCTION BOXES, PULL BOXES AND CABINETS

- .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.
- .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 Supply and Install a complete system of boxes for the installation of wiring and equipment.

1.2 References

- .1 CSA C22.1-Canadian Electrical Code, 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.
- .5 347 V outlet boxes for 347 V switching devices.
- .6 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/ft² 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

OUTLET BOXES, CONDUIT BOXES AND FITTINGS

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

2.3 Outlet Boxes for Rigid PVC Conduit

- .1 Materials:
 - .1 Rigid PVC boxes and fittings: Unplasticized PVC.
- .2 Components:
 - .1 Floor boxes: Round with threaded hubs for threaded female connectors.

2.4 Concrete Boxes

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

2.5 Conduit Boxes

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

OUTLET BOXES, CONDUIT BOXES AND FITTINGS

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 party walls to be offset by a minimum of one stud space.
- .14 Provide ceiling outlet boxes for every surface mounted fixture or row of fixtures installed on suspended "hard" ceilings.

OUTLET BOXES, CONDUIT BOXES AND FITTINGS

- .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.
- .19 Identify all boxes in accordance with Section 16010 – Electrical General Requirements.

END OF SECTION

WIRING DEVICES

1. GENERAL

1.1 Work Included

- .1 Supply, install, 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 Manufacturer's 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. For all devices, use the specification grade minimum, and wherever possible, use devices of the same manufacture.
- .2 Devices to be ivory 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 V, 20 A, single and double pole, three and four-way: As Hubbell No. 1221, 1222, 1223 and 1224.
- .2 For wet locations use the following switches: 20 A, 120 V single pole ivory, and side wired press-switch, as Hubbell #1281.
- .3 Provide manually - operated general purpose AC switches with 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 20 A, 120 V, 3 wire, ivory, U-ground, as Hubbell No. 6252, with the following features:
 - .1 Ivory urea molded housing.

WIRING DEVICES

- .2 Suitable for #10 AWG for back and side wiring.
- .3 Eight back wired entrances, four side wiring screws.
- .4 Break-off links for use as split receptacles.
- .5 Triple wipe contacts and rivetted grounding contacts
- .6 Dual 15/20 A configuration.
- .2 Duplex 15 A, 120 V, 3 wire, ivory, U-ground ground fault receptacle, as Hubbell No. GF-52621A.
- .3 Single 15 A, 120 V, 3 wire clock receptacle with stainless steel plate, as Hubbell No. 5235.
- .4 Single 30 A, 250 V, 4 wire receptacle with stainless steel cover, as Hubbell No. 9430.
- .5 Single 50 A, 250 V, 4 wire range receptacle with stainless steel cover, as Hubbell No. 9450.
- .6 Floor outlets, as Smith and Stone VIP Series or Odessey Controls Modular System c/w frames, as required, and receptacles and outlets, as indicated.

2.5 600 V Interlocked Receptacles

- .1 Interlocked receptacle with enclosed disconnect switch.
- .2 NEMA 4X enclosure complete with viewing window.
- .3 30 Amp rating, or as specified on Drawings.
- .4 NEMA type HD heavy duty 3 pole safety switch.
- .5 3 wire, 4 pole receptacle.
- .6 Crouse-Hinds Arktite WSRD series.

2.6 Coverplates

- .1 Provide coverplates for all wiring devices, including but not limited to receptacles, telephone and computers.
- .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.

WIRING DEVICES

- .5 Weatherproof spring - loaded cast aluminum coverplates complete with gaskets for single receptacles or switches.
- .6 Use gasketed DS cast covers on FS and FD type boxes.
- .7 For all 347 V switch plates, use stainless steel with the voltage pressed or engraved on the plate.

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 at the Site. The dimensions given in Section 16010 – Electrical General Requirements shall be used as a guide, but is subject to final verification prior to installation.
- .10 Supply and Install a separate neutral conductor from branch circuit panel to devices for all dimmer control circuits.

END OF SECTION

WIRE AND BOX CONNECTORS 0 - 1000 V

1. GENERAL

1.1 Work Included

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

1.2 Special Codes

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

1.3 References

- .1 CSA C22.2 No. 65 Wire Connectors.
- .2 EEMAC 1Y-2, Bushing Stud Connectors and Aluminum Adapters (1200 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 or solid round copper conductors.
 - .2 Clamp for stranded copper conductors.
 - .3 Stud clamp bolts.
 - .4 Bolts for copper bar.
 - .5 Bolts for aluminum bar.
 - .6 Sized for conductors as indicated.
- .4 Clamps or connectors for Teck cable and flexible conduit, as required.

WIRE AND BOX CONNECTORS 0 - 1000 V

2.2 Wire Connectors

- .1 Use 3M “Scotchlock”, self-insulated connectors for hand twist wire joints for lighting, small power, and control wiring.
- .2 Use T & B non-insulated ring type compression lugs for terminating #10 AWG and smaller motor connections. Tape with rubber and scotchtape. Lugs to accept ten - 32 x ³/₈” machine bolts.
- .3 Terminate conductors #8 AWG and larger with Thomas & Betts Colour-Keyed compression connectors Series 54000, or on lugs provided with equipment.
- .4 Thomas & Betts “KOPR-SHIELD” compound Series CP8 on all terminations for compression connectors.

3. EXECUTION

3.1 Installation

- .1 Remove insulation carefully from ends of conductors and:
 - .1 Apply coat of zinc joint compound on aluminum conductors prior to installation of connectors.
 - .2 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.
 - .3 Install fixture type connectors and tighten. Replace insulating cap.
 - .4 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

CONNECTORS AND TERMINATIONS

1. GENERAL

1.1 Inspection

- .1 Obtain inspection certificate of compliance covering high voltage stress coning (if applicable) from the Contract Administrator and include it with As-Built Drawings and maintenance manuals.

1.2 Product Data

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

2. PRODUCTS

2.1 Connectors and Terminations

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

3. EXECUTION

3.1 Installation

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

END OF SECTION

GROUNDING

1. GENERAL

1.1 Description

- .1 Supply and Install a complete grounding system. Securely and adequately ground all components of the electrical system in accordance with the requirements of all related sections in the latest Canadian Electrical Code and the local Electrical Inspection Branch.
- .2 The 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.

2. PRODUCTS

- .1 Cables 3/0 and smaller to be connected to ground bars via Burndy Quiklug Type QA-2B connectors. Braze connections for cables larger than 3/0.
- .2 All ground wires: stranded copper TWH complete with a green jacket, except in transformer yard where bare copper horizontal wire shall be used, unless otherwise shown.
- .3 Ground rods: 20 mm x 10000 mm copper clad steel.
- .4 Cable to pipe connectors: made with Burndy GAR connectors.
- .5 In the main power distribution cabinet, provide a copper ground bar complete with lugs suitable to terminate all ground cables.

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 transformers, switchgear, panelboards and splitters fed from the main distribution centre by grounding conductors sized in accordance with the Canadian Electrical Code. 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.

GROUNDING

- .4 Connect using #3/0 bare copper conductors from the main power distribution and control cabinet ground bus to the ground ring. Test the system for ground resistance and install additional ground rods as necessary to meet a minimum requirements of 3 ohms.
- .5 Ensure all main distribution centres, switchgear, and all panels requiring equipment grounds contain a ground bus of adequate size, and tapped for lugs for the ground wire required.
- .6 Ensure all bolted connections are accessible.
- .7 Ground all motors 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 Bond expansion joints and telescoping sections of raceways using jumper cables as per Canadian Electrical Code.
- .10 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".
- .11 Connect all transformer neutrals to the main ground bus using bolted connections.
- .12 Install rigid conduit sleeves where ground wires pass through concrete slabs.
- .13 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.
- .14 Ground all utility services to the electrical system ground.
- .15 Ground all metal fences and gates
- .16 Selected ground rods shall be accessible with ground wells as shown on Drawings

END OF SECTION

OUTDOOR EQUIPMENT ENCLOSURES

1. GENERAL

1.1 Description

- .1 Power Distribution Enclosure (DP-L11) shall contain 5 kV disconnect switches, 150 kVA 5 kV/600 V transformers, automatic transfer switch, 600 V panel (PP-L11), 5 kVA transformer, 120/240 V panel (PP-L12), pump control panel (LCP-L11), WTP Network Communication Panel (LCP-L11A), and panel heater(s).
- .2 The enclosure shall be fully assembled and shop tested prior to shipping.

1.2 Related Work

- .1 Section 11305 – Process Submersible Pumps.
- .2 Section 16322 – Dry Type Transformers.
- .3 Section 16430 – Distribution Panel Boards.
- .4 Section 16477 – Moulded Case Circuit Breakers.
- .5 Section 16461 – Dry Type Transformers up to 600 V Primary.
- .6 Section 16627 – Automatic Load Transfer Equipment.

1.3 Shop Drawings and Product Data

- .1 Submit Shop Drawings and product data in accordance with Section 1300 – Submittals.
- .2 Shop Drawings to include dimensioned panel layout, panel weight, and cable entry locations.

2. PRODUCTS

2.1 Equipment

- .1 Ratings as indication on Drawing, short circuit rating 10 kA for 600 V equipment.
- .2 Enclosures CSA 3 type, low profile, free standing as specified, dead front, size as indicated, 3-point lock, provision for padlocking.
- .3 Barrier each section from adjoining sections.
- .4 5 kV equipment in rear sections, 600 V and lower in front sections
- .5 Distribution section single line as indicated on Drawings.
- .6 Built for minimum 12" snow clearance.

OUTDOOR EQUIPMENT ENCLOSURES

- .7 Anti-condensate roof.
- .8 Strip heaters, thermostat and internal power supplies in each section except transformer sections.
- .9 Zinc wipe coat 12 gauge minimum steel, continuous weld seams and bases with lead and chromate-free brush-on rust inhibitive primer.
- .10 Two coats of UV resistant urethane paint finish. Colour to ANSI 61 grey.
- .11 Hinged inner access panels with captive knurled thumbscrews as required.
- .12 Bus bars and main connections: 99.3% copper.
- .13 Cable from load terminals of 150 kVA transformers to transfer switch and to main breaker of 600 V distribution section.
- .14 Identify phases with colour coding as specified in Section 16010 – Electrical General Requirements.
- .15 Two (2) copper ground buses extending full width of cubicles and located at bottom in both the front and rear sections.
- .16 All exterior doors shall be double flanged sealed and gasketed construction.
- .17 All exterior doors to be secured to CSA Enclosure 3R requirements using 3-point handle operated cams and latches. Use of additional clamps and latches to meet CSA Enclosure 3R requirements will not be permitted.
- .18 Transformer core and coils shall be copper wound with vacuum impregnated insulation. Transformer core and coil shall be mounted in a barriered section. All air-cooling louvers shall be double weatherproof type with snow/dust filters.
- .19 Heating and cooling systems designed to maintain the internal enclosure temperature between 5°C and 32°C under all operating conditions.

2.2 Acceptable Manufacturers

- .1 J.R. Stephenson.

3. EXECUTION

3.1 Installation

- .1 Assemble enclosure in accordance with Manufacturer's instructions and mount on concrete pad.
- .2 Mount and connect Pump Control Panel (LCP-L911) specified in Division 11 and WTP Network Communication Panel (LCP-L11A) specified in Division 17.

OUTDOOR EQUIPMENT ENCLOSURES

- .3 Factory test equipment prior to shipping.
- .4 Mount enclosure on concrete pad. Seal base to pad with polyethylene based sealant prior to placements.

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 Manufacturer's 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 dia 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

DRY TYPE TRANSFORMERS

1. GENERAL

1.1 References

- .1 CSA C9, Dry-Type Transformers.
- .2 EEMAC GL1-3, Transformer and Reactor Bushings.

1.2 Shop Drawings

- .1 Submit Shop Drawings in accordance with Section 1300 – Submittals.
- .2 Include:
 - .1 Dimensioned Drawing showing enclosure, mounting devices, terminals, taps, internal and external component layout.
 - .2 Standard factory test certificates of each transformer and type test of each transformer in accordance with CSA C9.
 - .3 Technical data:
 - .1 kVA rating
 - .2 Primary and secondary voltages
 - .3 Frequency
 - .4 Single or Three phase
 - .5 Polarity or angular displacement
 - .6 Full load efficiency
 - .7 Regulation at unity pf
 - .8 BIL
 - .9 Insulation type
 - .10 Sound rating

1.3 Operation and Maintenance Data

- .1 Provide operating and maintenance data for dry type transformers for incorporation into manual specified in Section 01730 – Operation and Maintenance Manuals.
- .2 Operating and maintenance instructions to include:
 - .1 Tap changing

DRY TYPE TRANSFORMERS

- .2 Recommended environmental conditions
- .3 Recommended periodic inspection and maintenance
- .4 Bushing replacement

2. PRODUCTS

2.1 Materials

- .1 Dry-type transformers: to CSA C9.
- .2 Bushings: to EEMAC GL1-3.

2.2 Transformer Characteristics

- .1 Type: ANN.
- .2 Rating: 150 kVA, 3 phase, 60 Hz.
- .3 220 insulation system class, 150°C temperature rise.
- .4 Impedance: standard.
- .5 Primary winding: 4160 V, delta, BIL 30 kV, ungrounded.
- .6 Secondary winding: 600 V, delta, BIL 30 kV, four wire with neutral brought out and effectively grounded.
- .7 High efficiency TP-1 (Energy Star).
- .8 Sound rating: 60 dB.

2.3 Enclosure

- .1 Fabricated from sheet steel.
- .2 Bolted removable panels for access to tap connections, enclosed terminals.
- .3 Conductor entry:
 - .1 Knockouts
 - .2 Potheads
 - .3 Junction boxes
 - .4 Bushings

DRY TYPE TRANSFORMERS

- .5 Clamping rings
- .6 Entry for cable.
- .4 Designed for wall mounting.
- .5 Outdoor, ventilated, self cooled type, CSA 1 enclosure, mounted inside Power Distribution Enclosure (DP-L11).

2.4 Voltage Taps

- .1 Standard

2.5 Tap Changer

- .1 Bolted-link type

2.6 Windings

- .1 Primary and secondary coils:
 - .1 Copper
- .2 Coil and core assembly:
 - .1 Taps located at front of coils for accessibility
- .3 Sound level: not to exceed 60 dB.

2.7 Accessories

- .1 Winding temperature detector relay and sensing elements with one set of SPDT contacts.
- .2 Wiring and terminal box for protective devices.
- .3 Grounding terminal: outside of enclosure.

2.8 Equipment Identification

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

3. EXECUTION

3.1 Installation

- .1 Locate, install and ground transformer[s] in accordance with Manufacturer's instructions.
- .2 Set and secure transformers in place, rigid plumb and square.

DRY TYPE TRANSFORMERS

- .3 Connect primary terminals to high voltage circuit.
- .4 Connect secondary terminals to secondary cable.
- .5 Use flexible conduit to make connections to transformer.
- .6 Energize transformers and check secondary no-load voltage.
- .7 Adjust primary taps as necessary to produce rated secondary voltage at no-load.
- .8 Wire one (1) set of contacts on winding temperature detector relay to PLC located in pump control panel, LCP-L911.
- .9 Use torque wrench to adjust internal connections in accordance with Manufacturer's recommended values.
- .10 Check transformer for dryness before putting it into service and if it has not been energized for some considerable time.

3.2 Field Quality Control

- .1 Perform tests in accordance with Section 16980 – Testing, Adjusting and Balancing of Electrical Equipment and Systems.
- .2 Energize transformers and apply incremental loads:
 - .1 0% for 4 h
 - .2 10% for next 1 h
 - .3 25% for next 2 h
 - .4 50% for next 3 h
 - .5 Full load
 - .6 At each load change, record temperatures for ambient and enclosure

END OF SECTION

DISTRIBUTION PANELBOARDS

1. GENERAL

1.1 Description

- .1 Provide panelboards for 347/600 V and 120/208 V branch circuit distribution as indicated on schedules shown on the Drawings, complete with all items listed.
- .2 Construct panelboards to CSA Standards, apply CSA approval labels.
- .3 Panelboards to be manufactured by Eaton Cutler Hammer, Schneider or Siemens.
- .4 To be read in conjunction with Section 16471 – Panelboards.

1.2 Shop Drawings and Product Data

- .1 Submit Shop Drawings on all panelboards, switchboards and CDPs in accordance with Section 01300 – Submittals.
- .2 Drawings to include electrical details of panel, branch breaker types and ratings, bussing type and rating and enclosure type and dimensions

2. PRODUCTS

2.1 Materials

- .1 Tub: CSA code gauge galvanized steel, reversible top and bottom, finish painted ANSI 61 grey enamel or as specified in Section 16010 – Electrical General Requirements.
- .2 Mains: Copper, ampere ratings as shown, solderless lug connectors sized for cables in panels without main breakers, bolt-on connectors for all main breakers and branch circuit breakers.
- .3 Neutral Bars: Same ampere ratings as mains, solderless lugs for connections.
- .4 Front shields to cover breaker assembly and neutral bars, leaving wiring gutters accessible when fronts removed.
- .5 Front Covers, Doors: CSA code gauge galvanized steel, with doors, concealed hinges, combination locks and latches, interior plastic covered circuit directory cardholders, concealed mounting screws, finish painted, same size as tubs where surface mounted, overlapping trim with wall gaskets where flush mounted.
- .6 Locks, Keys: All locks to be keyed alike.
- .7 Branch Circuit Breakers: Thermal magnetic with "ON", "OFF" and "TRIPPED" positions, single, two, and three pole as shown; ampere ratings as shown; bolt-on line connections, solderless lug load connections; common trip for two and three pole; rated 240 V 10,000 A symmetrical short circuit interrupting capacity in 120/208 V panelboards; rated 600 V,

DISTRIBUTION PANELBOARDS

22,000 A, symmetrical short circuit interrupting capacity in 347/600 V panelboards, unless otherwise indicated.

- .8 Spaces: Stamp out spaces, install removable fillers where breaker spaces are shown.
- .9 Ground Fault Circuit Interrupters: Install breakers having both 5 ma ground fault sensitivity and over current protection, of the amperage rating indicated, in the panelboards, where required. Wire each ground fault breaker with a separate neutral conductor wired through the interrupter to the ground bus.

3. EXECUTION

3.1 Mounting

- .1 Mount panel boards inside of main power distribution cabinet.

3.2 Wiring

- .1 Install branch circuit wiring in neat bundles at sides of wiring gutters, with wires to branch breakers horizontal.

3.3 Identification

- .1 Provide lamacoid plate securely and permanently attached to the exterior of each panelboard door showing panelboard designation, voltage, and source of feed.
- .2 For all ground fault breakers, provide a sign indicating that circuits are so protected and that equipment should be tested regularly.

3.4 Branch Circuit Directory

- .1 Provide typed directory identifying all branch circuits. Directory to indicate device and location.

3.5 Locking Straps

- .1 Locking Straps: To permit automatic tripping of breakers but prevent manual switching, for exit lights, receptacles feeding emergency battery packs, fire alarm panels and where designated.

3.6 Keys

- .1 Provide three (3) keys.

END OF SECTION

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

1. GENERAL

1.1 Description

- .1 Supply and Install disconnect switches for 347/600 V and 120/208 V distribution as indicated on the Drawings, as manufactured by Eaton Cutler Hammer, or Schnieder.

1.2 Shop Drawings

- .1 Submit Shop Drawings in accordance with Section 01300 – Submittals.
- .2 Provide data for various sizes and types to be used.

2. PRODUCTS

2.1 Disconnect Switches

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

2.2 Fuses

- .1 All fuses to be 100,000A (minimum) interrupting capacity of the current limited type. In addition, fuses feeding motors to be of the time delay type.

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

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 Fuse Rating: Install so that rating is visible.
- .4 Identification: Provide lamacoid plate in accordance with Section 16010 – Electrical General Requirements, on each switch showing voltage, source of supply and load being fed.
- .5 Example:
 - .1 Mixer MX-05A-161
 - .2 600 V
 - .3 Fed from MC-06A-901

END OF SECTION

DRY TYPE TRANSFORMERS UP TO 600 V PRIMARY

1. GENERAL

- .1 Provide enclosed dry type transformers 600 V primary to 120/208 V.
- .2 Product Data - Single Phase, Three Wire Secondary
 - .1 Submit product data in accordance with Section 16010 – Electrical General Requirements.
- .3 Transformers to conform to CSA C57.12 and L2 standards, and are to be approved to CSA Code Part 2, Standard C22.2, No. 47 and CSA C9.

2. PRODUCTS

2.1 Transformers

- .1 General: Dry type, air cooled, self ventilated. Enclosures to be EEMAC-1 type, code gauge steel, complete with ventilating openings, access panels, mounting brackets, and solderless primary and secondary cable connectors. Enclosures to have zinc chromate prime coat and enamel finish coat per Section 16010 – Electrical General Requirements. Transformers to be single or three phase as noted on the Drawings. Dry type transformers shall be Square D, FPE, Cutler-Hammer or approved equivalent.
- .2 Design:
 - .1 Type: ANN
 - .2 1 phase, 5, 600 V input, 120/240 V output, 60 Hz.
 - .3 Voltage primary taps: 2.5% Full capacity above and below normal
 - .4 Insulation: Class 220
 - .5 Basic Impulse Level (BIL): 10 kV B.I.L
 - .6 Hipot: 4 kV
 - .7 Average Sound Level: 45 dB
 - .8 Impedance at 170°C: 6.0% max.
 - .9 Enclosure: EEMAC 1, removable metal front panel
 - .10 Mounting: suitable for wall mounting
 - .11 Finish: In accordance with Section 16010 – Electrical General Requirements

DRY TYPE TRANSFORMERS UP TO 600 V PRIMARY

- .12 Max. Winding Temperature: 150°C rise with temperature continuous full load
- .13 Max. Lead Connection: 55°C rise with temperature continuous full load
- .14 Copper windings

2.2 Equipment Identification

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

3. EXECUTION

3.1 Installation

- .1 Mount dry type transformer inside Power Distribution Enclosure (DP-L11).
- .2 Ensure adequate clearance around transformer for ventilation.
- .3 Install transformers in level upright position.
- .4 Remove shipping supports only after transformer is installed and just before putting into service.
- .5 Loosen isolation pad bolts until no compression is visible.
- .6 Make primary and secondary connections in accordance with wiring diagram.
- .7 Record secondary voltage when transformers are carrying approximately 75% of full load. Adjust tap connections to give a continuous secondary voltage of 120 V phase to neutral. Set tap connections for above 120 V rather than below.
- .8 Connections to transformers shall be in flexible conduit and shall enter the enclosure below the coils.
- .9 Before energization, keep transformers or storage room enclosures above 10°C ambient.

END OF SECTION

PANELBOARDS - BREAKER TYPE

1. GENERAL

1.1 Shop Drawings

- .1 Submit Shop Drawings in accordance with Section 01300 – Submittals.
- .2 Drawings to include electrical detail of panel, branch breaker type, quantity and ratings and enclosure type and dimensions.

2. PRODUCTS

2.1 Panelboards

- .1 Panelboards: product of one (1) 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.
- .2 208 or 600 V panelboards: bus and breakers rated for symmetrical interrupting capacity or as indicated.
- .3 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.
- .4 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.
- .5 Two (2) keys for each panelboard and key panelboards alike.
- .6 Copper bus with neutral of same ampere rating as mains.
- .7 Mains: suitable for bolt-on breakers.
- .8 Trim with concealed front bolts and hinges.
- .9 Trim and door finish: baked grey enamel.

2.2 Breakers

- .1 Breakers: 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.
 - .1 Lock-on devices for breakers as indicated.

PANELBOARDS - BREAKER TYPE

2.3 Equipment Identification

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

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 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 01300 – Submittals.
- .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 Provide circuit breakers with interchangeable trips as indicated.
- .5 For breakers 400 A and larger, provide with solid state LSIG electronic trips.

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 Magnetic Breakers

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

2.4 Solid State Trip Breakers

- .1 Moulded case circuit breaker to operate by means of a solid-state trip unit with associated current monitors and self-powered shunt trip to provide inverse time current trip under overload condition, and long time, short time, instantaneous tripping for phase and ground fault short circuit protection.

MOULDED CASE CIRCUIT BREAKERS

2.5 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.
- .2 Identification: In accordance with Section 16010 – Electrical General Requirements, provide lamicaid plate on each breaker showing voltage and load being fed. Example - Transformer TX-05A-902.

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. Provide a unit compatible with non-linear loads, providing 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. Utilize non-linear voltage dependent metal oxide varistors or selenium cells. For the suppression system's components, do not utilize gas tubes, spark gaps, or silicon avalanche diodes. Refer to the device as a TVSS filter for the purpose of this Specification and Drawings.

1.3 Shop Drawings and Product Data

- .1 Submit Shop Drawings in accordance with Section 01300 – Submittals.
- .2 Provide mounting details, dimensions, wiring diagrams and ratings for each type.

2. PRODUCT

2.1 Operation and Environment

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

2.2 Suppression Component

Peak surge Current per Phase	240,000 A	(Main entrance panel applications)
	120,000 A	(Branch Panel Applications)
	30,000 A	(Plug-in / Cord -- connected individual equipment protection)

POWER SURGE PROTECTORS

Let Through Voltage (L-N)	120 V (individual equipment units)	330 V
	208 V Units	500 V
	600 V Units	1200 V
TVSS clamping components response time	< 1 nanosecond	

2.3 Filtering

- .1 TVSS: contain a high frequency extended range tracking filter.
- .2 Noise attenuation ≥ 45 dB @ 1`00 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: copper, tin plated main bus.
- .2 Circuit Breakers: over center toggle mechanism type which use bolt-on connectors to line side panelboard connectors.
- .3 Panelboard Enclosure: Provide the panelboard in an EEMAC 1 enclosure. Configure the TVSS/filter status indicators to be visible without the need to open the panelboard door. Provide a lockable door to limit access to authorized personnel only. Make trim assembly tamper proof. Finish the trim (doors) in grey ASA61 paint.
- .4 Neutral Bus: Equip with a copper 100% rated neutral bus, including a sufficient quantity at solderless type lugs to service the total unit circuit capacity.
- .5 Wiring Gutters: Equip the integrated TVSS filtering panel 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: Provide the integrated filter panel with a safety and insulated/isolated ground bus equipped with solderless type lugs of quantity to sufficiently service the circuit loads.

2.5 Individual Equipment Protection - Plug In

- .1 Incorporate an appropriately rated ULC listed thermal-magnetic molded case main circuit breaker.
- .2 Input Cord/Plug: Equip with an appropriately rated 1800 mm power cord and NEMA twist-lock or straight blade plug as required.

POWER SURGE PROTECTORS

- .3 Output Receptacles: Equip with two NEMA 5-15R duplex receptacles. Equip with up to six (6) appropriately rated NEMA twist-lock or straight blade receptacles as specified. Provide a unit with the capacity to accommodate large modern transfer plugs.
- .4 Enclosure: Provide in a NEMA 1 type enclosure, painted inside and out.

2.6 General Features

- .1 Factory install the integrated TVSS panel and connect to the bus bar.
- .2 Connectors: Provide terminals for all the necessary input and output power and ground connections on the TVSS.
- .3 Enclosure: Provide the specified system in a heavy duty NEMA 12 dust tight enclosure with no ventilation openings for maintenance and branch panel applications. Ensure indication of surge current module status is visible without opening the door.
- .4 Internal Connections: Make all surge current diversion connections by way of low impedance wiring. Wire surge current diversion components for reliable low impedance connections. Do not use plug-in component modules, quick disconnect terminals or printed circuit boards in surge suppression paths.
- .5 Unit Status Indicators: Provide red status indicators on the hinged front cover to indicate unit phase status. Take the absence of the red light to reliably indicate that one or more surge current diversion phases have failed and that service is needed to restore full operation.
- .6 Fuses: Utilize internal fuses rated with a minimum interrupting capability of 2000,000 A or greater.
- .7 Identification: Include Manufacturer's nameplate, ULC rating, and a CSA approval on the exterior enclosure.
- .8 Warranty: Manufacturer to provide a five (5) year warranty on the TVSS filter, a two (2) year warranty on the panelboard and circuit breakers, and a two (2) year warranty on individual equipment plug-in units, all commencing upon construction completion.
- .9 Testing: Include assurance checks, "Hi-Pot" test at two times rated voltage plus 1000 V per ULC requirements, and operation and calibration tests.

2.7 Approved Manufacturers

- .1 Current Technologies
 - Main panel application Model MP
 - Branch panel application Model DPA
 - Integrated TVSS panel Model EGP
 - Individual Equipment Protection

POWER SURGE PROTECTORS

- .2 Liebert Corporation
 - Main panel applications Model LCG-C3
 - Branch panel applications Model LCG-C2
 - Integrated TVSS panel Model LPG
- .3 Tycor International Corporation
 - Main panel applications Model PTY-HE
 - Branch panel applications Model PTY-SA
 - Individual Equipment Protection
- .4 Schnieder/Square D Model IMA
- .5 Siemens Model TPS-6

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. Twist input conductors to the TVSS together to reduce impedance during high frequency filtering.
- .2 Install an appropriately sized manual safety disconnect before and in line with the TVSS from the electrical service for the purpose of electrically isolating the device from the system should service be required without interrupting the main service. Coordinate required disconnect ampacity with TVSS Manufacturer.
- .3 The TVSS should follow the manufacturer's recommended practices as outlined in the Manufacturer's installation and Maintenance Manual and in compliance with all applicable electrical codes.
- .4 Install individual equipment protection devices at the same voltage rating as the intended protected equipment and as close as possible to the intended protected equipment.

END OF SECTION

AUTOMATIC LOAD TRANSFER EQUIPMENT

1. GENERAL

1.1 References

- .1 CAN3-C13, Instrument Transformers
- .2 CAN3-C17, Alternating-Current Electricity Metering
- .3 ANSI/NEMA ICS 2, Industrial Control Devices, Controllers, and Assemblies
- .4 UL 1008 - Standard for Automatic Transfer Switches
- .5 IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
- .6 NEMA Standard ICS10-1993 (formerly ICS2-447) - AC Automatic Transfer Switches

1.2 System Description

- .1 Automatic load transfer equipment which is electrically operated, mechanically held to:
 - .1 Monitor voltage on all phases of normal power supply.
 - .2 Transfer load from normal supply to alternate supply on normal power failure or abnormal voltage on any one phase below preset adjustable limits for adjustable period of time.
 - .3 Transfer load from alternate supply to normal power supply when normal power restored, confirmed by sensing of voltage on all phases above adjustable pre-set limit for adjustable time period.

1.3 Shop Drawings

- .1 Submit shop drawings in accordance with Section 13000 – Submittals.
- .2 Include:
 - .1 Make, model and type
 - .2 Single line diagram showing controls and relays
 - .3 Description of equipment operation including:
 - .1 Automatic transfer to alternate supply and back to normal power
 - .2 Test control
 - .3 Manual control

AUTOMATIC LOAD TRANSFER EQUIPMENT

1.4 Operation and Maintenance Data

- .1 Provide operation and maintenance data for automatic load transfer equipment for incorporation into manual specified in Section 01730 – Operation and Maintenance Manuals.
- .2 Detailed instructions to permit effective operation, maintenance and repair.
- .3 Technical data:
 - .1 Schematic diagram of components, controls and relays
 - .2 Illustrated parts lists with parts catalogue numbers
 - .3 Certified copy of factory test results

1.5 Source Quality Control

- .1 Complete equipment, including transfer mechanism, controls, relays and accessories factory assembled and tested.
- .2 Tests:
 - .1 Operate equipment both mechanically and electrically to ensure proper performance.
 - .2 Check selector switch, in all modes of operation Test, Auto, Manual and record results.
 - .3 Check voltage sensing and time delay relay settings.
 - .4 Check:
 - .1 Automatic transfer of load on failure of normal power
 - .2 Retransfer of load when normal power supply resumed

2. PRODUCTS

2.1 Mechanically Held Transfer Switch

- .1 The transfer switch shall be electrically operated and mechanically held. The electrical operator shall be a momentarily energized, single-solenoid mechanism. Main operators which include overcurrent disconnect devices, linear motors or gears shall not be acceptable. The switch shall be mechanically interlocked to ensure only two possible positions, normal or emergency.
- .2 The switch shall be positively locked and unaffected by momentary outages, so that contact pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life.

AUTOMATIC LOAD TRANSFER EQUIPMENT

- .3 All main contacts shall be silver composition.
- .4 Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. All stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.
- .5 Neutral conductors are to be solidly connected as shown on the plans; a copper neutral conductor plate with fully rated pressure connectors shall be provided.

2.2 Microprocessor Controller

- .1 The controller's sensing and logic shall be provided by a single built-in microprocessor for maximum reliability, minimum maintenance, and the ability to communicate serially through an optional serial communication module.
- .2 A single controller shall provide twelve selectable nominal voltages for maximum application flexibility and minimal spare part requirements. Voltage sensing shall be true RMS type and shall be accurate to 1% of nominal voltage. Frequency sensing shall be accurate to 0.2%. The panel shall be capable of operating over a temperature range of -20 to +60°C and storage from -55 to +85°C.
- .3 The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance. Sensing and control logic shall be provided on multi-layer printed circuit boards. Interfacing relays shall be industrial grade plug-in type with dust covers. The panel shall be enclosed with a protective cover and be mounted separately from the transfer switch unit for safety and ease of maintenance. The protective cover shall include a built-in pocket for storage of the operator's manuals.
- .4 All customer connections shall be wired to a common terminal block to simplify field-wiring connections.
- .5 Source status screens shall be provided for both normal and emergency to provide digital readout of voltage on all three phases, frequency, and phase rotation.

2.3 Enclosure

- .1 The ATS shall be furnished in a Type 1 enclosure unless otherwise shown on the plans.
- .2 All standard and optional door-mounted switches and pilot lights shall be 16 mm industrial grade type or equivalent for easy viewing and replacement. Door controls shall be provided on a separate removable plate, which can be supplied loose for open type units.

2.4 Accessories

- .1 Pilot lights to indicate switch position.
- .2 Solid neutral bar, rated: 200 A.

AUTOMATIC LOAD TRANSFER EQUIPMENT

- .3 Auxiliary relays to provide 2 N.O. contacts for switch position monitoring.
- .4 Auxiliary relay to provide 1 N.O. and 1 N.C. contacts for monitoring of phase loss, undervoltage and power fail on load side of transfer switch.
- .5 Test pushbutton (momentary contact) to simulate failure of normal power.

2.5 Equipment Identification

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

2.6 Acceptable Manufacturers

- .1 ASCO 7000 series, or approved equals.

3. EXECUTION

3.1 Installation

- .1 Locate, install, and connect transfer equipment in power distribution panel, DP-L11.
- .2 Check solid state monitors and adjust as required.
- .3 Connect two (2) transfer switch position contacts and one (1) power fail contact to PLC located in pump control panel, LCP-L911.

3.2 Field Quality Control

- .1 Perform tests in accordance with Section 16980 – Testing, Adjusting and Balancing of Electrical Equipment and Systems.
- .2 Energize transfer equipment from normal power supply.
- .3 Set selector switch in "Test" position to ensure proper transfer to alternate supply and retransfer.
- .4 Set selector switch in "Manual" position and check to ensure proper performance.
- .5 Set selector switch in "Auto" position and open normal power supply disconnect. Load should transfer to alternate supply. Allow to operate for 5 minutes, then close main power supply disconnect. Load should transfer back to normal power supply.

END OF SECTION

UNIT HEATERS

1. GENERAL (NOT USED)

2. PRODUCT DATA

- .1 Submit product data in accordance with Section 01300 – Submittals.
- .2 Product data to include:
 - .1 Mounting methods
 - .2 Physical size
 - .3 Layout and diagrams of unit heaters
 - .4 kW rating, voltage, phase
 - .5 Cabinet material thicknesses
 - .6 Finish.

2.2 Operation and Maintenance Data

- .1 Provide operation and maintenance data for unit heaters for incorporation into manual specified in Section 01730 – Operation and Maintenance Manuals.

3. PRODUCTS

3.1 Unit Heaters

- .1 Unit heater: Corrosion resistant horizontal discharge complete with adjustable louvers finished to match cabinet.
- .2 Fan type unit heaters with built-in high-heat limit protection.
- .3 Fan motor: totally enclosed, permanently lubricated ball bearing type with resilient mount. Built-in fan motor thermal overload protection.
- .4 Hangers for wall mounting.
- .5 Elements: stainless steel fintube.
- .6 Cabinet: stainless steel with brackets for wall mounting.

3.2 Controls

- .1 Built in thermostat and support controls.

UNIT HEATERS

3.3 Acceptable Manufacturers

- .1 Chromolox HD3D Series, size and voltage as indicated on Drawings.

4. EXECUTION

4.1 Installation

- .1 Mount on wall as indicated.
- .2 Supply and install NEMA 4X disconnect switch for unit heater.
- .3 Make power and control connections.

4.2 Field Quality Control

- .1 Test cut-out protection when air movement is obstructed.
- .2 Test fan delay switch to assure dissipation of heat after element shut down.
- .3 Test unit cut-off when fan motor overload protection has operated.
- .4 Ensure that heaters and controls operate correctly.

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 Supply and install three phase starters with fused 120 V control transformers and overload relays.
- .9 Supply and install all power wiring for all motors and control wiring as indicated on the Drawings.
- .10 Refer to Motor Control Equipment Schedule.

CONNECTIONS TO MECHANICAL EQUIPMENT

2. PRODUCTS

2.1 3 Phase Motor Disconnect Switches

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

2.2 120 V, 1 Phase Disconnect Switches

- .1 Manual starter without overload relay.

2.3 208 V, 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 SYSTEMS

1. GENERAL

1.1 Related Work

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

1.2 Coordination

- .1 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 Verify phase rotation at MCCs.
 - .2 Confirm motor nameplate data with motor starter heater overloads.

STARTING OF ELECTRICAL EQUIPMENT SYSTEMS

3.3 Energizing Equipment

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

END OF SECTION

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

1. GENERAL

1.1 Intent

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

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 approximately qualified Manufacturer's representatives where Site testing, adjusting, or balancing of electrical equipment or systems' performed by Manufacturer's representatives is:
 - .1 Specified, or
 - .2 Otherwise required to ensure that electrical equipment and systems are operational in full compliance with the Contract Documents

1.7 Sequencing and Scheduling

- .1 Except where otherwise specified, perform all testing, adjusting, balancing and related requirements specified herein prior to Interim Acceptance of the Work.
- .2 Perform voltage testing and adjusting after user occupancy or utilization of facility.

2. PRODUCTS

2.1 Test Equipment

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

3. EXECUTION

3.1 Testing of Wiring and Wiring Devices

- .1 All power and control wiring shall be tested for insulation resistance value with a 1000 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 Interim Acceptance of the Work, are operable.
- .2 Turn on all possible loads.
- .3 Test load balance on all feeders at distribution centres, MCCs 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 Test voltage at all elevators.
- .3 Test voltage at MCC.
- .4 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 operating and maintenance personnel with electrical systems and their operating and maintenance.
- .2 Submit system sign off sheets for each system listed prior to substantial completion.
- .3 Complete a motor survey sheet for each motor and submit prior to substantial completion. Include a control wiring diagram for each motor neatly drawn in ladder form. Indicate all terminal and wire numbers. Identify all associated control components. Provide typed copies of these lists and diagrams in the 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 appropriately qualified Manufacturer's Representatives to provide or assist in providing electrical equipment and system demonstration and instruction as specified herein.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 Systems Demonstration

- .1 Demonstrate operation of following systems:
 - .1 Primary Distribution and Transformer
 - .2 600/347 V Electrical System Emergency and Normal
 - .3 208/120 V System Emergency and Normal
 - .4 Pump Protection Panels
 - .5 Mechanical Equipment Connections and Controls
 - .6 Grounding System
 - .7 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