ELECTRICAL GENERAL REQUIREMENTS

1. GENERAL

1.1 Work Included

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

1.2 Related Work

.1 General Requirements: Division 1

.2 Site Work: Division 2

.3 Concrete: Division 3

.4 Mechanical: Division 15

1.3 Drawings and Specifications

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

1.4 Quality Assurances

.1 Codes, Rules, Permits, & Fees

.1 Comply with all rules of the Canadian Electrical Code, CSA Standard C22.1 and the applicable building codes. Do Overhead Lines in accordance with CAN/CSA-C22.3 No. 1 and Underground Systems in accordance with CAN/CSA-C22.3 No. 7 except where specified otherwise.

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

.3 Prior to installation, verify location, arrangement and point of attachment for service and service entrance equipment with supply authority and inspection departments.

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

.2 Standard of Workmanship:

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

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

1.5 Submittals

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

.2 Prior to delivery of any products to Job Site and sufficiently in advance of requirements to allow ample time for checking, submit shop drawings for review as specified in Division 1. Submit Shop Drawings for all equipment as required in each section of this Specification.

.3 Prior to submitting the Shop Drawings to the Contract Administrator, the Contractor shall review the Shop Drawings to determine that the equipment complies with the requirements of the Specifications and Drawings.

.4 Indicate materials, methods of construction and attachment of support wiring, diagrams, connections, recommended installation details, explanatory notes and other information necessary for completion of Work. Where equipment is connected to other equipment, indicate that such items have been coordinated, regardless of the section under which the adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.

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

.5 Manufacture of products shall conform to revised Shop Drawings.

.6 Keep one (1) complete set of Shop Drawings at Site during construction.

1.6 Product Handling

.1 Use all means necessary to protect the products of this Division before, during and after installation and to protect products and installed Work of all other trades.

.2 Immediately make good any damage by repair or replacement at no additional cost to the City and to the approval of the Contract Administrator.

.3 Remove advertising labels from all electrical equipment. Do not remove identification of certification labels.

.4 Remove dirt, rubbish, grease, etc. resulting from this work from all surfaces, including the inside of all cabinets, equipment enclosures, panelboard tubs, etc.

2. PRODUCTS

2.1 Quality of Products

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

.2 If products specified are not CSA approved, obtain special approval from the local regulatory authority. Pay all applicable charges levied and make all modifications required for approval.

.3 Products provided, if not specified, shall be new, of a quality best suited to the purpose required and their use subject to approval by the Contract Administrator.

2.2 AREA CLASSIFICATION

.1 Unless otherwise indicated, supply equipment enclosures, boxes, electrical materials and products suitable for ambient environment of the following areas:

Area	Gen. Classification	Area Classification
Electrical and Mechanical Rooms	Dry, clean	CSA 1
Control Rooms	Dry, clean	CSA 1
Chemicals Area	Dry, Dusty, Corrosive	CSA 4/4X
Outdoor Areas	Wet	CSA 3R, 4

2.3 Uniformity of Manufacture

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

2.4 Product Finishes

.1 Finish all cabinets, panelboards, switchboards, equipment cabinets, cable trays, etc. in ANSI 61 grey enamel unless otherwise specified.

.2 Apply primer on all items which are to be finished as part of the Work.

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

3. EXECUTION

3.1 Coordination with Other Divisions

.1 Examine the Drawings and Specifications of all Divisions and become fully familiar with their Work. Before commencing Work, obtain a ruling from the Contract Administrator if any conflict exists, otherwise no additional compensation will be made for any necessary adjustments.

.2 Lay out the work and equipment with due regard to architectural, structural, and mechanical features. Architectural and Structural Drawings take precedence over Electrical Drawings regarding locations of walls, doors and equipment.

.3 Do not cut structural members without approval of the Contract Administrator.

.4 Coordinate with all Division installing equipment and services, and ensure that there are no conflicts.

.5 Install anchors, bolts, pipe sleeves, hanger inserts, etc. in ample time to prevent delays.

.6 Examine previously constructed work and notify the Contract Administrator of any conditions which prejudice the proper completion of this work. Commencement of this work without such notification shall constitute acceptance of other Work.

3.2 Location of Outlets and Luminaires

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

.2 Outlet and equipment locations shown on the drawings are approximate. Locations may be revised up to 3 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.

3.3 Separation of Services

.1 Maintain separation between electrical wiring system and building piping, ductwork, etc. so that wiring system is isolated (except at approved connections to such systems) to prevent galvanic corrosion.

.2 In particular, contact between dissimilar metals, such as copper and aluminum, in damp or wet locations is not permitted.

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

3.4 Equipment Identification

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

NAMEPLATE SIZES

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

.1 Distribution Centres (indicate designation, bus capacity, voltage)

.2 MCC's (designation, voltage)

.3 Starters, contactors, Disconnects (designation, voltage, load controlled)

.4 Panelboard (designation, voltage, bus capacity)

.5 Automatic transfer switch (designation, voltage, rating)

.6 Terminal cabinets and pull boxes (system, voltage)

.7 Transformers (designation, capacity, primary, and secondary voltage)

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

SYSTEM	MAJOR BAND	MAJOR BAND
347/600 V Normal	Dk. Blue	
120/208 V Normal	Lt. Blue	
UPS System	Lt. Blue	White
Fire Alarm System	Red	
Telephone	Lt. Green	

.3 Provide neatly typed circuit directories in panelboards to indicate the area or equipment controlled by each branch circuit.

.4 All conductors shall be identifiable by coloured insulation and permanent markers at every terminal and accessible points throughout its entire run.

.1 Conductors:

.1 Equipment Grounding – Green

.2 Neutral Conductor – White

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

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

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

3.5 Wiring to Equipment Supplied by Others

.1 Electrical connection to City Supplied Equipment or equipment supplied by other Divisions equipment shall supplied and installed by the Contractor.

3.6 Testing

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

3.7 Instructions to City's Personnel

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

3.8 Access Panels

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

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

3.9 Mounting Heights

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

Receptacles in Mechanical Rooms 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
Computer Outlets	300 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

3.10 Sealing of Wall and Floor Openings

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

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

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

3.11 Housekeeping Pads

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

3.12 Sleeves

.1 Provide sleeves of galvanized steel pipe with machine cut ends of ample size to accommodate conduits passing through walls, partitions, ceilings, floors, etc.

.2 For wall, partitions and ceilings the ends shall be flush with the finish on both sides but for floors they shall extend 4" above finished floor level.

.3 The space between the sleeve and the conduit shall be filled with Dow Corning silicone RTV foam for fire stop and caulked around the top and bottom with approved permanently resilient, non-flammable and weatherproof silicone base compound and ensure that the seal is compatible with the floor and ceiling finishes.

.4 Locate and position sleeves exactly prior to construction of walls, floors.

.5 Failure to comply with the above requirements shall be remedied at this Division's expense.

3.13 Insulation Resistance Testing

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

.2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.

.3 Check resistance to ground before energizing.

.4 Carry out tests in presence of Contract Administrator.

.5 Provide instruments, meters, equipment and personnel required to conduct tests during and at Total Performance.

.6 Submit test results for Contract Administrator’s review.

3.14 Load Balance

.1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance. Adjust branch circuit connections as required to obtain best balance of current between phases and record changes (maximum deviation of 15%).

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

.3 Submit, by date of Substantial Performance, report listing phase and neutral currents on panelboards, dry-core transformers, and MCCs, operating under normal load. State hour and date at which each load was measured, and voltage at time of test.

END OF SECTION

SCOPE OF ELECTRICAL WORK

1. GENERAL

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

2. WORK INCLUDED

2.1 General Requirements

.1 General Clean-up.

.2 All inspection and other permits, licenses required by various Inspection Agencies and local regulations related to Electrical Trade.

.3 Special testing or inspection, additional to the above as required.

.4 Scaffolding.

.5 Shop Drawings.

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

.7 O&M Data, where specified.

2.2 Specific Requirements

.1 Installation of 4160/600 V transformers and 600 V switchgear supplied as City Supplied Equipment.

.2 Supply and installation of concrete duct banks and cabling as indicated on the Drawings.

.3 Supply and installation of cabling and ground grid for 4160/600 transformers

.4 Supply and installation of MCCs, 600 V, 120/208 V power distribution including transformers panelboards, breakers and raceways.

.5 Supply and installation all lighting, lighting controls and general power as specified herein and indicated on the Drawings.

.6 Supply and installation electrical services to the mechanical equipment as specified in Divisions 15 and 16 and as indicated on Drawings.

.7 Supply and installation of all cabling required to make a complete and operational facility.

.8 Supply and installation of two (2) complete Fire Alarm Systems for the Sodium Hypochlorite building and the Chemical Storage building as specified herein and indicated

on the Drawings. Systems shall be interconnected by fiber optic cables and shall provide communication to WTP system.

.9 Supply and installation of lightning protection system.

.10 Supply and installation of conduit stubouts at exterior door frames for future door alarm contacts.

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

.12 Control panels associated with any electrical equipment covered under this Section of Work.

.13 Grounding systems, as required by the Manitoba Electrical Code, or as otherwise specified.

.14 Motor starters of all types and for all types of applications, including combination starters, multi-speed, sequential, reversing operations, etc., unless part of Mechanical Equipment.

.15 Transformers of various types, dry, liquid filled, encapsulated etc., and for all applications, except control transformers supplied with Mechanical Equipment included in Division 15.

END OF SECTION

INSTALLATION OF CABLES IN TRENCHES AND IN DUCTS

1. GENERAL

1.1 Related Work

.1 Division 3, Concrete

2. PRODUCTS

2.1 Cable Protection

.1 Concrete encased duct bank.

2.2 Markers

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

3. EXECUTION

3.1 Direct Burial of Cables

.1 After sand bed is in place, lay cables maintaining 75 mm clearance from each side of trench to nearest cable. Do not pull cable into trench.

.2 Provide offsets for thermal action and minor earth movements. Offset cables 150 mm for each 60 m run, maintaining minimum cable separation and bending radius requirements.

.3 Underground cable splices not acceptable.

.4 Minimum permitted radius at cable bends for rubber, plastic or lead covered cables, 8 times diameter of cable; for metallic armoured cables, 12 times diameter of cables or in accordance with manufacturer’s instructions.

.5 Maintain 75 mm minimum separation between cables of different circuits. Maintain 300 mm horizontal separation between low and high voltage cables. When low voltage cables cross high voltage cables maintain 300 mm vertical separation with low voltage cables in upper position. At crossover, maintain 75 mm minimum vertical separation between low voltage cables and 150 mm between high voltage cables. Maintain 300 mm minimum lateral and vertical separation for fire alarm and control, cables when crossing other cables, with fire alarm and control cables in upper position. Install treated planks on lower cables 0.6 m in each direction at crossings.

.6 After sand protective cover is in place, install continuous row of concrete patio blocks as indicated to cover width and length of run.

3.2 Cable Installation in Ducts

.1 Install cables as indicated on Drawings in ducts.

.2 Do not pull spliced cables inside 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 Markers

.1 Mark cable every 150 m along cable or duct runs and changes in direction.

.2 Where markers are removed to permit installation of additional cables, reinstall existing markers.

.3 Lay concrete markers flat and centered over cable with top flush with finish grade.

3.4 Field Quality Control

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

.2 Perform tests using qualified personnel. Provide necessary instruments and equipment.

.3 Check phase rotation and identify each phase conductor of each feeder.

.4 Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 50 megohms.

.5 Pre-acceptance test.

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

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

.6 Acceptance Tests

.1 Ensure that terminations and accessory equipment are disconnected.

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

.3 High Potential (Hipot) Testing.

.1 Conduct hipot testing at 200% of original factory test voltage in accordance with manufacturer's or IPCEA recommendations.

.4 Leakage Current Testing.

.1 Raise voltage in steps from zero to maximum values as specified by IPCEA or 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.

.5 Provide Contract Administrator with list of test results showing location at which each test was made, circuit tested and result of each test.

.6 Remove and replace entire length of cable if cable fails to meet any of test criteria.

END OF SECTION

CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS

1. GENERAL

1.1 Work Included

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

2. PRODUCTS

2.1 Rigid Steel Conduit

.1 Galvanized with threaded joints and connections.

.2 Connections in dry locations: steel or malleable iron locknuts inside and outside enclosures. Insulated bushings Thomas & Betts Series 222 or approved equal.

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

.4 Fittings: cast metal "Condulet" as manufactured by Crouse-Hinds Canada Ltd. including gasketted covers in damp locations.

.5 Expansion joints: cast metal Crouse-Hinds type XJ or approved equal.

2.2 Rigid PVC Conduit

.1 Conduit: rigid non-metallic conduit of unplasticized PVC as manufactured IPEX. "Sceptre" Schedule 40.

.2 Fittings: threaded male or female solvent weld connectors and solvent weld couplings, as supplied by conduit manufacturer.

.3 Solvent: as recommended by conduit manufacturer.

2.3 Flexible Conduit

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

2.4 Rigid PVC Duct

.1 Duct: Rigid non-metallic conduit of unplasticized PVC Type DB-2, conforming to CSA Standard.

.2 Accessories: Bell ends, couplings, adapters, bends and other fittings of same material as duct. Use solvent recommended by manufacturer. Horizontal, vertical and foundation spacers as manufactured by Pilgrim Products Ltd.

2.5 Liquid-Tight Flexible Conduit

.1 Conduit: flexible metal conduit with liquid-tight PVC jacket. Industrial Wire & Cable "Liquiseal".

.2 Connectors: captive sealing jacket and ground cone insulated throat, steel (Thomas & Betts Ltd. "Super-Tight", Series 6000).

2.6 Zinc Fittings

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

3. EXECUTION

3.1 Rigid Steel Conduit

.1 Use as raceways for following applications:

.1 In all areas exposed to weather.

.2 Locations where mechanical damage may occur and in mechanical rooms to a height of 1 m.

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

3.2 Rigid PVC Conduit

.1 Use as raceways for following applications

.1 In poured concrete floors and walls and on underground runs exterior to the buildings unless otherwise noted.

.2 Wiring installed in areas subject to intermittent or continuous moisture but not surface mounted.

.3 Rigid PVC conduit shall not be surface mounted.

.2 Use strictly in accordance with the Canadian Electrical Code. Do not use in return air plenums and for exit and fire escape lights.

.3 Provide insulated ground wire in all rigid PVC conduits in accordance with the Canadian Electrical Code.

.4 Where rigid PVC conduit is set in poured concrete, solvent joints must be completed and allowed to set as per manufacturer's instructions.

.5 Bend rigid conduit in strict accordance with manufacturer's directions. Distorted bends will not be accepted.

3.3 Flexible Conduit

.1 Use as raceways for following applications:

.1 Connections to fhp motors in dry locations.

.2 Flexible connections to luminaires.

.2 Provide a separate insulated ground wire in all flexible conduits.

3.4 Rigid PVC Duct

.1 Provide a separate green insulated copper ground wire in all ducts sized as required by the Code.

.2 Arrange ducts in a horizontal layer separated by plastic spacers to provide spacing between duct centres, as shown on the Drawings.

.3 Support duct bank on plastic spacers to maintain 190 mm center to center spacing of ducts. Foundation spacers to maintain at least 200 mm clearance between ducts and exterior coverage.

.4 Make joints with tapered couplings to provide a secure watertight connection. Stagger all joints to provide 200 mm vertical and horizontal clearance between adjacent couplings. Where needed, use factory bends to provide bends of radius required.

.5 When all ducts are installed, brace whole assembly at each spacer group to prevent duct floating when concrete is placed.

.6 Terminate ducts with standard bell ends where ducts enter cable pits, junction boxes and building interiors.

.7 Cap ends of unused ducts with plug ends of same material as ducts.

.8 Seal all joints in ducts with solvent cement.

.9 Install Roxtek seals inside conduits where ducts enter cable pits, junction boxes and building interiors

3.5 Liquid-Tight Flexible Conduit

.1 Use as raceways for following applications:

.1 At all motors, pipe mounted control devices, and other devices subject to movement or water.

.2 At all motors provide a short length before connecting to the motor terminal box. Minimum length shall be 450 mm plus 4 times the conduit diameter.

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

3.6 Corrosion Control (Special Application)

.1 In wet locations fittings, outlet boxes, junction boxes, rack members, clamps and fasteners shall be zinc or cadmium plated. All threads shall be completely coated.

.2 In the containment areas all exposed conduit, couplings and straps shall be corrosion resistant epoxy-polyester coated Columbex Green Guard II or equivalent.

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

3.7 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.

.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 of moisture during construction. Swab out conduit and thoroughly clean internally before wires and cables are pulled.

.15 Take extreme care in reaming ends of all conduit to ensure a smooth interior finish that will not damage the insulation of the wires.

.16 Use insulated non-metallic bushings on all conduit terminations.

.17 Ensure electrical continuity in all conduit systems.

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

.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

CABLE TRAYS

1. GENERAL

1.1 Description

.1 Provide a complete system of cable trays as shown on the Drawings complete with all supports and hangers and seismic bracing necessary for the installation.

.2 Coordinate the location of the support channels so as not to interfere with other services.

1.2 Shop Drawings and Product Data

.1 Submit Shop Drawings and product data in accordance with Section 01300 – Submittals.

.2 Indicate various types of cabletroughs with terminology used in Part 2.

.3 Prior to construction, submit design drawings and calculations indicating all tray loading and seismic support designs have been reviewed by and bear the stamp of a Professional Engineer registered in the Province of Manitoba.

2. PRODUCTS

2.1 Cabletray

.1 All power trays shall be rigid aluminum ladder type, Class E to CSA C22.2 No. 126 with 300 mm rung spacing, 150 mm side rails and width as indicated on Drawings.

.2 All I&C trays to be rigid aluminum ventilated, Class E to CSA C22.2 No. 126, 150 mm side rails and width as indicated on Drawings.

.3 Horizontal elbows, end plates, drop outs, vertical risers and drops, tees, wyes, expansion joints, reducers and other fittings where required. Field fabricate only those fittings not available from manufacturer.

.4 Provide stainless steel rod hanger clamps, rod hangers, wall mounting support brackets and all necessary accessories for complete installation.

.5 Barriers where different voltage systems or electrical systems are in the same cabletrough, or as indicated.

.6 Approved manufacturers: Pilgrim, Unitray, B-Line, Comtray, Canstrut, ElectroTray.

.7 Unless otherwise approved by the Contract Administrator, provide cabletrays of the same manufacturer throughout the Work

2.2 Supports

.1 Provide stainless steel rod hangers, rod hanger clamps and accessories as required.

.2 Wall mounted support brackets: Provide aluminum channel strut supports mounted vertically in concrete wall complete with mounting brackets sized to suit cabletray width and loading.

3. EXECUTION

3.1 Installation

.1 Suspend cabletrays on rod hangers and hanger clamps or channels spaced as required by loading classification rating and not more than 3000 mm on centers. Fasten hangers to channels securely mounted to the structure and provide seismic restraint as required.

.2 Install trays and raceways generally as indicated on Drawings. Coordinate this Work with the other trades to ensure adequate horizontal and vertical clearances.

.3 Provide minimum vertical clearance above the trays as indicated on the Drawings.

.4 Provide minimum 600 mm horizontal clearance on one side of cabletray throughout.

.5 All trays are shown diagrammatically on the Drawings. Determine the exact location in the field. Install tray runs to prevent interference with process or service piping and ducting and to maintain clearance for tray access. Coordinate the exact location of tray supports and runs with the work of other Divisions. The electrical building crawl space requires extensive cable trays. Refer to the Drawings and isometric views to identify the multiple vertical layer of trays required.

.6 Do not install tray routes and tray supports until the location of same has been reviewed by the Contract Administrator.

.7 Install tray systems in such a manner as to conserve head-room and minimize the use of free space through which they pass. Maintain a minimum 2100 mm clear head-room wherever possible.

.8 Run trays parallel to building lines unless otherwise shown on the Drawings. A tray in tunnel areas to run parallel with the ceiling lines as the floor is graded for drainage. Where two or more trays run the same route, make parallel and ensure offsets and bends are uniform.

.9 When the ends on Unistrut type shelf brackets are below 2100 mm AFF in a walking area, cut flush with tray. Permanently cap the end of Unistruts, etc. with plastic caps. Suitably protect sharp corners and edges of tray to prevent personal hazard.

.10 Use beam clamps to fasten support systems to structural steel. Do not weld, drill or cut structural steel without approval by the Contract Administrator.

.11 Where hanger rods are used, use stainless steel and not be smaller than 12 mm in diameter.

.12 Extend a stranded #2/0 tin plated bare copper ground conductor the length of each power tray route, and solidly connect sections of tray runs to the ground bus of the electrical room.

Connect ground conductor to tray every 15 m with approved grounding clamps. Provide a #6 tin plated copper ground conductor in the instrumentation trays, or where instrumentation tray runs are parallel to power tray, bond instrumentation tray to power tray ground every 15 m.

.13 Generally run cables of different voltage classes in separate trays. Where a common tray is shown on Drawings, separate the cables for different voltage classes from each other by metal barriers as supplied by the tray Manufacturer.

.14 Check all trays for surface smoothness prior to installation and remove all burrs, ridges, etc. on tray surfaces facing cables.

.15 Size cabletrays as indicated on Drawings. If any discrepancies are found or changes in tray size are required, advise the Contract Administrator before installing the tray.

3.2 Cables in Cabletray

.1 Install cables individually.

.2 Lay cables into cabletray. Use rollers when necessary to pull cables.

.3 Secure cables in cabletrough at 5 m centers, with nylon ties.

.4 Identify cables with nameplates in accordance with Section 16010 – Electrical General Requirements.

.5 Mark power and communication runs in accordance with colour coding outlined in Section 16010 – Electrical General Requirements.

END OF SECTION

BUSWAYS

1. GENERAL

1.1 Description

.1 Provide a complete system of CSA certified cable bus as shown on the drawings.

.2 Coordinate the location of the support channels so as not to interfere with other services.

1.2 Shop Drawings and Product Data

.1 Submit shop drawings and product data in accordance with Section 01330 – Submittals.

.2 Indicate in detail exact routing of busways, from the transformer secondary to the switchgear located in the building, in relation to column lines and structural slabs and walls. Provide voltage drop test results for each size of busway.

.3 Provide shop drawings for fire stop systems, supports,

2. PRODUCTS

2.1 General

.1 Feeder cable bus to be complete system of cable, lugs, seals, frestops, termination kits, supports, ventilated enclosure. .

.2 Full capacity neutral.

.3 Line to line voltage drop not exceeding 1.5 V per 30 m at rated current with concentrated load at one end at any system power factor.

2.2 Cable

.1 Copper, sized for the ratings indicated

2.3 Ratings

.1 Cablebus to be rated 347/600 V, three phase, four conductor with full capacity neutral,. Brace assembly to withstand 100 kA symmetrical three phase, 60 Hertz, short circuit at 600 V. Ampere ratings of busway to be as indicated on drawings. If busway has different ampere rating when mounted vertically or horizontally, use the lower rating and provide same duct and bus bar size for horizontal and vertical installation. Busway minimum ratings must equal ratings indicated. Select busway design to reduce electrical impedance. Voltage drops at 95% power factor to be in accordance with manufacturer's data sheets at the time of tender.

2.4 Ground

.1 Supply and Install a continuous ground in all feeder distribution busway sections to provide low impedance ground path. Ground shall be 4/0 green insulated copper

conductor. Bond to enclosure at required intervals using lug suitable for copper to aluminum connection.

2.5 Fire Barriers

.1 At all locations where cablebus pass through fire retarding walls or floors, provide approved fire barriers sealing busway penetrations.

2.6 Fittings

.1 Supply and Install complete system of fittings for cablebus installation, including:

.1 Transformer tap-offs.

.2 Flanged throats for connection to switchboards.

.3 Tee and angle fittings, tap-off boxes, end caps, elbows, reducers and offsets.

.4 Busway clamp hanger frames.

2.7 Hangers and Supports

.1 Supply and Install a complete system of hangers and supports, generally as indicated on drawings or required for installation shown. Use busway clamp hanger frames to clamp to busway. Provide light field welded angle iron brackets to transfer weight of busway to building structure. Use columns as shown on structural drawings to hold vertical supports across transformer yard. Spacing of supports to be as shown on drawings and as required by CSA Code. For vertical riser busways, provide brackets to transfer weight of busway to building structure at each support.

2.8 Finish

.1 Clean and de-scale all metal parts. Apply a zinc-chromate prime coat and two coats of spray enamel to exterior and interior surfaces as per Section 16010 - Electrical General Requirements. Use galvanized or corrosion resistant bolts for all bolted connections.

2.9 Main Service Feeder Cablebus

.1 Supply and Install low impedance cable bus from transformer secondary throat connections to main secondary switchboard. Match busway flanges to transformer and switchboard flanges.

2.10 Approved Manufacturers

.1 MPHuskey

3. EXECUTION

3.1 Installation

.1 Before manufacture, field measure all critical and non-standard lengths of busway. Do not scale from drawings. Install all off-sets, corners and elbows to suit job conditions.

.2 Provide all necessary miscellaneous fittings space hangers and brackets. Provide a complete system of independent support for all busway runs. Connect from supports to busway clamp hanger fittings. Space hangers in accordance with manufacturer's recommendation, maximum spacing 3 m.

.3 Torque bolts in accordance with Manufacturer's recommendations. Record torques and advise Contract Administrator in writing. Re-torque all connections after no more than six (6) months after energizing and report to Contract Administrator in writing.

.4 Cover busway with plastic envelope until building is clean and bus ready to be meggered and energized.

.5 Connect all busway sections in the presence of Contract Administrator and have readings approved before energizing.

.6 Provide lamicoid plate identification on outside of busway covers. Install identification plates wherever busways enter or leave an area, but do not duplicate identification, if identification at one location is sufficient. Show busway designation, voltage and source of feed:

.7 Locate expansion joints as shown on the drawings.

.8 Coordinate concrete curbed slots at all points the busways passed through floors.

.9 Install all fire barriers where required.

END OF SECTION

HV POWER CABLES & 8 KV SHIELDED CABLE TERMINATIONS

1. GENERAL

1.1 Description

.1 Complete supply, installation, and termination of 4160 V power cables with 8 kV insulation rating.

1.2 Codes and Standards

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

2. PRODUCTS

.1 Armoured Cables.

.1 The Armoured Cables shall have the following characteristics:

.1 Approved by CSA or other recognized Certification Organization in Canada.

.2 Three soft drawn, bare, Class B compact or compressed stranded copper conductors sized as indicated per ASTM.

.3 Conductor Shield: Extruded thermosetting semiconducting shield which is free stripping from the conductor and bonded to the insulation.

.4 Insulation Rating: 90°C rating, 133% insulation level.

.5 Insulation Shield: Extruded thermosetting semiconducting shield with controlled adhesion to the insulation providing the required balance between electrical integrity and ease of stripping.

.6 Metallic Shield: Helically applied non-magnetic uncoated copper tape over the insulation shield with a maximum 15% gap.

.7 Assembly: Three conductors shall be twisted together with fillers and soft drawn, bare copper bonding conductors and covered with a binder tape

.8 Sunlight resistant PVC jacket tightly applied over the binder tape

.9 Flexible AIA applied over the inner jacket for mechanical protection.

.10 Low-temperature, sunlight-resistant PVC jacket applied over the armour.

.11 Short circuit rating 60 kA, 1 cycle; 14 kA, 30 cycles.

.12 90°C normal, 130°C emergency rating, 250°C short circuit rating.

.2 The Armoured Cables shall be Prysmian 8 kV 3/C Armortek or approved equal.

2.2 Termination

.1 Coldapplied, silicone rubber termination qualified to IEEE 48-1996, designed for indoor and outdoor applications

.2 Use silicone molded skirts on outdoor applications

.3 Prysmain Elasticfit, or approved equal

3. EXECUTION

3.1 Cables General

.1 Do not splice cables. A continuous length is required for all feeds.

.2 Submit certified Manufacturer's data sheets.

3.2 Receiving/Handling Cable

.1 Visually inspect cable reels for any damage that may have occurred in transit.

.2 Visually check each reel to insure that it has the proper tags and labels as described in the Specifications.

.3 Handling of Cable Reels. When moving cable reels, care should be taken to insure that material handling equipment does not come in contact with cable surfaces or with protective covering on the reel. Under no circumstances should cable reels be dropped from any height, or be allowed to roll uncontrolled.

.4 Storage of Cable Reels. Where possible, cable reels are to be stored indoors on a hard, dry surface to prevent deterioration of the reels and possible ingress of moisture into the cables. Cable reels stored outdoors must be supported off the ground and covered with a suitable weatherproof material.

3.3 Installation

.1 Install in accordance with Manufacturer's recommendations, observing requirements for minimum bending radius and pulling tensions.

.2 Clearing Duct. Using a plug approximately the same diameter as the inside of the duct, clear all burrs and obstructions in the duct or conduit by pulling the plug through the structure. Follow with a wire brush and swab to clean and remove foreign matter from the duct.

.3 Rack/Trays. Check the entire path that the cable will follow during pulling to make sure that the cable will ride free and clear of all obstructions, sharp edges or projections which might cause it to jam or be damaged in passage.

.4 Cable Pulling and Cable Guides. To avoid abrasion and damage of the cable jacket when guiding the cable from the reel to the duct mouth or trench, all guides shall be in the form of large diameter, smooth-surfaced, free-turning sheaves or rollers.

.5 Maximum Pulling Tensions. Pulling tensions for installing electrical cables should be maintained as low as possible to prevent damage to the cable. Follow Manufacturer recommendation.

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

3.4 Terminations

.1 Follow Manufacture’s recommended installation procedures.

.2 Remove the insulation to fit the connector. Avoid nicking the conductor strands. Remove enough insulation to allow crimp connectors to “grow” without pushing into insulation. Follow connector Manufacturer’s instructions for use of oxide inhibiting compounds, crimp tools, dies, etc.

.3 Thoroughly read Manufacturer’s instructions before beginning installation, taking note of any special requirements. Make sure that the dimensions for cable prep are for the appropriate voltage class. Make sure that the connectors used are appropriate for the application (suitable for use on copper, sealed lugs if outdoor, length, tapered, if required, etc.) and that the proper crimp tool (and dies, if needed) is available.

.4 Clean the cable jackets to the specified distance. To eliminate the risk of damaging the underlying metallic shield, do not cut completely through the jacket. Instead, ring cut through at least 50% of the material and tear off the remainder.

.5 Metallic Shields. Remove the metallic shield to the specified distance. Consult instructions prior to bundling.

.6 Semiconductive Layer. Remove the extruded semiconductive layer. Any nick through this layer into the insulation shall be sanded out or discharge will occur and could lead to failure.

.7 Cleaning Solvents. Solvents should be used with lint-free cloths. Do not pour solvents directly onto cable insulation. Read solvent Manufacturer’s instructions thoroughly.

.8 Install compression connectors using tools provided by the connector Manufacturer in accordance with the Manufacturer's recommendations.

3.5 Tests

.1 The Contractor shall test cables prior to energization, as follows:

.1 Megger

.2 VLF Highpot

END OF SECTION

WIRES AND CABLE 0-1000V

1. GENERAL

1.1 Work Included

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

1.2 References, Codes and Standards

.1 CSA C22.2 No. 0.3, Test Methods for Electrical Wires and Cables.

.2 Install and rate power cables in accordance with the Canadian Electrical Code requirements or in accordance with ICEA requirements where permissible.

1.3 Product Data

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

2. PRODUCTS

2.1 Building Wires

.1 Minimum conductor size #12 AWG.

.2 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.

.3 Copper conductors: size as indicated, with 600 V insulation of chemically XLPE material rated RW90.

2.2 Teck Cable

.1 Minimum conductor size #12 AWG.

.2 Conductors:

.1 Grounding conductor: copper.

.2 Circuit conductors: copper, size as indicated.

.3 Insulation:

.1 Chemically cross-linked thermosetting polyethylene rated type RW90, 1000 V.

.4 Inner jacket: PVC material.

.5 Armour: interlocking aluminum.

.6 Overall covering: thermoplastic polyvinyl chloride material.

.7 Fastenings:

.1 One hole malleable iron straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.

.2 Channel type supports for two or more cables at 1500 mm centers.

.3 Six mm diameter threaded rods to support suspended channels.

.8 Connectors:

.1 Watertight approved for TECK cable.

2.3 Variable Frequency Drive Cable

.1 DriveRX or approved equal.

.2 Minimum conductor size #12 AWG.

.3 Conductors:

.1 Grounding conductor: 3 sectored copper grounds.

.2 Circuit conductors: stranded copper, size as indicated.

.4 Insulation:

.1 Chemically cross-linked thermosetting polyethylene rated type RW90, 1000 V.

.5 Inner jacket: PVC material.

.6 Armour: continuous corrugated aluminum.

.7 Overall covering: thermoplastic PVC material.

.8 Fastenings:

.1 One hole malleable iron straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.

.2 Channel type supports for two or more cables at 1500 mm centers.

.3 Six mm diameter threaded rods to support suspended channels.

.9 Connectors:

.1 Nexan type ‘D’ and type ‘W’ DriveRX connectors

2.4 Control Cables

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

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

.3 600 V type: stranded annealed copper conductors, sizes as indicated with PVC insulation type R90, XLPE type with shielding of wire braid each pair of conductors and overall covering of thermoplastic jacket interlocked armour and jacket over sheath of PVC.

2.5 Luminaire Wire

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

3. EXECUTION

3.1 Installation of Building Wires

.1 Install wiring as follows:

.1 In conduit systems in accordance with Section 16111 – Conduits, Conduit Fastenings and Conduit Fittings.

.2 In trenches in accordance with Section 16106 – Installation of Cables in Trenches and in Ducts.

3.2 Installation of Teck Cable 0 - 1000 V

.1 Install cables.

.2 Group cables wherever possible on channels.

.3 Install cable in trenches in accordance with Section 16106 – Installation of Cables in Trenches and in Ducts.

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

3.3 Installation of Variable Frequency Drive Cable

.1 Install cables for power supply on all variable frequency drive/motor applications.

.2 Group cables wherever possible on channels.

.3 Terminate cables in accordance Manufactures recommendations.

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 Lay cable in cabletroughs in accordance with Section 16114 – Cable Trays.

.4 Terminate cables in accordance with Section 16151 – Wire and Box Connectors.

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.

.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 Provide a complete system of splitters, junction boxes, pull boxes and cabinets for the installation of wiring and equipment.

1.2 Shop Drawings and Product Data

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

2. PRODUCTS

2.1 Junction Boxes and Pull Boxes, Weatherproof

.1 Materials:

.1 Cast steel, Crouse Hinds, WBJ Series.

2.2 Junction Boxes and Pull Boxes, Indoor Dry Locations

.1 Materials:

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

.2 Components:

.1 For flush mounting, covers to overlap box by 25 mm minimum all around with flush head cover retaining screws.

.2 Use rolled edges for surface boxes.

.3 Junction boxes mounted in exterior walls shall be complete with box vapour barriers.

2.3 Cabinets

.1 Materials:

.1 Cabinets: Code gauge sheet steel, welded construction, phosphatized and factory paint finish, suitable for field painting.

.2 Locks: to match panelboards.

.3 Mounting: Galvanized U channel, secured to structure and cabinet, at top and bottom of cabinet.

.2 Components:

.1 With hinged door and return flange overlapping sides, with handle, lock and catch for surface mounting, size as indicated or to suit.

.2 Surface or flush with trim and hinged door, latch and lock and two keys, size as indicated or to suit. Keyed to match panelboard keys.

2.4 Splitters

.1 Materials:

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

.2 Components:

.1 Formed hinged cover suitable for locking in the closed position.

.2 Main and branch lugs to match required size and number of incoming and outgoing conductors as indicated.

.3 At least three spare terminals on each set of lugs in splitters less than 400 AMP.

3. EXECUTION

3.1 Installation

.1 Junction Boxes and Pull Boxes:

.1 Supply all pull boxes and junction boxes shown on the drawings or required for the installation.

.2 Identify with system name and circuit designation as applicable.

.3 Size in accordance with the Canadian Electrical Code, as a minimum.

.2 Cabinets:

.1 Mount cabinets with top not greater than 1980 mm above finished floor, coordinated with masonry, panelboards, fire hose cabinets and similar items. Securely fasten backboards to cabinet interiors.

.2 Install terminal block where indicated.

.3 Splitters

.1 Install splitters and mount plumb, true and square to the building lines.

.2 Extend splitters full length of equipment arrangement except where indicated otherwise.

.4 Identification

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

END OF SECTION

OUTLET BOXES, CONDUIT BOXES AND FITTINGS

1. GENERAL

1.1 Work Included

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

1.2 References

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

2. PRODUCTS

2.1 Outlet and Conduit Boxes General

.1 Size boxes in accordance with CSA C22.1.

.2 102 mm square or larger outlet boxes as required for special devices.

.3 Gang boxes where wiring devices are grouped.

.4 Blank cover plates for boxes without wiring devices.

.5 Combination boxes with barriers where outlets for more than one system are grouped.

2.2 Outlet Boxes for Metal Conduit

.1 Materials:

.1 Surface or recessed concealed type: Die formed steel, hot dip galvanized, 3.95g/m^2 minimum zinc coating.

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

.2 Components:

.1 Outlets boxes, mounted on concrete:

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

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

2.3 Outlet Boxes for Rigid PVC Conduit

.1 Materials:

.1 Rigid PVC boxes and fittings: Unplasticized PVC.

2.4 Conduit Boxes

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

2.5 Fittings - General

.1 Bushing and connectors with nylon insulated throats.

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

3. EXECUTION

3.1 Installation

.1 Support boxes independently of connecting conduits.

.2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.

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

.4 Install all outlets surface mounted as required for the installation.

.5 Surface mount on unfinished areas.

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

.7 Do not use sectional boxes.

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

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

.10 Primary bushings in termination box for cable connection.

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

.12 Control junction box.

.13 Stainless steel nameplate and connection diagram.

END OF SECTION

WIRING DEVICES

1. GENERAL

1.1 Work Included

.1 Supply and 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 Manufacturers shall be Hubbell, Leviton, or Pass & Seymour.

2.2 Devices

.1 The catalogue numbers shown below are for the particular manufacturer's series and all necessary suffixes shall be added for the requirements as stated. All devices shall be specification grade minimum and wherever possible shall be of the same manufacture.

.2 Devices to be brown with galvanized steel coverplates for surface mounted devices.

2.3 Switches

.1 120-277 V, 20 A, single and double pole, three and four-way: As Hubbell No. 1221, 1222, 1223 and 1224.

.2 Manually - operated general purpose AC switches shall have the following features:

.1 Terminal holes approved with AWG #10 wire.

.2 Silver alloy contacts.

.3 Urea or melamine molding for parts subject to carbon tracking.

.4 Suitable for back and/or side wiring.

2.4 Receptacles

.1 Duplex 15 ampere, 120 V, 3 wire, ivory, U-ground, as Hubbell No. 5252, with the following features:

.1 Brown urea molded housing.

.2 Suitable for #10 AWG for back and side wiring.

.3 Eight back wired entrances, four side wiring screws.

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

.5 Triple wipe contacts and rivetted grounding contacts.

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

2.5 Welding Receptacles

.1 Crouse-Hinds AJP AR624, 600V, 60A, 3 wire. Interlocked receptacle and disconnect switch.

2.6 Coverplates

.1 Supply and Install coverplates for all wiring devices

.2 For category 1 and 2 areas defined in Section 16010 – Electrical General Requirements and exteriror locations use weatherproof double lift spring - loaded cast aluminum coverplates, complete with gaskets for single receptacles or switches.

.3 For ordinary locations use sheet steel utility box cover for wiring devices installed in surface mounted utility boxes.

.4 For ordinary locations use stainless steel 1 mm thick coverplates on all wiring devices mounted in flush-mounted outlet boxes unless otherwise specified.

.5 Use gasketted DS cast covers on FS and FD type boxes.

3. EXECUTION

3.1 Installation

.1 Install single throw switches with handle in the "UP" position when switch closed.

.2 Install switches vertically in gang type outlet box when more than one switch is required in one location.

.3 Mount switches on the latch side of the doorway as close as possible to door frame unless otherwise indicated on drawings.

.4 Install receptacles vertically in gang type outlet box when more than one receptacle is required in one location.

.5 Where split receptacle has one portion switched, mount vertically and switch upper portion.

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

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

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

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

END OF SECTION

WIRE AND BOX CONNECTORS

1. GENERAL

1.1 Work Included

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

1.2 Special Codes

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

1.3 References

.1 CSA C22.2 No. 65 Wire Connectors.

.2 EEMAC 1Y-2, Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).

2. PRODUCTS

2.1 Materials

.1 Pressure type wire connectors: with current carrying parts same material as conductors sized to fit the conductors as required.

.2 Fixture type splicing connectors: with current carrying parts same material as conductors sized to fit the conductors 10 AWG or less.

.3 Bushing stud connectors: to EEMAC 1Y-2 to consist of:

.1 Connector body and stud clamp for stranded copper conductors.

.2 Clamp for stranded copper conductors.

.3 Stud clamp bolts.

.4 Bolts for copper conductors.

.5 Sized for conductors as indicated.

.4 Clamps or connectors for aluminum sheathed cable, flexible conduit, as required.

2.2 Wire Connectors

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

.2 Use Thomas & Betts 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 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by the Manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2 No. 65.

.2 Install fixture type connectors and tighten. Replace insulating cap.

.3 Install bushing stud connectors in accordance with EEMAC 1Y-2.

3.2 Wire Connectors

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

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

.3 Install compression connectors using methods and tools recommended by the Manufacturer.

.4 Do not install stranded conductors under screw terminals unless compression lugs are installed.

END OF SECTION

GROUNDING

1. GENERAL

1.1 Description

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

.2 The system to consist of cables, ground rods, supports, and all necessary materials and inter-connections to provide a complete system. Ensure measured resistance to ground of the network does not exceed 3 ohms.

.3 Run all above ground grounding conductors in conduit or in Cable Trays as per drawings.

2. PRODUCTS

.1 Cables 2/0 and smaller to be connected to ground bars via Cadweld exothermic weld.

.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 x 6000 mm copper clad steel.

.4 Cable to pipe connectors: made with Burndy GAR connectors.

.5 Supply and install ground bars as indicated on Drawings.

3. EXECUTION

3.1 Grounding - General

.1 Ground all frames and metallic enclosures of all electrical equipment and electrically operated equipment through the conduit system via a ground wire.

.2 Ground all transformers, switchgear, panel boards and splitters fed from the main distribution centre by grounding conductors sized as specified on Drawings and 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.

.4 Connect using 4/0 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

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 manufactures connecting components and fasteners for a complete system.

.2 Heavy duty supporting structures: fabricated from welded steel structural members and hot dipped galvanized before installation.

.3 Nuts, bolts, machine screws: stainless steel.

2.2 Concrete and Masonry Anchors

.1 Materials: Hardened steel inserts, zinc plated for corrosion resistance. Epoxy adhesive type.

.2 Components: non-drilling anchors for use in predrilled holes, sized to safely support the applied load with a minimum safety factor of 4.

.3 Manufacturer: Hilti (Canada) Limited.

2.3 Non-Metallic Anchors

.1 Material: Plastic anchors for sheet metal screws.

.2 Manufacturer: Fischer.

2.4 Conduit Supports

.1 General: Malleable iron one-hole conduit straps where exposed to weather. Stamped steel two-hole straps indoors.

.2 Structural Steel: Crouse-Hinds “Wedgetite” supports or equivalent manufactured by Appleton.

.3 Masonry, concrete, stone, etc.: Anchors.

.4 Title: Toggle bolts.

.5 Metal studs, ceiling hangers, etc.: “Caddy-Clips”.

.6 Unistrut: Unistrut conduit clamps.

2.5 Cable Supports and Clamps

.1 General: As per conduit supports, except that for single conductor cables, 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.

.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

DISTRIBUTION TRANSFORMERS - LIQUID COOLED

1. DESCRIPTION

1.1 Description

.1 City Supplied transformers to transform primary 4160 V, 3 phase, 3 wire supply to main secondary distribution voltage of 600 V, 3 phase, 3 wire.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 Installation

.1 Install transformers only after other work in area is completed.

.2 Install transformers as indicated on the Drawings and in accordance with the Manufacturer's recommendations.

.3 Use spreader bars on slings when lifting transformers into place.

.4 Set and secure transformers in place rigid, plumb, square.

.5 Ensure internal connections are mechanically tight.

.6 Make power and control and monitoring connections.

.7 Connect transformer ground terminal to system ground with 4/0 copper cable, 2 ground connections minimum.

.8 Fill transformers when required with metal hose and ensure care is taken to prevent contamination of liquid and components.

.9 Set taps to produce rated secondary voltage at no-load.

.10 Wire one set contacts on liquid temperature measuring device, gas detector relay, to Powerlogic monitoring contacts in main primary breaker in switchboard to indicate when unsafe condition reached,

.11 Mount the transformers on housekeeping pads; ensure that the pads are true and level. Mount the transformer assembly on the isolators as recommended by the manufacturer. Ensure concrete pad is fully cured for 28 days before installation of transformer.

.12 Connect the high temperature contact to alarm circuit as indicated and to trip the main secondary vacuum circuit breaker.

.13 Before energization, keep transformers or storage room enclosure above 10°C, ambient.

3.2 Testing (Coordinate with Section 16980)

.1 After the transformers have been set in place, prior to energizing, verify in writing that the transformers have been installed and tested in accordance with recommended practice and are suitable for energizing and use.

.2 Without limiting the foregoing, include the following, as a minimum:

.1 Prior to connecting, inspect visually and conduct the following tests:

.1 Megger insulation and correct reading to 20°C base. Megger high voltage to ground with the secondary grounded for the duration of the test. Megger low voltage to ground with the primary grounded for the duration of the test.

.2 Perform electrical centres test on high voltage off-load tap changer switch.

.3 Sample transformer insulating liquid laboratory analysis to be carried out as follows:

.1 Dielectric breakdown

.2 Neutralization number

.3 Colour

.4 Interfacial tension

.5 Specific gravity

.4 Leak test piping.

.5 Perform ratio test for all transformer gap positions.

.1 Verify that shipping braces and shipping shims have been removed.

.2 After connection of line, load, control, and alarm wiring, but prior to energizing, the calibration and verification firm is to inspect the installation and confirm the following:

.1 That the transformer has been properly cleaned, is dry and free of foreign materials and contaminants, and otherwise is suited for energizing.

.2 That all bus and connector bolts have been installed, tightened, torqued properly, and uninsulated surfaces of connectors and buses have been taped.

.3 That transformer taps have been set to provide secondary voltage required.

.4 That all insulators are in perfect condition, without cracks, chips, or surface contaminants.

.5 That core, coil, terminal boards, tap changers, bushings and all insulated surfaces have not been damaged.

.6 That the forced cooling fans are functioning and that the power supply circuits to the fans have been properly connected and protected.

.7 That all alarm and indicating devices are operating correctly, and are properly connected either internally or externally from the terminal of the instrument to the external system, including the following:

.1 Liquid level and pressure

.2 Liquid temperature, with hi and hi-hi contacts connected to the building control computer

.3 Sudden pressure is unblocked and wired to trip the primary circuit breaker.

.3 Any other tests or inspections deemed necessary or appropriate by the Manufacturer.

3.3 Training

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

END OF SECTION

SECONDARY SWITCHGEAR

1. DESCRIPTION

1.1 Description

.1 City Supplied 600 V, 3 phase, 4 wire switchgear.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 Installation

.1 Locate switchgear assembly as indicated and bolt to base channels.

.2 Connect main secondary power supply to main breaker.

.3 Connect load side of breakers in distribution cubicles to distribution feeders.

.4 Check factory made connections for mechanical security and electrical continuity.

.5 Run two grounding conductor 4/0 AWG bare copper in 25 mm conduit from each end of ground bus to ground.

3.2 Training

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

3.3 Testing and Calibration

.1 Program and check trip unit settings against co-ordination study to ensure proper working and protection of components.

END OF SECTION

DISCONNECT SWITCHES FUSED AND NON-FUSED UP TO 600V - 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 Cutler Hammer, Schnieder Electric.

2. PRODUCTS

2.1 Disconnect Switches

.1 Ratings: 600 V for 347/600 V distribution, 240 V for 120/208 V distribution. Unless otherwise shown, 3 pole for 3 phase, 3 wire distribution, 3 pole and solid neutral for 3 phase 4 wire distribution. Ampere ratings as shown on the drawings or to suit load requirements. For motors, use disconnect switches with HP ratings at least equal to motor HP.

.2 Enclosures: CSA code gauge galvanized steel, hinged doors, external operating handles. Disconnect switches in dry locations shall be EEMAC-1 and EEMAC-3 where exposed to weather. Provide ON-OFF switch position indication on switch enclosure cover.

.3 Finish: One primer coat and one finish coat on all metal surfaces, colours as per Section 16010 – Electrical General Requirements.

.4 Switch mechanisms: Quick make and quick break action with self wiping contacts, solderless pressure lug connectors. For switches 100 A and over, provide non-tracking arc shrouds. All switch poles to operate together from a common operating bar. Provide for padlocking disconnect switches in "Off" position. Doors to be interlocked and complete with defeat mechanism, to prevent opening when handle in ON position.

.5 Neutral Bars: Where distribution system has grounded neutral conductor, provide neutral bar where required with ampere rating equal to switch rating, in enclosure. Provide ground bar for terminating ground conductors.

.6 Fuse Holders: Provide fuse holders (relocatable and suitable without adapters) on load side of switches, ampere rating equal to switch ratings, suitable for fuses specified.

2.2 Fuses

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

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, for example:

UPS

120/208 V

Fed from DP-G101-31,33,35

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 - 3 Phase, 4 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 Westinghouse, FPE, or approved equal.

.2 Design

.1 Type: ANN.

.2 3 phase, 15 and 30 kVA as indicated, 600 V input, 120/208 V output, 60 Hz.

.3 Voltage primary taps: 2.5% Full capacity above and below normal.

.4 Insulation: Class.

.5 Basic Impulse Level (BIL): 10 kV B.I.L.

.6 Hipot: 4 kV.

.7 Average Sound Level: To meet the local municipal & building codes and meet at minimum the following criteria:

.1 45 dB max. up to 45 kVA

.8 Impedance at 170°C: 6.0% max. up to 112½ kVA.

.9 Enclosure: As indicated suitable for area in which unit is to be installed.

.10 Mounting: Up to 45 kVA suitable for wall or floor mounting and above 45 kVA suitable for floor mounting unless otherwise shown.

.11 Finish: In accordance with Section 16010 – Electrical General Requirements.

.12 3 Phase Windings: Arrange with three primary windings connected in delta and three secondary windings connected in wye.

.13 Max. Winding Temperature: 150°C rise with temperature continuous full load.

.14 Max. Lead Connection: 55°C rise with temperature continuous full load.

.15 Windings: Copper.

.16 Losses not to exceed CAN/CSA C802 and NEMA TP-1 standards.

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 transformers up to 45 kVA as indicated on Drawings.

.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 Mount transformers as indicated on Drawings and connect primary, secondary, neutral and ground conductors. Provide brackets and bolts for wall mounted transformers. Ensure all transformers have good ventilation.

.8 Do not use permanent distribution system dry type transformers for temporary power distribution without permission for the Contract Administrator.

.9 Mount transformers to reduce direct and transmitted noise. Mount core and coils of transformers on vibration and sound absorbing pads.

.10 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.

.11 Connections to transformers shall be in flexible conduit and shall enter the enclosure below the coils.

.12 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 16010 – Electrical General Requirements.

.2 Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

2. PRODUCTS

2.1 Panelboards

.1 Panelboards: product of one manufacturer.

.1 Install circuit breakers in panelboards before shipment.

.2 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.

.2 250 V panelboards: bus and breakers rated for 10 kA (symmetrical) interrupting capacity or as indicated.

.3 600 V panelboards: bus and breakers rated for 10 kA (symmetrical) interrupting capacity or as indicated.

.4 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.

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

.6 Two (2) keys for each panelboard and key panelboards alike.

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

.8 Mains: suitable for bolt-on breakers.

.9 Trim with concealed front bolts and hinges.

.10 Trim and door finish: baked grey enamel.

2.2 Breakers

.1 Breakers: to Section 16477 – Moulded Case Circuit Breakers.

.2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.

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

.4 Lock-on devices for 10% of 15 A breakers installed as indicated. Turn over unused lock-on devices to City.

2.3 Equipment Identification

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

.2 Nameplate for each panelboard size 4 engraved as indicated.

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

3. EXECUTION

3.1 Installation

.1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.

.2 Install surface mounted panelboards on 40mm galvanized U channel. Where practical, group panelboards.

.3 Mount panelboards to height specified in Section 16010 – Electrical General Requirements or as indicated.

.4 Connect loads to circuits.

.5 Connect neutral conductors to common neutral bus with respective neutral identified.

END OF SECTION

AIR CIRCUIT BREAKERS

1. DESCRIPTION

1.1 Description

.1 City Supplied air circuit breakers.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 Installation

.1 Install air circuit breakers as indicated.

.2 Connect electronic trip units to communicate with the Central electrical monitoring system

.3 Set all breakers trips according to the City supplied Co-ordination study results.

END OF SECTION

MOULDED CASE CIRCUIT BREAKERS

1. GENERAL

1.1 Product Data

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

.2 Include time-current characteristic curves for breakers with interrupting capacity of 22,000 A symmetrical (rms) and over at system voltage.

2. PRODUCTS

2.1 Breakers General

.1 Bolt-On Moulded Case Circuit Breaker: Quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40°C ambient.

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

.3 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting. Trip settings on breakers with adjustable trips to range from 3 to 8 times current rating.

.4 Circuit breakers with interchangeable trips as indicated.

2.2 Thermal Magnetic Breakers [Design A]

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

2.3 Magnetic Breakers [Design B]

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

2.4 Enclosure for Individually Mounted Breakers

.1 Enclosure shall be CSA code gauge galvanized steel, hinged door, front mounted external operating handle, lockable in “off” position. Enclosure rating determined by area classification as specified in 16010 – Electrical General Requirements,. Increase enclosure size above standard for large cables.

.2 Where distribution system has grounded neutral conductor, provide neutral bar, with ampere rating equal to breaker/switch rating in enclosure.

3. EXECUTION

3.1 Installation

.1 Install circuit breakers as indicated.

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

END OF SECTION

POWER SURGE PROTECTORS

1. GENERAL

1.1 Related Work

.1 Section 16010 – General Electrical Requirements

.2 Section 16471 – Panelboards - Breaker Type

1.2 System Description

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

2. PRODUCT

2.1 Operation and Environment

.1 Voltage: The TVSS devices shall be suitable for the voltage and systems configuration as indicated on the single line diagram(s).

.2 Maximum Continuous Operating Voltage (MCOV): The MCOV of the suppressor unit shall be greater than 125% for 120/208 V systems and 115% for 347/600 V systems.

.3 Protection Modes: Transient voltage surge suppression paths shall be provided for all possible common and normal modes (between each line and ground, neutral and ground, line to line and each line and neutral). The primary suppression path shall not be to ground.

2.2 Suppression Component

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

.3	TVSS clamping components response time	< 1 nanosecond

2.3 Filtering

.1 TVSS shall contain a high frequency extended range tracking filter.

.2 Noise attenuation ≥45 dB @ 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: The device shall have a copper, tin plated main bus.

.2 Circuit Breakers: Are to be of the over center toggle mechanism type which use bolt-on connectors to line side panelboard connectors.

.3 Panelboard Enclosure: The panelboard shall be provided in an EEMAC 1 enclosure. The TVSS/filter status indicators shall be visible without the need to open the panelboard door. A lockable door shall be provided to limit access to authorized personnel only. Trim assembly shall be tamper proof. The trim (doors) shall be finished in grey ASA61 paint.

.4 Neutral Bus: The unit shall be equipped with a copper 100% rated neutral bus, which shall include a sufficient quantity of solderless type lugs to service the total unit circuit capacity.

.5 Wiring Gutters: The integrated TVSS filtering panel shall be equipped with a complete perimeter wiring gutter with a cross-sectional dimensions of not less that 12,200 mm^2.

.6 Safety and Insulated/Isolated Ground Bus: The integrated filter panel shall have a safety and insulated/isolated ground bus equipped with solderless type lugs of quantity to sufficiently service the circuit loads.

2.5 General Features

.1 The integrated TVSS panel shall be factory installed and connected to the bus bar.

.2 Connectors: Terminals shall be provided for all the necessary input and output power and ground connections on the TVSS.

.3 Enclosure: The specified system shall be provided in a heavy duty NEMA 12 dust tight enclosure with no ventilation openings for maintenance and branch panel applications. Indication of surge current module status shall be visible without opening the door.

.4 Internal Connections: All surge current diversion connections shall be by way of low impedance wiring. Surge current diversion components shall be wired for reliable low

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

.5 Unit Status Indicators: Red status indicators shall be provided on the hinged front cover to indicate unit phase status. The absence of the red light shall reliably indicate that one or more surge current diversion phases have failed and that service is needed to restore full operation.

.6 Fuses: The unit shall utilize internal fuses rated with a minimum interrupting capability of 200,000 A or greater.

.7 Identification: The unit shall include manufacturer's nameplate, UL rating, and a CSA approval on the exterior enclosure.

2.6 Approved Manufacturers

.1	Current Technologies	
	-- Integrated TVSS panel	Model EGP
.2	Liebert Corporation	
	-- Integrated TVSS panel	Model LPG
.3	Square D	
	-- Integrated TVSS panel board	
.4	Cutler - Hammer	
	-- Integrated TVSS panel board	Clipper Power System – Visor Series

3. EXECUTION

3.1 Installation

.1 Install with Manufacturer's recommended conductors tapped from the electrical service switchboard conductor system. Conductors are to be as short and straight as possible. Input conductors to the TVSS shall be twisted together to reduce impedance during high frequency filtering.

.2 An appropriately sized manual safety disconnect shall be supplied and installed before and in line with the TVSS from the electrical service for the purpose of electrically isolating the device from the system should service be required without interrupting the main service. Coordinate required disconnect ampacity with TVSS manufacturer.

.3 The TVSS should be following the Manufacturer's recommended practices as outlined in the Manufacturer's installation and Maintenance Manual and in compliance with all applicable electrical codes.

END OF SECTION

GENERAL PROVISIONS FOR INTERIOR LIGHTING

1. GENERAL

1.1 Work Included

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

1.2 Code Requirements

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

1.3 Shop Drawings

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

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

1.4 Manufacturer's Operational Test

.1 Test fixtures for acceptance of lamp made to maximum tolerance as required in ANS standards listed in 16.4-3.

.2 Test fixtures with rated lamps for starting and operation.

.3 Check wiring for agreement with design circuit.

.4 Test for short circuits and improper grounds.

.5 Test operation of fixture and lamp with ballast.

1.5 Samples

.1 Provide samples of all fixtures, lamps, ballasts and accessories when requested.

.2 If directed, set up these fixtures on or near site, to show co-ordination of fit with ceiling and other equipment i.e., mechanical air diffuser assemblies, wiring channels, brackets, davits and standards. Retain fixture design, if approved, at the site as a control standard. If submitted fixtures are disapproved, resubmit after revision for further field tests until approval is given.

.3 Install one or more sample fixtures in a mock-up of specified ceiling. Pay all costs associated with work of this trade in connection with construction of mock-up, installation and connection of fixtures, lamps, ballasts and accessories.

1.6 Lamps Used for Temporary Lighting

.1 Fluorescent lamps may be used for temporary light and lamps used for this purpose will be accepted at Substantial Performance. Spot relamp faulty or burned out lamps without additional cost to City.

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

2. PRODUCTS

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

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

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

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

.5 Use self-aligning ball joint hangers for rod suspended fixtures.

.6 Use cadmium plated chains for suspended fixtures in unfinished areas.

3. EXECUTION

3.1 Installation

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

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

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

.4 Ground lighting equipment to a separate grounding conductor.

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

3.2 Workmanship

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

.2 Provide suitable extension couplings for row mounted fixtures.

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

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

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

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

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

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

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

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

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

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

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

END OF SECTION

EXIT LIGHTS

1. GENERAL

1.1 Product Data

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

1.2 References

.1 CSA C860

2. PRODUCTS

2.1 Standard Units

.1 Housing: Molded high impact thermo plastic.

.2 Face and back plates: Molded high impact thermo plastic.

.3 Lamps: LED-2W 120 V.

.4 Letters: 150 mm high x 19 mm, with 13 mm thick stroke, red on white glass, reading EXIT.

.5 Face plate to remain captive for relamping.

.6 Universal mounting.

3. EXECUTION

3.1 Installation

.1 Install exit lights.

.2 Connect fixtures to exit light circuits.

.3 Connect emergency lamp sockets to emergency circuits.

.4 Ensure that exit light circuit breaker is locked in on position.

END OF SECTION

UNINTERRUPTIBLE POWER SYSTEMS STATIC

1. GENERAL

1.1 Description of System

.1 System to consist of:

.1 Rectifier cubicle

.2 Inverter cubicle

.3 Battery cubicle

.4 Bypass switch cubicle

.5 Controls and meters

.2 System to use normal power supply mains and battery to provide continuous, regulated AC power to isolated load.

.3 Equipment to operate continuously and unattended.

.4 Ensure that UPS is compatible with equipment that it feeds.

1.2 Shop Drawings

.1 Submit shop drawings in accordance with Section 01300 – Submittals.

.2 Include:

.1 Outline sketch showing arrangement of cubicles, meters, controls, recommended aisle spaces, battery rack, battery arrangement and dimensions.

.2 Shipping weight.

.3 Schematic diagram showing interconnection of rectifier, inverter, battery, bypass switch, meters, controls and indicating lamps.

.4 Description of system operation, referenced to schematic diagram, for:

.1 Manual control during initial start-up and load transfer to bypass and back to inverter output.

.2 Inverter.

.3 Bypass.

.5 System performance and reliability:

.1 Consider any deviation from the required output power waveform as a failure in the UPS and include an estimate, with supporting calculations, of the Mean Time Between Failures (MTBF) expressed in hours.

.2 Provide an estimate with supporting data for the Mean Time to Repair factor (MTTR).

.6 Full load kVA output at 0.8 power factor.

.7 Efficiency of system at 25%, 50%, 75%, and 100% rated load.

.8 Type of ventilation: natural or forced.

.9 Battery:

.1 Number of cells.

.2 Maximum and minimum voltages.

.3 Type of battery.

.4 Type of plates.

.5 Catalogue data with cell trade name and type.

.6 Size and weight of each cell.

.7 Cell charge and discharge curves of voltage, current, time and capacity.

.8 Derating factor for specified temperature range.

.9 Nominal ampere hour capacity of each cell.

.10 Maximum short circuit current.

.11 Maximum charging current expected for fully discharged condition.

.12 Recommended low voltage limit for fully discharged condition.

.13 Expected life.

.10 Inverter:

.1 Type and catalogue number.

.2 DC current at minimum battery voltage to produce full load AC output.

.11 Rectifier:

.1 Type and capacity, with catalogue number.

.2 Battery charging sequence.

.3 Current-time data for SCR protective devices.

.4 Guaranteed noise level.

.5 Estimated life.

.6 Metering.

.7 Alarms.

.12 Manufacturer's field experience with uninterruptible power systems of similar ratings including engineering expertise, manufacturing facilities and listing of UPS units manufactured and installed during last five (5) years including model, customer, location and installation dates.

.13 Heat losses at no load, 25%, 50%, 75%, and 100% of rated output, in kW.

.14 Cooling air required in m^3/s.

.15 List of recommended spare parts, tools and instruments with catalogue numbers and current prices.

.16 Typical O&M Manual.

.17 Description of factory test facilities.

.18 Manufacturer's maintenance capabilities including:

.1 Willingness to undertake maintenance contract.

.2 Number of trained personnel available.

.3 Location of trained personnel and repair facilities.

1.3 Operation and Maintenance Data

.1 Provide data for incorporation into O&M Manual specified in Section 01300 – Submittals.

.2 Submit interim copies to Contract Administrator prior to notification of factory test date.

.3 O&M Manual to include:

.1 O&M instructions concerning design elements, construction features, component functions and maintenance requirements to permit effective operations maintenance and repair.

.2 Technical data:

.1 Characteristic curves for automatic circuit breakers and protective devices.

.2 Project data.

.3 Technical description of components.

.4 Parts lists with names and addresses of suppliers.

1.4 Maintenance Materials

.1 Provide maintenance materials in accordance with Division 1 – Maintenance Materials, Special tools and spare parts

.2 Include:

.1 Four (4) sets of each type and size of fuses used.

.2 Four (4) sets indicating lamps.

.3 Spare parts provided.

1.5 Care, Operation, and Start-Up

.1 Arrange with Contract Administrator:

.1 For Manufacturer's Representative to provide support start-up of system, checking, adjusting and testing on Site.

.2 For instruction of City staff on theory, construction, installation, operation and maintenance of system:

.1 After installation and during Site testing.

.2 At factory during shop testing.

.2 Advise on:

.1 Expected failure rate of equipment

.2 Type of expected failures

.3 Estimated time between major overhauls based on twenty (20) year equipment life.

.4 Estimated cost of major overhaul based on current costs and excluding traveling expenses.

.5 Type and cost of test equipment needed for fault isolating and performing preventive maintenance.

1.6 Delivery and Storage

.1 Crating:

.1 Adequately enclosed and protected from weather and shipping damage by use of minimum 12 mm plywood with vapour barrier inside.

.2 For tractor train or sea shipment, use double layer of vapour barrier and 19 mm plywood covering.

.3 Subassemblies may be packed separately.

.4 Label crates:

.1 Shipping address.

.2 Weight and dimensions.

.3 Serial number of unit and brief description of contents.

.4 Stenciled with durable paint on at least two sides of each crate.

.5 List of contents:

.1 In weatherproof envelope stapled on outside of each crate.

.2 Copy placed inside each crate.

1.7 Source Quality Control

.1 Complete system including rectifier, inverter, bypass switch, remote annunciator panel, controls and battery factory tested.

.2 Tests:

.1 Visual inspection to determine that:

.1 Materials, workmanship, and assembly conform to design requirements.

.2 Parts are new and free of defects.

.3 Battery and components are not damaged.

.4 Battery cells are of identical construction.

.5 Electrolyte in each cell is at manufacturer's recommended full level.

.6 Each battery cell polarity and polarity of connections to inverter is correct.

.7 Proper size fuses are installed.

.8 Meters have suitable range.

.9 Accessories are present.

2. PRODUCTS

2.1 Uninterruptible Power System

.1 Input power:

.2 3 phase, 208 V, 3 wire, grounded neutral, 60 Hz.

.3 Normal supply from AC mains.

.4 Emergency supply from standby automatic diesel-electric unit.

.2 Output power:

.1 Three phase, 208 V, 4 wire, grounded neutral, 60 Hz.

.2 Full load output at 0.8 power factor lagging 10 kVA.

.3 Overload capability: 125% of rated full load current at 0.8 power factor and rated voltage for 10 minutes.

.4 Frequency - nominal 60 Hz:

.1 Adjustable from 58.5 to 61.5 Hz.

.2 Maximum variation from set value under load changes, including transients, not to exceed 0.3 Hz.

.3 Drift from set value - after two months normal operation within ambient temperature range of 0° to 40°C, not to exceed 0.6 Hz.

.5 Duration of full load output after mains failure not less than 15 minutes.

.6 Output voltage control:

.1 Continuously adjustable on load at least 5% from rated value.

.2 Voltage regulation: voltage not to change by more than 2% as load increases gradually from zero to 100%, or for specified duration of full load after mains failure.

.3 Transient voltage change not to exceed +/-10% of rated voltage upon 50% sudden load change, loss or return of AC input voltage to system when fully loaded or transfer of full load from inverter to bypass and vice versa, and return to normal within 3 Hz.

.4 Harmonics over entire load range:

.1 Total rms value not to exceed 5% rms value of total output voltage.

.2 Single harmonic not to exceed 3% of total output voltage.

.5 Proper angular phase relation maintained within 4 electrical degrees at up to 20% load unbalance.

.7 Efficiency: Overall system efficiency at rated load with battery fully charged not less than 75%.

.8 Interference suppression:

.1 If UPS equipment generates electromagnetic rf interference at levels which adversely affects other equipment in vicinity, install suppression circuits or shielding as required to eliminate such interference.

.2 If harmonics reflected back to mains from rectifier adversely affect other loads connected to same bus, install suppression circuits to prevent that condition.

2.2 System Performance

.1 Normal operation:

.1 System operates on mains power when mains voltage is within +/-10% of nominal value and mains frequency is between 59.5 and 60.5 Hz.

.2 Battery operation:

.1 System transfers automatically to battery operation.

.1 When manually selected at control panel.

.2 When mains power fails.

.3 When mains voltage varies more than 10% from nominal or mains frequency varies more than 0.5 Hz from 60 Hz.

.4 When mains power is restored and mains voltage is within 10% of nominal and mains frequency is within 0.3 Hz of 60 Hz, system automatically resynchronizes with mains.

.5 Slew rate of frequency during transition period of system output automatically synchronizing with mains and return to its internal frequency to be set between 0.5 to 1.0 Hz per second.

.3 Bypass operation:

.1 For maintenance purposes, system can be bypassed automatically by manual selection at control panel to connect load directly to AC mains. Transfer without load interruption and leaving inverter energized.

.2 Load transfer from mains back to system automatically by manual selection at control panel when maintenance completed.

.3 Automatic transfer of load to mains in not more than $^1/_4$ cycle including sensing with inverter left energized but disconnected from load in case of:

.1 Inverter overloaded.

.2 Short circuit in load.

.4 Automatic retransfer of load to system without load interruption when above conditions disappear.

.5 Automatic transfer of load to mains in not more than $^1/_4$ cycle including sensing and shutdown of inverter in case of inverter internal malfunctions.

.6 Automatic transfer of load to mains without load interruption and inverter shutdown in case of:

.1 Over-temperature harmful to system.

.2 Loss of forced ventilation.

.3 Low voltage of DC supply to inverter.

.7 Bypass capable of closing onto and withstanding momentary fault current of 800% of rating for 0.01 s.

2.3 System Protection

.1 Circuit breakers in system used to isolate it from load and from mains for safe working on equipment, and for manual blocking of bypass automatic control to prevent inadvertent operation of bypass during work on inverter.

.2 Automatic circuit breakers and protection included in:

.1 AC input to rectifier.

.2 Battery input.

.3 Bypass circuit input.

.4 Inverter output.

.3 Surge suppressors:

.1 To protect system against supply voltage switching transients.

.2 To protect internal circuits where necessary against voltage transients.

.4 Current limiting devices, with panel front indication of device operation, to protect inverter SCRs.

.5 Suitable devices, with panel front indication of device operation, to protect rectifier diodes.

.6 Failure of circuit or component not to cause equipment to operate in dangerous or uncontrolled mode.

2.4 Electrical Requirements

.1 Bring out test points to protected coded pin jacks at convenient locations to permit testing without hazard, including:

.1 Inverter output ahead of output switch, 3 phase and neutral.

.2 Mains power 3 phase and neutral.

.3 Voltage across each SCR.

.4 Points requiring monitoring for on Site alignment, for determination of faulty sub-assemblies or printed circuit cards, including indication of oscillator pulse and operation of voltage control.

.2 No battery, other than main battery incorporated in design.

.3 Wires number tagged or colour coded with same designation on drawings. Tags: non deteriorating type.

.4 Variable resistors: fine adjustment, rheostat type.

.5 Phasing marked on input and output terminals, viewed from front of equipment:

.1 Left to right.

.2 Top to bottom.

.3 Front to back.

.6 Indicator lamps: long life incandescent or neon, rated for continuous duty, with sockets having adequate heat dissipation of lamps and dropping resistor if used.

.7 Solid state circuits used where more reliable than mechanical timers or control relays.

.8 Standard components available from commercial sources used throughout, with ten (10) years minimum shelf life.

.9 Arrangement to permit easy removal of defective components to facilitate servicing by replacing with stock spares.

.10 Small components, related to specific function, removable plug-in modular sub-assembly or printed circuit card.

.11 Heavy sub-assemblies easily accessible, or slide on runners of anti-friction material, and have flexible leads and bolted connections.

.12 Components and sub-assemblies accurately made for interchangeability.

2.5 Enclosure

.1 Dead front free standing sheet steel minimum 2.5 mm thick, CSA Enclosure 1A.

.2 Access preferably from front only, or from front and rear.

.3 Meters, indicating lamps and controls group mounted in panel front.

.4 Panel front enclosed by hinged doors to prevent tampering and to protect instruments and controls during shipping. Doors formed wrap-around type, rigid, to open and close smoothly, locking type handle with two (2) keys. Hinges to permit doors to be lifted off cubicle.

.5 Cubicle height not to exceed 1.8 m.

.6 External cable connections at top of cubicle through bolted plate for drilling at Site to suit.

.7 Ambient temperature range during operation –20°C to +40°C. Natural or forced ventilation as required. For forced ventilation power from inverter output and fan directly driven by single phase motor mounted on vibration isolators. Each enclosure to have redundant fans, with fan failures alarmed. Air inlet and outlet openings protected with screens and metal guards.

.8 Disposable air filters on fan cooled enclosures. Method of attachment and opening locations to make removal convenient and safe.

.9 Maximum operating sound level not to exceed 80 db(A) as measured on sound level meter with A weighting and slow response, at a distance of 1.o m.

.10 Enclosure frames interconnected by ground bus with ground lug for connection to ground.

2.6 Rectifier

.1 Input power supply from:

.1 AC mains.

.2 Input disconnect: bolt-on molded case 3 pole air circuit breaker, quick make, quick break type for manual or automatic operation, temperature compensated for 40°C ambient, magnetic instantaneous trip element.

.3 Isolating transformer: connected between AC input and rectifier input.

.4 Surge suppressor: to protect equipment from supply voltage switching transients.

.5 Rectifier:

.1 Silicon controlled rectifier assembly or sealed silicon diodes.

.6 Filter: for rectifier DC output.

.7 Fuse: to protect DC output.

.8 Meters:

.1 DC voltmeter, switchboard type, accuracy +/-2% of full scale, to measure rectifier output voltage.

.2 DC ammeter, switchboard type, accuracy +/-2% of full scale, to measure rectifier output current.

.9 Adjustments and controls:

.1 Line voltage adjusting taps to allow for +/-10% variation from nominal.

.2 Manual adjustment of float voltage with range of +/-5%.

.3 Manual adjustment of equalizing voltage.

.4 Automatic current limiting on rectifier adjustable between 80 and 120% of normal rating.

.5 Provision to disconnect rectifier from inverter and battery if rectifier DC output exceeds safe voltage limits of battery.

.10 Meters, adjustments, and controls to be grouped on front panel.

.11 Performance of rectifier:

.1 Automatically maintain battery in fully charged state while mains power available, and maintain DC float voltage within +/-1% of setting, no load to full load, during mains voltage variations up to +/-10%.

.2 Battery charging rate such that after battery has provided full load power output for specified duration, charger returns battery to 95% of fully charged state in 4 h.

.3 Automatic equalize charging circuit to initiate equalize charging of battery for 24 h after discharge of 5% of ampere hour battery rating.

.4 Manually initiated equalize charging feature with automatic timer adjustable from 0 to 24 h to return unit to float charge.

2.7 Inverter

.1 Input power supply from:

.1 Rectifier DC output.

.2 Battery DC output.

.2 Input disconnect: bolt-on molded case, single pole, circuit breaker, quick make, quick break type, for manual or automatic operation, temperature compensated for 40°C ambient, magnetic instantaneous trip element.

.3 Input filter: with separately fused computer grade capacitor banks and indicator lights, to eliminate inverter source noise and restrictions on input cable length.

.4 Power stage: high frequency switching type, dual cooled disc type SCR. Components, solid state devices capable of satisfactory operation under ambient conditions of -35°C to +55°C.

.5 Logic module:

.1 Integrated circuit logic.

.2 Silicon semiconductors.

.3 Plug-in modules.

.4 Gold plated plug-in connector.

.5 Front accessible field adjustments for voltage and frequency.

.6 Front accessible test points: suitably protected coded pin jacks.

.7 Frequency reference module.

.8 Current limiting module, automatic high speed by controlled reduction of output voltage.

.9 Voltage regulator.

.6 Output filter: output of high frequency switching stage contains elements of carrier frequency which are filtered to low harmonic sine wave.

.7 Meters:

.1 AC voltmeter: switchboard type, accuracy +/-2% of full scale, to measure inverter output voltage with 7 position selector switch to select phase to neutral, phase to phase, off.

.2 AC: switchboard type, accuracy +/-2% of full scale, to measure inverter output current with 4 position selector switch to select each phase and off.

.3 Wattmeter: switchboard type, accuracy +/-2% of full scale to measure inverter load.

.4 Frequency meter: switchboard type, scale 58 to 62 Hz, pointer type, to measure inverter output frequency.

.5 Synchroscope: with switch to check inverter output potential against supply mains potential.

.8 Output disconnect: bolt-on, molded case, three pole circuit breaker, quick make, quick break type, for manual or automatic operation, temperature compensated for 40°C ambient, magnetic instantaneous trip element.

.9 Meters and controls: grouped on front panel.

2.8 Battery

.1 Battery type and electrical characteristics:

.1 Discharge current to supply inverter at full load output, for 60 min.

.2 Sealed lead acid. Ten (10) year life.

2.9 Static Bypass Switch

.1 Two (2) solid state closed circuit automatic transfer switches.

.2 Logic unit with three (3) normal source voltage sensors, which monitor over-voltage under-voltage and loss of voltage.

.3 High speed automatic transfer from normal voltage to alternate source when:

.1 Normal source voltage lost: transfer time and sensing $^{1}/_{4}$ cycle.

.2 Normal source: under-voltage at 80% of nominal value adjustable.

.3 Normal source: over-voltage at 110% of nominal value.

.4 Loss of normal source static switch continuity.

.5 Short circuit on normal source trips normal source breaker.

.4 Return to normal source:

.1 When normal source remains within return voltage limits of 95% to 110% of nominal value (adjustable) for approximately 1 s timing interval, circuit checks voltage balance and phase synchronization, then initiates return with zero switching time.

.5 Switch position lights and contacts.

.6 Synchronizing verification light.

.7 Manual reset push-button.

.1 Transfer test switch.

.8 Alternate power source monitor light.

.9 Accessories:

.1 Manual bypass switch for maintenance and testing without load disturbance.

.2 Continuity monitor: automatic transfer to alternate source in event of static switch discontinuity.

.3 Alternate power source loss alarm contacts.

2.10 Operating Devices

.1 Operating Accessories:

.1 Counter for number of failures of normal mains AC power: non-reset type, zero to 99,999 operations.

.2 Elapsed time meter indicating accumulated time of battery discharge in minutes non-reset type, zero to 99,999.9 minutes.

.3 Elapsed time meter indicating accumulated time of inverter operation in hours, non-reset type, zero to 99,999.9 hours.

.2 Mode lights mounted on front panel to indicate:

.1 AC output on inverter – green.

.2 AC input available – green.

.3 Inverter and AC input synchronized – green.

.4 Inverter and AC input not synchronized – amber.

.5 Static bypass switch in bypass position – red.

.6 Over-temperature alarms:

.1 Rectifier – red.

.2 Inverter – red.

.3 Bypass switch – red.

.7 Cooling fan fuse open – red.

.8 Inverter output over voltage – red.

.9 Inverter output under voltage – red.

.10 Battery over-voltage – red.

.11 Battery under-voltage – red.

.12 Inverter fuse/breaker open – red.

.13 Rectifier fuse/breaker open – red.

.14 Static bypass switch fuse/breaker open - red.

.15 UPS on battery operation – red.

.16 Rectifier in equalize mode – amber.

.17 Battery discharging indicator - red, to change from steady to flashing during final 5 to 10 minutes of battery duration.

.3 Alarms: audible alarm when any mode light shows red. Silence pushbutton not to extinguish trouble light.

.4 Remote status alarm system:

.1 Two (2) status alarm annunciators for indication at two (2) remote points, up to 10 m distant. Illuminated nameplates installed in cabinets for flush mounting in existing panels.

.2 Transmission cable supplied and installed by Contractor.

.3 Transmission distance 30 m.

2.11 Finishes

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

.2 Cubicles:

.1 Inside finish: white.

.2 Exterior finish: Manufacturer's standard colour.

.3 Exterior hardware and trim: corrosion resistant and not requiring painting such as stainless steel or aluminum.

2.12 Equipment Identification

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

.2 For major components such as AC input breaker, inverter breakers, bypass switch: size 4 nameplates.

.3 For mode lights, alarms, meters: size 2 nameplates.

2.13 Fabrication

.1 Shop assemble:

.1 Rectifier unit.

.2 Inverter unit.

.3 Bypass switch unit.

.4 Battery rack and battery.

.2 Interconnect units, and add remote mode lights, alarms and controls to produce complete uninterruptible power system before requesting Contract Administrator to witness factory tests.

2.14 Approved Manufacturers

.1 The following are approved manufactures of this equipment

.1 Liebert - UPStation S3

.2 Powerware

.3 APC - DP330E

.4 Powerco

3. EXECUTION

3.1 Installation

.1 Locate UPS cubicles, battery rack and battery as indicated.

.2 Assemble and interconnect components to provide complete UPS as specified.

.3 Connect AC mains to main input terminal

.4 Connect UPS output to load.

.5 Start-up UPS and perform testing to ensure satisfactory performance.

3.2 Testing

.1 Competent field personnel to perform test, adjustments and instruction on UPS equipment.

.2 Dummy load adjustable to 150% of system rated output.

.3 Notify Contract Administrator ten (10) Business Days in advance of test date.

.4 Tests:

.1 Inspection of cubicles, battery rack and battery.

.2 Inspection of electrical connections.

.3 Inspection of installation of remote mode lights and alarms.

.4 Demonstration of system start-up and shut-down.

.5 Run UPS for minimum period of 4 h at full rated load to demonstrate proper operation with AC mains input, emergency generator input, no AC input.

.6 Discharge battery by operating UPS with AC mains open for specified duration of full load. Record readings of temperature of each cell.

.7 Recharge battery automatically with full rated load on UPS for 4 h and record readings of voltage of each cell.

.5 Complete Form 103 after successful completion of testing.

3.3 Training

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

3.4 Extended Warranty

.1 The Contractor hereby warrants the battery against defects in material and workmanship in accordance with C.13 and D25, but for ten (10) years. This warranty is for 100% replacement for the first year and prorated in equal yearly decreasing increments for the remaining nine (9) years until the expiration of the warranty at the end of ten (10) years from the date of Total Performance.

END OF SECTION

LIGHTNING PROTECTION

1. GENERAL

1.1 References

.1 ANSI/IEEE 837, Qualifying Permanent Connections Used In Substation Grounding

.2 CAN/CSA-B72, Installation Code for Lightning Protection Systems

.3 Canadian Electrical Code Part 1 C.22-1, all relevant sections

1.2 Description of System

.1 System shall conform to Class I as defined in CSA-B72. System to consist of metallic air terminals, lightning conductors connecting air terminals to ground, through roof connectors, building steel grounding attachments, secondary conductors, and conductor for connection to the below grade ground system.

1.3 Shop Drawings

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

.2 Indicate materials and methods of attachment of conductors to air terminals to satisfy the requirements noted herein and as shown on the Drawings.

2. PRODUCTS

2.1 Materials

.1 All materials to be approved by the local authority for Class I structures.

.2 Lightning protection materials shall be copper or copper alloy. Where mounted on or bonded to aluminum provide materials suitable to prevent galvanic corrosion.

.3 A minimum #2/0 gauge, tinned copper stranded conductor or as per local authority. Below grade conductors shall be #3/0 stranded copper.

.4 Fastenings and attachment straps: As per manufacturer’s recommendation and/or local authority and as shown on the Drawings.

.5 Air Terminals shall be solid copper with cast bronze base.

.6 Ground rods shall be 19 mm x 3000 mm copper clad steel.

.7 Bonding devices and miscellaneous connectors on the roof shall be cast bronze with bolt pressure connections.

.8 All connections to building structural steel shall be made with cast bronze bonding plates

.9 All buried connections, including connections to ground rods, shall be CADWELD (exothermic).

.10 All roof penetrations to be made using an approved thru-roof assembly consisting of a 13 mm stainless steel rod housed in a 38 mm PVC conduit. Top end complete with universal parallel cable connection and lower end complete with straight inline cable to rod coupler.

3. EXECUTION

3.1 General

.1 Provide a complete installation in conformance with the Drawings and the applicable codes and standards.

.2 Coordinate all through roof connections with roofing installer.

3.2 Spacing or Bonding Electrical and Lightning Rod Systems

.1 Where practicable, a clearance of at least 2 m shall be provided between lightning rod conductors and electrical conductors and equipment.

.2 Install lightning protection in accordance with CAN/CSA – B72.

.3 Submit certificate of installation to the Contract Administrator.

3.3 Inspection

.1 Provide resistance measurements of all ground rods and of complete system.

END OF SECTION

MULTIPLEX FIRE ALARM SYSTEM

1. GENERAL

1.1 Scope of Work

.1 Design, supply and install complete and working fire detection and alarm systems including but not limited to alarm initiating devices, alarm notification appliances, FACP, auxiliary control devices, annunciators and wiring for both the Sodium Hypochlorite and Chemical Storage Buildings.

1.2 References

.1 The following is a list of standards which may be referenced in this Section:

.1 IEEE: C62.41, Surge Voltages in Low-Voltage AC Power Circuits.

.2 NFPA:

.1 72, National Fire Alarm Code

.2 90A, Standard for the Installation of Air Conditioning and Ventilating Systems

.3 101, Code for Safety to Life from Fire in Buildings and Structures

.3 NEMA 250, Enclosures for Electrical Equipment (1000 V Maximum).

.4 Telecommunications Industry Association (TIA):

.1 232, Interface between Data Terminal Equipment and Data Circuit Terminating Equipment Employing Serial Binary Data Interchange

.2 485, Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems

.5 ULC:

.1 S524-M, Standard for the Installation of Fire Alarm Systems

.2 S525, Standard for Audible Signal Devices for Fire Alarm Systems

.3 S526, Standard for Visual Signal Devised for Fire Alarm Systems

.4 S527, Standard for Control Units for Fire Alarm Systems

.5 S528, Standard for Manual Pull Stations for Fire Alarm Systems

.6 S529, Standard for Smoke Detectors for Fire Alarm Systems

.7 S530, Standard for Heat Activated Fire Detectors for Fire Alarm Systems

.8 S536, Inspection and Testing of Fire Alarm Systems

.9 S537-M, Standard for the Verification of Fire Alarm Systems

.10 S541, Standard for Speakers for Fire Alarm Systems

.11 S553, Manual Pull Stations for Fire Alarm Systems, Including Accessories

.6 UL:

.1 217, Single and Multiple Station Smoke Alarms

.2 228, Door Closures-Holders, With or Without Integral Smoke Detectors

.3 268, Smoke Detectors for Fire Protective Signaling Systems

.4 286A, Smoke Detectors for Duct Application

.5 464, Audible Signal Appliances

.6 497B, Protectors for Data Communication and Fire Alarm Circuits

.7 864, Control Units for Fire-Protective Signaling Systems

.8 1449, Standard for Transient Voltage Surge Suppressors

.9 1480, Speakers for Fire-Protective Signaling Systems

.10 1604, Electrical Equipment for Use in Class I and Class II, Division 2, and Class III Hazardous (Classified) Locations

.11 1638, Visual Signaling Appliances – Private Mode Emergency and General Utility Signaling

.12 1971, Signaling Devices for the Hearing Impaired

1.3 Design Requirements:

.1 Drawings show location of fire alarm panel, annunciator panel, emergency alarm components. Other component locations and quantities shall be determined by Contractor and shall be included as part of their design. This includes, but is not limited to, smoke detectors, heat detectors, manual pull stations, duct detectors, notification appliances. Design and installation shall meet requirements of the local Authority Having Jurisdiction.

.2 Drawings show location of fire alarm system components.

.3 Coordinate, and include in design, requirements for interfacing with fuel transfer system.

.4 Equipment suitable for addressable fire alarm system.

1.4 Performance Requirements:

.1 Actuation of alarm (heat detector or other normally open initiating device contact) or trouble (trouble or supervisory switch) shall cause audible and visual indications of alarmed devices on FACP display, and on remote annunciator.

.2 Allow for fibre optic connection to master FACP for remote alarm and trouble indication.

.3 Actuation of heat detectors in generator room shall shut down fuel transfer system.

1.5 Submittals

.1 Action Submittals:

.1 Descriptive product information for each individual system component including Manufacturer's name, model number, ratings and power requirements.

.2 Dimensional drawings of panels and associated equipment.

.3 Itemized bill of material.

.4 Operating and programming instructions.

.5 Control panel configuration and module data.

.6 Complete point-to-point wiring diagrams of system and device interconnection. Identify spare connection points.

.7 Alarm initiating, indicating, and supervisory device electrical data.

.8 Annunciator configuration and module data.

.9 Plans showing device and panel locations as well as conduit and cable sizes. Prepare drawings and diagrams on drawing sheets of uniform size without extraneous information. Marked up electrical, HVAC, lighting or similar drawings or copies of catalog data sheets are not acceptable in lieu of required drawings or diagrams.

.10 Sequence of Operation Matrix.

.11 Battery sizing calculations.

.12 Supervisory power requirements for equipment.

.13 Alarm power requirements for equipment.

.14 Power supply rating justification showing power requirements for system power supplies.

.15 Voltage drop calculations for wiring runs, demonstrating worst case condition.

.16 Conduit fill calculations.

.17 Sample warranty.

.18 Recommended types and quantities for spare parts.

.19 For each system's control panel, provide written schedule of active and spare addresses provided on each addressable circuit.

.2 Informational Submittals:

.1 Experience and qualifications of firm(s) proposed to design and install system.

.2 Certifications documenting service technician's training. Certification shall indicate name of individual, training, dates, systems qualified, and current status.

.3 Copy of design documents, Shop Drawings, and calculations submitted to code-enforcement authorities.

.4 Code-enforcement authority approval letter.

.5 Factory test reports.

.6 O&M Data as specified in Section 01730 – Operation and Maintenance Manuals.

.7 Detailed program and schedule for testing, inspection, and maintenance of fire alarm system that satisfies requirements of ULC-S524, NFPA 72, Manufacturer's recommendations, and Authority Having Jurisdiction.

.8 Written documentation for logic modules as programmed, for system operation, with matrix showing interaction of input signals with output commands.

.9 System program hard copy and CD-ROM showing system functions, controls, and labelling of equipment and devices.

.10 Documentation of system voltage, current, and resistance readings taken during system installation and testing.

.11 System Record Drawings and wiring details including one set of reproducible masters and drawings on CD-ROM in a DXF format suitable for use in a CAD drafting program.

.12 NFPA 72, Record of Completion: Submit to Contract Administrator and code enforcement authorities.

.13 NFPA 72, Inspection and Testing Form: Submit to Contract Administrator and code enforcement authorities.

1.6 Quality Assurance

.1 Qualifications:

.1 Technician with minimum of Engineering Technologist Certification for fire alarm systems or Professional Engineer registered in Province of Manitoba shall be available on Site.

.2 Service technician shall be formally trained by Manufacturer.

.2 Regulatory Requirements: Submit Shop Drawings and system design calculations for approval to the following code enforcement authorities.

.1 Local and national building codes.

.2 Authority Having Jurisdiction.

2. PRODUCTS

2.1 Manufacturers

.1 Materials, equipment, and accessories specified in this section shall be products of:

.1 Siemens Building Technologies

.2 Simplex/Grinnell

.3 Notifier Fire Systems

.4 Edwards Systems Technology

2.2 General

.1 Material and equipment shall be standard products of their respective manufacturers, and shall be of a model that has been in production for not less than three (3) years. Equipment shall be supported by a service organization that is, in the opinion of Contract Administrator, reasonably convenient to Site.

.2 Contractor shall become familiar with details of Work, verify dimensions in field, and revise conduit and equipment locations to avoid obstructions and allow installation of new equipment.

.3 Contractor shall not begin system installation prior to receiving written approval of Shop Drawings from Contract Administrator.

.4 Electrical equipment shall be CSA Approved.

2.3 UL/ULC Compliance

.1 Products manufactured within scope of UL of ULC shall conform to UL/ULC Standards and have an applied UL/ULC listing mark.

.2 Equipment shall be UL/ULC listed in accordance with requirements of NFPA.

2.4 Service Conditions

.1 Altitude: Not greater 260 m above sea level.

.2 Ambient Temperature:

.1 Maximum 40°C.

.2 Minimum 10°C.

.3 Equipment shall be fully rated without derating for these conditions.

2.5 Posted Operating Instructions

.1 POIs shall be prepared on full size drawing sheets.

.2 POIs shall be framed in extruded metal frames, mounted under glass and shall be water/weather resistant. Instructions shall be permanently mounted on reserved wall area in space shown on Drawings.

.3 POIs shall include:

.1 Facility floor plans showing location of fire equipment and devices with coordinated identification. Show items such as firewalls, fire dampers, and fire alarm devices.

.2 Fire alarm wiring diagrams and schematics, with zone identification and device address list**.**

2.6 Fire Alarm Control Panels

.1 General:

.1 Control panel circuit for 24 VDC, power limited, initiating circuits per NFPA 70, Article 760.

.2 Enclosure:

.1 NEMA 250 Type 1

.2 Color: Red

.3 Internally Mounted Module with:

.1 Transformer with 120 VAC input.

.2 Solid state rectifier, fuse protected, filtered, and regulated.

.3 Solid state transfer switch, minimum 8 amp-hours.

.4 Standby batteries sized for system operating period of twenty four (24) hours of standby mode operation.

.5 Solid state battery charger.

.6 Over/under voltage monitor supervisory circuit.

.7 LEDs for status of normal power, battery trouble, and power supply module trouble.

.8 Alarm mode of 5 minutes after standby operation.

.4 Local differentiating audible sound device for alarm, trouble, and supervisory conditions.

.5 Full digital transmission protocol.

.6 Addressable signal transmission protocol to be either digital pole/response protocol or proprietary communication protocol, with all antilog sensing device signals digitally transmitted to control panel.

.7 Form C output circuitry for remote alarm control panel rated for a minimum of 2.0 amps at 30 VDC.

.8 MOV/gas discharge transient protection for power supply module, plus initiating and indicating alarm devices**.**

.9 For addressable systems provide additional 20 percent capacity for future indicating and initiating devices.

.10 EMI/RF Protection:

.1 Protect control equipment, devices, and wiring against unwanted radiated electro-magnetic interference (EMI) and from affects of audio and radio frequencies (RF) that can cause transmission of spurious alarms.

.2 System shall be designed and installed so as to be unaffected (with control cabinet faceplates installed) by operation of handheld, portable radios of up to 5 watts, or portable cellular telephones up to 1 watt, within 300 mm of system components.

.2 Three-Mode Control Panel:

.1 Alarm, supervisory, and trouble modes of operation.

.2 Modular construction with solid state microprocessor-based components and central processing unit, continuously scanning each module for status change.

.3 Operator Interface Panel:

.1 Indicators, control switches, and tone device.

.2 LCD or digital display to indicate event type and zone location or LEDs with differentiating color lenses for:

.1 AC power on

.2 Power trouble

.3 System trouble

.4 Supervisory alarm

.5 Earth-ground trouble

.6 Alarm for each zone

.7 Trouble for each zone

.8 Alarm signaling circuit trouble

.9 Annunciator circuit trouble

.3 Control Switches for:

.1 Alarm silence

.2 System reset

.3 Trouble signal silence and ring-back feature

.4 Municipal connection circuit disconnect

.5 Manual evacuation drill

.6 Auxiliary one bypass

.7 Auxiliary two bypass

.4 Piezo-electric tone device with pulsed march time rate for alarm and continuous for trouble conditions.

.4 Separate annunciator outputs rated 2 mA supervisory and 120 mAs alarm.

.5 Smoke Detector Output:

.1 Two or four wire as required, rated 2 A, 24VDC.

.2 Interrupted when system is reset.

.6 Supervised remote inputs for alarm silence and system reset.

.7 Switch Selectable:

.1 System diagnostic tests

.2 Alarm verification

.3 Alarm silence inhibit

.4 March time alarm code at cadence of 120 beats per minute

.5 Temporal alarm code repeated at ½ second on and off intervals

.6 Signal alarm circuit cutout

.7 Manual evacuation

.8 Selective signaling

.8 Four alarms and one trouble, Form C auxiliary/output relays rated 2 A, 30 VDC, 0.5 A, 120 VAC each.

.9 Minimum of twelve (12) input zones.

.3 Addressable Control Panel:

.1 Modular construction with solid state, microprocessor-based components, programmable CPU, back lighted display of primary control status and essential alarm operating conditions, and concealed, maintenance, purpose operator's keypad.

.2 Class B Signaling Line Circuits.

.3 Class B, Style Y Notification Appliance Circuits.

.4 Class B, Initiating Device Circuits.

.5 Main control module consisting of operator's keyboard/keypad, local and remote communications and supervision capabilities, system control memory, and programming interface.

.1 Two-line, back lighted, 80 alphanumerical LCD characters with:

.1 Visible cursor for entering data information.

.2 Displayable when cabinet door is open.

.2 Primary operators keypad with:

.1 Acknowledge keys and LEDs for system alarm, supervisory service, and system trouble conditions.

.2 Power on LED.

.3 Alarm silence reset keys.

.4 Displayable when cabinet door is closed.

.3 Pass code protected action display keypad for:

.1 Circuit/device enable or disable

.2 Control on/off

.3 Test/status

.4 Auto or manual

.5 Activate/reset

.6 Display historical logs/real time

.7 Function/menu

.8 Program

.9 Delete

.10 Displayable when cabinet door is open

.4 Numerical entry and selection keypad, used in conjunction with action display keypad, to perform control function on system zones, initiating circuits, or auxiliary relays, and to gain access to system information. Displayable when cabinet door is closed.

.5 Programmable control keypad with five pass code keys, associated LEDs, and identification labels for:

.1 Manual evacuation

.2 Displayable when door is open

.6 Four function keys for control of variable functions related to primary operations keypad, displayable when door is open.

.6 TIA 485, NFPA 72, Style 4, Style 6, or Style 7 data circuit capability for remote annunciators.

.7 Form C relay contacts rated 2 A, 24 VDC.

.8 Down loader port for connection to microprocessor-based transponder.

.9 Power supply interface module generating digital voltage and current data to LCD with:

.1 DC power conversion and output terminals.

.2 Supervision and control of power supply.

.10 Modules with coded input on first alarm, local trouble LED, and in/out capabilities for:

.1 120 addressable initiating alarm sensors consisting of analog/addressable or traditional detector methods.

.2 Four hardwired I/O points, field selectable in any combination to be either NFPA 72, Style B or Style D, initiating device circuits or NFPA 72, Style Y or Style Z, indicating appliance circuits or auxiliary control circuits.

.3 Auxiliary control circuit contacts shall be single-pole, double-throw, rated 2 amperes at 24VDC and 0.5 A at 120VAC.

.11 Auxiliary control circuit contacts shall be single-pole, double-throw rated, 2 A at 24 VDC and 0.5 A at 120 VAC.

.12 Two isolated TIA 232 communication port modules.

2.7 Central Processing Control Panel

.1 Modular construction with solid state, microprocessor-based programmable control processor, printer, operator console, and 10 levels of priorities for staging of system events.

.2 Operator Panel:

.1 80-character, 2-line, LCD display.

.2 Individual keys for location information, silence signal, and detector reset.

.3 Lamp test pushbutton with associated LED.

.4 Priority and trouble alarm light-emitting diode and associated acknowledge pushbuttons.

.3 Examine pushbuttons for "Monitor On" and activating control points.

.4 Keyboard consisting of 48 keys labelled with letters, numbers, and options for programming and operational commands.

.5 Printer with thermal print head for 20-column record system events produced in 80-column format.

.6 Input/output ports as required for TIA 232 communication to local UL listed printer.

.7 Selectable alarm verification and distribution processing.

.8 Capable of interfacing with remote panels connected to hardwire circuits with:

.1 Analog/addressable or traditional detectors.

.2 Either normally open or normally closed contacts.

.3 Supervised and 24 VDC operated fire alarm signaling circuits.

.4 Capable of interfacing with NFPA 72, hard-wired, Style B and Style D, initiating device circuits and NFPA 72, hard-wired, Style Y and Z, indicating appliance circuits.

.5 Fibre optic network capability.

2.8 LED Lighted Annunciator

.1 Modular constructed back illuminated, with group mounted LEDs installed in surface mounted cabinet having lockable, full hinged door panel, and red baked enamel finish.

.2 Rectangular LED units extending through black modular insert with multiple red LEDs per module, engraved zone identification nameplate above each lamp, group mounted with quick disconnect harness, and attached to door by concealed fasteners.

.1 Nameplates:

.1 12 mm high x 12 mm wide.

.2 Two lines with 11 maximum, 2.4 mm high engraved letters, and spaces per line.

.3 Black plate surface with white engraved letters.

.3 LED test feature with one test switch mounted on cabinet back plate for group test of LEDs on each module.

.4 Remote system reset key switch, trouble assembly consisting of LED, buzzer, and relay and key switch for trouble silence, two-step drill key switches, operating power trouble lamp, and audible tone alarm.

2.9 Serial Annunciators

.1 Modular constructed with 80-character LCD display and remote command modules installed in surface mounted cabinet having lockable, full hinged door panel, and red baked enamel finish.

2.10 Addressable Detector Base

.1 Solid state circuitry with integral LED visual alarm, remote LED output, DIP switch or program selectable addressing, and common base receptacle for ionization, photoelectric, and heat detectors. Device address shall be located in base.

.2 Constantly monitors detector status and status changes.

.3 Suitable for mounting on standard outlet box.

.4 Normally open contacts rated 3 A, for resistive loads.

2.11 Individual Addressable Module

.1 Solid state circuitry with selectable latch/nonlatch operating conditions and mounting plate.

.2 Monitors single and multiple devices with dry contacts.

.3 Suitable for installing inside 100 x 100 mm by 64 mm electrical box.

2.12 Initiating Device

.1 Pull Station, Fire:

.1 Constructed of die-cast metal with baked red enamel finish, weatherproof housing**,** and raised white letters stating “FIRE.”

.2 Finished Areas: Flush-mounted with hinged front cover having keyed or allen-wrench reset lock. Provide surface mounted type in unfinished areas.

.3 Where required, rated for use in hazardous environments.

.4 Recessed pull handle for single action lift door and pull handle for double action operating station with plastic break rod.

.5 Activated station pull handle, latched in protruding position until reset by key.

.6 Stations keyed alike with FACP.

.7 Normally open, contacts rated 3 A, for resistive loads.

.8 Manual Pull Station: Microprocessor-based communication circuit, DIP switch selectable address, and compatible with FACP.

.2 Heat Detector:

.1 Combination rate-of-rise and fixed, temperature elements with 57°C trip setting, complete with addressable mounting base.

.2 Fixed temperature elements with high temperature trip point in generator room, complete with addressable mounting base.

.3 Nonrestorable fixed temperature elements self-restoring rate-of-rise temperature elements.

.4 Dangling disk indicator for activated fix temperature element LED indicator for activated rate-of-rise temperature element.

.5 Attach detector bases on surface mounted octagon boxes.

.6 Conceal surface mounted boxes with surface trim skirt.

.7 Double-screw terminals for supervised connection.

.8 Normally open, contacts, rated 3 amperes, for resistive loads.

.3 Intelligent Fire Detectors:

.1 Photoelectric and thermal detector software programmable from FACP to match specific hazards and reduce nuisance tripping.

.2 Addressable base to be field mounted on octagon box.

.3 Software programmable to provide pre-alarm notification.

.4 Capable of producing alarm from photoelectric detector, thermal detector, or microprocessor logic.

.5 Field cleanable chamber with replaceable chamber components.

.6 LED in base to provide status; Pulsed green for normal status, flashing amber for fault or fail condition, and flashing red for alarm.

.4 Detector Accessories:

.1 Remote test station and power-on indictor with LED alarm indicator and two-position, key-operated switch for air duct smoke detectors.

.2 Remote LED alarm indicator.

.3 End-of-line device with normally open relay contacts for zone voltage monitoring.

2.13 Alarms

.1 Audible Alarm:

.1 General:

.1 Polarized, 24 VDC device with sound power measured dB in accordance with UL 464.

.2 Separate in/out wire leads for field connections.

.3 Baked red enamel finish.

.4 Audibility: In accordance with NFPA 72 and local requirements.

.5 Weather proof housing.

2.14 Wiring

.1 AC power wiring shall meet requirements of Section 16122 – Wires and Cables 0-1000V.

.2 Low voltage wiring shall be solid copper or bunch tinned (bonded) stranded copper, minimum 14 AWG, and shall meet NEC Article 760 for nonpower limited service.

.3 Network or addressable loop cables shall be as recommended by manufacturer for installation of their system and UL Listed for Fire Alarm Systems.

2.15 Raceways

.1 Conduit used for installation of Fire Alarm system shall follow requirements as identified in Section 16111 – Conduit, Conduit Fastenings and Conduit Fittings.

.2 Coordinate with Division 16.

2.16 End-of-Line Resistors

.1 Ohmic value and power rating as determined by manufacturer based upon number of circuit devices supplied and circuit configuration as installed.

2.17 Surge Suppressors

.1 TVSS:

.1 Provide to suppress voltage transients that might damage fire alarm panel/transmitter components. Unit shall wire in series to power supply of protected equipment with screw terminations.

.2 Unit shall be UL 1449 listed with a 330 V suppression level and have a maximum response time of 5 ns.

.3 Unit shall meet IEEE C62.41 Category B tests for surge capacity.

.4 Features:

.1 Multi-stage construction that includes inductors and silicon avalanche zener diodes.

.2 Long life indicator lamp (LED or neon lamp) which extinguishes upon failure of protection components. Fusing shall be externally accessible when this feature is available.

.5 Manufacturer and Product: Edco of Florida, Ocala, FL; Model HSP-121BT2.

3. EXECUTION

3.1 General

.1 Coordinate with other trades for mounting and interfacing with fire alarm system related devices.

.2 Install control panels, initiating and alarm devices, conduit, and wiring for interconnection of devices specified herein.

3.2 Installation

.1 Install and connect fire detection and alarm equipment in accordance with Manufacturer's instructions and recommendations, and in accordance with applicable codes and standards.

.2 Mount devices in accordance with Manufacturer's instructions.

.3 Provide outlet and junction boxes that are compatible with raceway system.

.4 Mount detector LEDs so they are readily visible from floor.

.5 Install conductors in accordance with Section 16122 – Wires and Cables 0-1000V.

.6 Install initiating alarm, signal, and communication conductors in separate and independent raceway system.

.7 Circuit wiring color-code, as established by Contractor, to be maintained throughout installation.

.8 Size conductors in accordance with device manufacturer's recommendations. Increase AWG size of alarm conductors, if necessary, to maintain terminal voltage drop within acceptable level required by NEC and NFPA.

.9 Detectors shall not be installed until after construction clean up of trades is complete, per requirements of NFPA. Exception, where required by Authority Having Jurisdiction for protection during construction, detectors installed prior to final clean-up by trades shall be cleaned or replaced.

3.3 Conduit

.1 Requirements apply to fire alarm system conduits, electrical enclosures, terminal cabinets, junction boxes, pullboxes, and device backboxes.

.2 Conduit systems shall be dedicated to fire alarm system and shall contain no unrelated conductors.

.3 Fire alarm system conduits shall be of sizes and types specified under Section 16111 – Conduits, Conduit Fastenings, and Conduit Fittings.

.1 Conduit shall be as identified under Section 16111 – Conduits, Conduit Fastenings, and Conduit Fittings. Flexible metallic conduit may be used for whips to devices only, maximum length 1.8 m, 20 mm diameter minimum. Set screw type couplings or connectors are specifically prohibited.

.2 Size conduits according to conductors contained therein. Cross sectional area percentage fill for fire alarm system conduits shall not exceed 40%.

.4 Route and install conduit to minimize potential for physical damage, either mechanical or by fire, and so as not to interfere with existing building systems, facilities or equipment, and to facilitate service and minimize maintenance. Coordinate installation between different trades to avoid conflicts.

.1 Conduit, except flexible conduit whips to devices, shall be solidly attached to building structural members or permanent walls. Conduit shall not be attached to existing conduit, ductwork, cable trays, other ceiling equipment, drop ceiling hangers/grids or partition walls, except where necessary to connect to initiating, evacuation signalling or auxiliary function devices.

.2 Conduit shall be routed either parallel or perpendicular to building structural members.

.3 Conduit shall be installed at a height so as not to obstruct any portion of a window, doorway cable tray, stairway or a passageway, and shall not interfere with operation of existing mechanical or electrical equipment.

.4 Conduit, junction boxes, pull boxes, terminal cabinets, electrical enclosures and device backboxes shall be readily accessible for inspection, testing, service and maintenance.

.5 Conduits shall be arranged to minimize the possibility of water in those conduits draining through control panels.

.1 Conduit, except nipples between control panels shall be arranged to enter control cabinets from below.

.2 Conduit shall be provided with three, 6 mm drain holes at horizontal low point beneath each control cabinet.

.6 Bushings shall be provided at termination of conduit, prior to installation of wire.

.7 Install junction boxes as necessary. Conductors shall be pulled through junction boxes, without splices.

.8 Pullboxes shall be installed in each conduit at intervals not to exceed 100 ft. Pullboxes shall be 100 mm^2, minimum.

.9 Device backboxes and junction boxes shall be sized to accommodate number of conductors contained. Extension rings or extension boxes are prohibited.

.10 Junction boxes, pull boxes, terminal cabinets, device backboxes, and raceways shall be gasketed and weather-tight per requirements of Section 16111 – Conduits, Conduit Fastenings and Conduit Fittings.

.5 Conduit, junction boxes, panels, electrical enclosures, relays and device backboxes shall be exposed in unfinished areas. Conduit and device backboxes shall be concealed in walls, ceiling spaces, electrical shafts or closets, in finished areas, except as noted on Drawings. Exposed conduit penetrations of walls shall be provided with escutcheon plates on either side of the wall.

.6 Conduit penetrations of walls, floors and ceilings will be sealed around conduit(s), by other, restoring walls, floors and ceilings to their original condition, fire resistance and integrity.

.7 Pull boxes, junction boxes, conduit bodies, and terminal cabinets shall be painted “fire engine red” prior to installation. Provide touch-up painting, of normally visible pull boxes, junction boxes, and terminal cabinets prior to final acceptance testing.

.8 Conduit shall be grounded by approved ground clamps.

.9 Mount end-of-line resistors on terminal blocks.

.10 Detection and alarm wire shall be installed in separate conduits. Outgoing and return conductors for each supervised circuit shall be routed in separately as required by NFPA 72. The minimum separation of outgoing and return conduits shall be 300 mm vertically and 1.2 m horizontally.

3.4 Identification

.1 Junction, terminal, and pulling box covers shall be painted red and identified with engraved labels by loop number and circuit that it contains.

.2 Detection and terminal devices shall have engraved alphanumeric identification that shall be keyed to posted operations and maintenance instructions.

3.5 Conductors

.1 Requirements apply to fire alarm system conductors, including all signalling line, initiating device, indicating appliance, releasing function, remote signalling, AC and DC power and grounding/shield drain circuits.

.2 Conductors shall be:

.1 New. Wire that has scrapes, nicks, gouges or crushed insulation shall not be used.

.2 Installed in conduit.

.3 Continuous between devices and between devices and intermediary terminal cabinets.

.4 Low voltage conductors shall be minimum size No. 14 AWG. Smaller conductors shall only be permitted where part of a manufacturer's specific communications cable, i.e. addressable system.

.3 Splices in conductors are specifically prohibited.

.4 Types:

.1 Conductors, except ac power conductors and grounding conductors, shall be solid copper or bunch tinned (bonded) stranded copper.

.2 Stranded copper conductors are acceptable for ac power conductors and grounding conductors only.

.5 Terminations, including field connections to supervisory resistors, diodes, relays or other devices shall be to numbered terminals or terminal strips and readily accessible for inspection, service, testing and maintenance.

.1 Terminations shall be within junction boxes, device backboxes, terminal cabinets, control panels or other suitable metal enclosures.

.2 Terminals and terminal strips shall be suitable for the size and number of conductors connected to them.

.3 Each conductor termination shall be uniquely numbered with durable plastic tags or uniquely identifiable by a combination of numbers and color codes. These conductor numbers shall be shown on Contractor's Record Drawings (floor plans and detailed wiring diagrams) in a manner allowing ready identification of conductor terminations.

.4 Wire nuts are prohibited.

.5 Where pigtail devices are factory provided with wires too short to be connected to terminal strips (i.e., solenoids), such connections shall be soldered and taped.

.6 Control Panel Wiring:

.1 Fully dressed and bundled with nylon tie wraps at 75 mm intervals.

.2 Bundled wiring shall be routed parallel to terminal strips within control panels, with individual conductors turned out at 90° angles to their associated terminal connections.

.3 AC power conductors shall be bundled and routed separately from low voltage conductors. A minimum 50 mm separation shall be maintained between ac power conductors and low voltage conductors wherever possible.

.4 Control cabinets shall be sized to accommodate the requirements of this Section.

.5 Control panels shall not be used as raceways. Conductors that do not terminate within a control panel shall not be routed through that control panel.

.7 Conductors shall be separated into the following categories:

.1 Low voltage circuits that serve devices.

.2 AC power circuits.

.8 Each category of conductors shall be installed in physically separated, dedicated conduits, and shall not interface with one another, except at common associated control equipment. Conductors shall be further segregated as necessary to conform to fire alarm system Manufacturer's recommendations and as necessary to prevent electrical crosstalk between conductors installed in common conduits.

.9 Wiring shall be THHN or TFFN stranded. Use of multi-conductor twisted pair or similar wiring is not permitted.

.10 Install as nonpower limited circuits in accordance with NFPA 72.

.11 Conductors looped around terminals are prohibited.

.12 Wire nut splices are prohibited.

.13 T-tapping of circuits is prohibited.

.14 Circuits shall be megger tested to voltage rating of their insulation before final terminations are made.

3.6 Overvoltage and Surge Protection

.1 Install TVSS for FACP as per the Manufacturer's requirements.

3.7 Repair/Restoration

.1 Touch up scratches, mars, and dents, incurred during shipment or installation of equipment.

.2 If required because of extensive damage, as determined by Contract Administrator, refinish entire assembly.

.3 Keep covers on smoke detectors until areas have been thoroughly cleaned.

3.8 Tests and Inspection

.1 In accordance with ULC-S537 and NFPA 72.

.2 Demonstrate entire system meets performance requirements specified in Article System Description.

.3 Perform tests in presence of code-enforcement authorities and Contract Administrator

.4 Each smoke detector shall be individually field tested prior to installing device at its designated location to ensure reliability after shipment and storage conditions. A dated log indicating system address, type of device, sensitivity and initials of technician performing test, using test equipment specifically designed for that purpose, shall be prepared and kept for final acceptance documentation. After testing detection devices, base shall be labeled with system address, date, and initials of installing technician. Labeling shall not be visible after installation is complete.

.5 Test wiring runs for continuity, short circuits, and grounds before system is energized. Resistance, current, and voltage readings shall be made as work progresses.

.1 Systematic record shall be maintained of all readings using schedules or charts of tests and measurements. Areas shall be provided on logging form for readings, dates, and witnesses.

.2 Notify the Authority Having Jurisdiction and Contract Administrator before start of any required tests. Correct items found at variance with Drawings or Specification during testing or inspection.

.3 Deliver test reports to the authority having jurisdiction and Contract Administrator as completed.

.6 Prepare as-built Sequence of Operations Matrix referencing each alarm input to every output function affected as a result of an alarm, trouble, or supervisory condition on that. In case of outputs programmed using more complex logic functions involving “any”, “or”, “not”, “count”, “time”, and “timer” statements; complete output equation shall be referenced in matrix.

.7 Prepare complete listing of device labels for alphanumeric annunciator displays and logging printers prior to acceptance test.

.1 Test system wiring to demonstrate correct system response and correct subsequent system operation in event of:

.1 Open, shorted, and grounded intelligent analog signaling line circuit.

.2 Open, shorted, and grounded network signaling line circuit.

.3 Open, shorted, and grounded conventional initiating device circuits.

.4 Primary power or battery disconnected.

.5 Intelligent device removal.

.6 Incorrect device address.

.7 Loss of data communications between system control panels.

.8 Loss of data communications between system annunciators.

.2 Demonstrate system evacuation alarm indicating appliances as follows:

.1 Alarm notification appliances actuate as programmed.

.2 Audibility and visibility at required levels.

.3 System indications shall be demonstrated as follows:

.1 Correct message display for each alarm input, at control panel, each remote alphanumeric LCD display.

.2 Correct annunciator light for each alarm input, at each annunciator and color graphic terminal.

.4 Demonstrate system onsite and offsite reporting functions as follows:

.1 Correct alarm custom message display, address, device type, date and time transmitted, for each alarm input.

.2 Correct trouble custom message display, address, device type, date and time transmitted, for each alarm input.

.3 Trouble signals received for disconnect.

.5 Secondary power capabilities shall be demonstrated as follows:

.1 Disconnect system primary power for a period of time as specified herein; at end of period, alarm condition shall be created and system shall perform as specified for period as specified.

.2 Restore system primary power for forty eight (48) hours and system-charging current shall be normal trickle charge for fully charged battery bank.

.3 Check system battery voltages and charging currents at FACP using test codes and LCD displays

.8 In the event system fails to perform as specified and programmed during acceptance test, test shall be terminated at discretion of acceptance inspector.

.1 Retest system, correcting deficiencies and providing test documentation to acceptance inspector.

.2 In event that software changes are required during acceptance test, system manufacturer to compare edited program with original and shall supply utility program. Utility shall yield printed list of changes and system functions, inputs and outputs affected by changes. Items listed by program shall be minimum acceptable to be retested before calling for resumption of acceptance test. Submit printed list and printer log of retesting before scheduling of acceptance test.

.3 Acceptance inspector may elect to require complete acceptance test to be performed again if, in their opinion, modifications to system hardware or software warrant complete retesting.

.9 Upon completion of tests, complete and provide the following:

.1 NFPA 72, Record of Completion, and Inspection and Testing Form.

.2 Certification that final system meets ULC.

3.9 Manufacturer's Services

.1 Furnish Manufacturer's Representative **f**or the following services at Site or classroom as designated by Contract Administrator, for minimum person-days listed below, travel time excluded:

.1 Three (3) person-days for installation assistance and inspection.

.2 Three (3) person-days for Functional and performance testing.

.3 Two (2) person-days for Prestartup classroom or Site training.

END OF SECTION

1. GENERAL

1.1 References

.1 NEMA Contactors and Motor Starters.

1.2 Related Work

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

1.3 Starter Requirements

.1 In general, there are categories of starting equipment for 3- phase motors.

.1 Integral Mounted Starters: Some items of mechanical equipment such as boilers, have the starter mounted as part of the equipment. For this equipment, supply disconnects and wire to the terminals of the equipment.

.2 Separately Mounted Starters: For motors without integral mounted starters, supply separately mounted starters as indicated on the Drawings and wire the equipment.

.3 Starters in MCC: For motors fed from motor control centres, wire from the equipment to the motor control centres.

.2 Provide manual starters for all single phase motors unless otherwise indicated on the motor schedule.

.3 Provide interlocking between starters where required.

.4 All starter accessories such as pilot lights, Hand-Off-Auto, Start-Stop, etc. whether integrally or remote mounted shall be heavy duty oil tight, unless otherwise specified.

1.4 Shop Drawings and Product Data

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

.2 Indicate:

.1 Mounting method and dimensions

.2 Starter size and type

.3 Layout of identified internal and front panel components

.4 Enclosure types

.5 Wiring diagram for each type of starter

.6 Interconnection diagrams

1.5 Operation and Maintenance Data

.1 Provide operation and maintenance data for motor starters for incorporation into manual specified in Section 16010 – Electrical General requirements.

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

1.6 Maintenance Materials

.1 Provide maintenance materials and listed spare parts for each different size and type of starter:

.1 Three (3) contacts, stationary.

.2 Three (3) contacts, movable.

.3 One (1) contacts, auxiliary.

.4 One (1) control transformer.

.5 One (1) operating coil.

.6 Two (2) fuses.

.7 10% indicating lamp bulbs used.

2. PRODUCTS

2.1 Materials

.1 Starters: to NEMA Standards

2.2 Enclosure

.1 All individually mounted motor starter enclosures shall be rated according to Section 16010 – Electrical General Requirements..

2.3 For all motors 22.4 kW and above, the starters shall contain thermistor control relay and accessories.

2.4 Manual Motor Starters

.1 Manual motor starters of size, type, rating, and enclosure type as indicated, with components as follows:

.1 Switching mechanism, quick make and break

.2 Overload heaters, manual reset, trip indicating handle

.3 Rated volts and poles to suit application.

.2 Accessories:

.1 Push-button: oil-tight labelled as indicated.

.2 Indicating lights: oil tight type and colour as indicated, LED lamps.

.3 Locking tab to permit padlocking in "ON" or "OFF" position.

2.5 Full Voltage Non Reversing (FVNR) Magnetic Starters

.1 Magnetic and combination magnetic starters of size, type, rating and enclosure type as indicated with components as follows:

.1 Contactor solenoid operated, rapid action type

.2 Motor overload protective device in each phase, manually reset from outside enclosure

.3 Wiring and schematic diagram inside starter enclosure in visible location

.4 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.

.2 Combination type starters to include motor circuit interrupter with operating lever on outside of enclosure to control motor circuit interrupter, and provision for:

.1 Locking in "OFF" position with up to three (3) padlocks.

.2 Independent locking of enclosure door.

.3 Provision for preventing switching to "ON" position while enclosure door open.

.3 Accessories:

.1 Pushbuttons and selector switches: oil tight labelled as indicated.

.2 Indicating lights: oil tight type and red pilot light to indicate energized motor circuit and where called for, green pilot light to indicate de-energized motor circuit. Pilot lights to be push-to-test transformer type. Lamps shall be LED type

.3 In addition to standard, 1-N/O and 1-N/C spare auxiliary contacts unless otherwise indicated.

.4 For all starters and components, provide interconnection wiring to WTP SCADA system. Monitored status includes the following:

.1 COA control switch position

.2 Motor running status

2.6 Full Voltage Reversing (FVR) Magnetic Starters

.1 Full voltage reversing magnetic starters of size, type, rating and enclosure type as indicated with components as follows:

.1 Two - 3 pole magnetic contactors mounted on common base

.2 Mechanical and electrical interlocks to prevent both contactors from operating at same time

.3 Three smart overload relays with adjustable settings, manual reset.

.2 Accessories:

.1 Pushbuttons and selector switches: oil-tight labelled as indicated

.2 Indicating lights: oil-tight type and color as indicated, LED type lamp

.3 Auxiliary control devices as indicated.

2.7 Multi-Speed Starters

.1 2 speed starters of size, type, rating and enclosure type as indicated. Starter suitable for constant torque, variable torque, or constant kW type motor (as required) and with components as follows:

.1 One (1) 3 pole contactor for each winding for separate winding motors.

.2 One (1) 3 pole and one (1) 5 pole contactor for each reconnectable winding for consequent pole type motors.

.3 Three overload relays with three heater elements and manual reset for each speed.

.2 Accessories:

.1 Pushbuttons and selector switches: oil-tight labelled as indicated.

.2 Indicating lights: oil-tight, type and color as indicated, LED type lamp.

.3 Auxiliary control devices as indicated.

.4 Automatic sequence accelerating and decelerating relays for each speed.

2.8 Control Transformer

.1 A control transformer of sufficient VA capacity, dry type, with primary voltage as indicated and 120 V secondary, complete with primary and secondary fuses (HRC Form J), installed in with starter as indicated.

.2 Size control transformer for control circuit load plus 20% spare capacity.

2.9 Finishes

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

2.10 Equipment Identification

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

.2 Manual starter designation label, white plate, black letters, size 1, engraved as indicated.

.3 Magnetic starter designation label, white plate, black letters, engraved as indicated.

3. EXECUTION

3.1 Installation

.1 Install starters, connect power and control as indicated.

.2 Ensure correct fuses and overload devices elements installed.

3.2 Starter Verification

.1 Field check motor starters supplied prior to Performance Verification. As a minimum, verify the following:

.1 Check of control circuits

.2 Verify that overload relay installed is correctly sized for motor used

.3 Record overload relay size and motor nameplate amperage

.4 Visual inspection of fuses and contactors

.5 Ensure all connections are tight.

.2 Measure and record motor amps, under load conditions and compare with full load amps and motor service factor. Report any excessive readings and unbalance. Measure voltage as close to motor terminals as possible while motor is running

.3 Set all motor circuit protectors to the minimum level which will consistently allow the motor to start under normal starting conditions.

3.3 Overload Relays

.1 For starters provided, select overload relays in accordance with relay and motor manufacturers' recommendations, considering motor service factors, ambient temperature, temperature differences between motor and starter locations. Monitor motor operation during Running Tests and Performance Tests to ensure motor operation is satisfactory and relays provide proper protection. For side inlet fans and other long acceleration time loads, provide special overload relays to suite the start-up condition. Provide manufacturers' curves and data sheets where necessary to provide supporting data for motor protection.

3.4 Field Quality Control

.1 Perform tests in accordance with Section 16980 – Testing, Adjusting and Balancing of Electrical Equipment and Systems and manufacturer's instructions.

.2 Operate switches, contactors to verify correct functioning.

.3 Perform starting and stopping sequences of contactors and relays.

.4 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

END OF SECTION

VARIABLE FREQUENCY DRIVES

1. GENERAL

1.1 Standards

.1 All VFDs shall meet or exceed the following specifications.

.2 Provide a complete inventory (as specified) of spare cooling fans, and fuses, for each VFD supplied.

.3 Design the adjustable frequency controller to operate standard squirrel cage induction motor with a 1.15 S.F. or definite purpose motors meeting NEMA MG1 Part 31.

.4 Harmonic loading will not exceed a motor service factor of 1.0.

.5 Use products complying with IEEE Standard 519.

.6 Use VFD units that UL listed and CSA certified.

.7 VFD unit to comply with applicable requirements of the latest standards of CSA, ANSI, IEEE and the Canadian Electrical Code.

1.2 Tests

.1 Factory testing

.1 Factory test VFD units prior to shipment. Provide confirmation from factory of actual tests completed and results.

.2 Provide certified copies of production test results required by CSA and EEMAC, prior to acceptance of the equipment.

.2 Field testing

.1 Employ the VFD Manufacturer's Rep to provide on Site startup, fine-tuning, Performance Verification, operator training and instruction.

.2 Employ the VFD Manufacturer's Representative to provide Site functionality test reports indicating loading/current levels during testing as well as control point proving results.

.3 Have the VFD Manufacturer's Representative ensure shaft to ground voltages do not exceed 1.5 V at any speed or load requirement.

.4 Allow for all costs and labour for as many trips as necessary to complete requirements.

.5 Provide a VFD installation that does not adversely affect the electrical system. Included in the Contract Documents is information on the electrical system including:

.1 Single line drawing

.2 Additional information on electrical system layout and load profile

The VFD Manufacturer's Rep can use this information to evaluate the predicted effect of the VFD installation on the electrical system and design input line reactors to mitigate these adverse effects. For the purposes of analysis, the point of common coupling (PCC) will be taken as the secondaries of the main 600 V distribution transformers.

.3 Provide certified copies of all production test results required by CSA and NEMA.

1.3 Shop Drawings

.1 Provide Shop Drawings in accordance with Section 01300 – Submittals.

.2 Indicate:

.1 Rating: voltage, amperage, maximum horsepower

.2 Mounting methods and dimensions

.3 Wiring diagram

.4 Layout and identification of front panel components

.5 Enclosure type

.6 Interconnection diagrams

.3 The Shop Drawings for each type/size of VFD must be specific to that unit. A generic shop drawing is not acceptable. The shop drawings are to include dimensions and physical details of the cabinets, a wiring diagram and a ladder diagram showing both internal connections and terminals for field wiring. Separate diagrams are required for each VFD/motor functions. Generic diagrams are not acceptable.

1.4 Operation and Maintenance Data

.1 Provide O&M data for each size and type of VFD for incorporation into the Maintenance manual as specified in Section 01730 – Operations and Maintenance Manuals.

.2 Include:

.1 Copy of the approved Shop Drawings

.2 Parameter settings and test reports

2. PRODUCTS

2.1 Variable Frequency Drives

.1 VFDs as supplied by one of the following acceptable manufacturers:

.1 ABB

.2 For variable speed controller, use electronic adjustable frequency and voltage output unit.

.3 Use VFD employing a minimum 6-pulse PWM (pulse width modulated) inverter system utilizing Insulated Gate Bipolar Transistors (IGBT) power switching devices and come complete with line reactors or DC link filters.

.4 Provide drive rated for continuous duty while operating a NEMA design induction motor of the sizes and operating voltages as shown in the following schedules and indicated on the Drawings. Size drive output for a 1.0 motor service factor. Ensure the VFD has a current rating at least 10% in excess of the motor full load amp rating. Provide overload service factors of 110% for thirty minutes and 135% for one minute, to ensure adequate safety margins. Base VFD selection on load current at constant torque ratings. Do not size VFD's based on variable torque maximums.

.5 Use a VFD that has a fixed bridge type converter (PWM) with a minimum of 98% input displacement power factor over a 10 to 100% speed range. Ensure the efficiency is a minimum of 97% for all inverters when operated at full speed and load.

.6 Input voltage - as indicated on motor schedules and drawings (line voltage variation ±10%), based on 347/600 V systems (Not 575 V). Line frequency variation ±5%. Design so that output voltage varies with motor speed to nominal motor voltage. Speed stability - ±1%. Select and design drive to match torque characteristic of load.

.7 Input frequency setting signal - selective between 4 to 20 mA or 0 to 10 VDC. Output speed monitoring signal - selective between 4 to 20 mA or 0 to 10 VDC.

.8 Open copper buswork to be tin plated.

.9 Enclosure:

.1 Install drive in motor control centres or with individual enclosure rated as required in Section 16010 – Electrical General Requirements. Provide filters for any forced air cooled enclosures as required by the Manufacturer. Use VFD(s) suitable for mounting in a typical building electrical room able to operate under these conditions with no special cleaning requirements. Mount VFD cabinets in such a way that there is adequate room for ventilation and no build up of heat. Ensure the minimum clearance in front of VFD's is 1 m.

.10 Protective devices to be incorporated are:

.1 Fast acting electronic circuit board protective devices for protection of electronic components.

.2 Supply and install 3% line reactor, in the drive input to protect electronic components from transient voltage conditions.

.3 Integral electronic motor overload protection adjustable up to 150% of motor rating for 60 seconds.

.4 Overcurrent instantaneous trip 250%.

.5 Programmable short-circuit protection.

.6 Programmable ground fault protection.

.7 Overvoltage/overcurrent DC bus monitor/protection.

.8 Undervoltage protection.

.9 Loss of phase and phase unbalance protection.

.10 Inverter over-temperature protection.

.11 Capable of running without motor for startup.

.12 Output filter package to limit motor voltage to 1200 V maximum at motor terminals.

.13 Longlead (motor feeder) filter package, as required for these installations. Contractor is responsible to determine where this will be required, at the pre-construction meeting. All motors further than 45 m from the VFD to be considered longlead.

.14 Maximum acceptable noise level is 80 dBA at 1 m.

.11 Operational features:

.1 Provide integral flush mounted display in VFD cover with keypad for programming, monitoring and operating of drive, accessible through password or other acceptable security measure only. Also provide remote keypads, completely duplicating functions of integral keypads, for all VFD(s). In these cases, locate the remote keypads on the MCC door or motor starter enclosure door.

.2 Fault shutdown and indication.

.3 Automatic restart following power outage.

.4 Ability to disconnect motor load for setup or trouble.

.5 Manual speed control (potentiometer or keypad).

.6 Adjustable maximum and minimum speed.

.7 Acceleration and deceleration time adjustment.

.8 Controller "stop" interlock from a NC dry contact.

.9 Drive fault contact.

.10 Stop/start push buttons on key pad.

.11 Transient voltage protection.

.12 Provide three (3) dry "C" type contacts programmable for any combination of the following:

.1 Running (output frequency being generated)

.2 Fault lockout

.3 Stopped

.4 At speed

.5 Under speed

.6 Forward/Reverse

.7 Low reference

.8 Manual/Auto Mode

.9 Local/Remote Mode

.13 Soft start sequence.

.14 Regenerative braking.

.15 Minimum of three (3) skip frequencies.

.16 Provide Hand/Off/Auto selector switch. Keypad H/O/A is not an acceptable replacement.

.17 Password protection of parameter programming or some method to prevent unauthorized changes.

.18 Output speed monitoring signal to be selective between 4 to 20 mA. or 0 to 10 V.

.19 Devicebus data communication link.

.1 Provide data communication links with various components in the electrical distribution system as specified in various Sections of this Division and as shown on drawings. The data communication link shall be Modbus TCP/IP.

.1 Motor control data communication link.

.2 Provide each motor control component (motor starter, VFD) with data communication link capable of communicating with the WTP SCADA system.

.2 Refer to the following Sections for the functionality of the motor controller communication link:

.1 Section 16811 – Motor Starters to 600 V

.3 The data communication link selected and used to communicate with the motor controller described above must be identical.

.12 Environmental Capabilities: Select and design the drive to operate without mechanical or electrical damage under any combination of conditions as follows:

.1 Ambient temperature -0° to 40°C.

.2 Humidity 0 to 90% (non condensing).

.3 Vibration up to 0.5 g.

.4 Altitude to 1250 m.

.5 Slight (trace) sulphur environment (H_2S) present (less than 1 ppm).

.13 Diagnostic and indicating features:

.1 Power On indication.

.2 Percentage speed indicator.

.3 Overload indication.

.4 Short circuit indication.

.5 Ground fault indication.

.6 Overvoltage indication.

.7 Undervoltage indication.

.8 High temperature (controller).

.9 AC voltmeter (output).

.10 AC ammeter (output).

.11 Inverter ready.

.12 Inverter fault.

.13 External fault.

.14 Cooling System:

.1 Provide adequate proven cooling devices for VFD equipment.

.2 Ensure any enclosure utilized will not allow a build up of heat. This can be accomplished by use of fans or sufficient guarded filtered openings, or both.

.15 Normal Distribution

.1 Normal power distribution is subject to voltage surges and sags as a normal condition of operation. Design and supply with each VFD the required inverter protection such that the VFD will not be stressed or damaged, in the following conditions:

.1 Line transients of up to 3,000 V with energy levels of 50 J.

.2 Line surges of up to 115% of rated voltage for up to ten (10) cycles. Based on 347/600 V systems.

.3 Line voltage sags down to 85% of rated voltage of up to 1 second duration.

.2 Control wiring - TEW 105° C rise.

.3 Terminal blocks in separate control enclosures for remote interface - Weidmueller SAK6N.

.4 Provide wire markers at both ends of all control wires, Electrovert Type Z.

3. EXECUTION

3.1 Operations Manual Information

.1 Orovide the VFD manufacturer an as built of each motor application. Motor application data will include at a minimum, the following:

.1 Motor manufacturer

.2 Class

.3 Motor model number

.4 Motor serial number

.5 Motor frame

.6 Motor horsepower (hp)

.7 Motor full load amps

.8 Motor conductor size

.9 Ground conductor

.10 Length of conductors from VFD to Motor

.11 Motor MCP or fuse and overload

.2 Installation

.1 Identify mounting requirements and include all materials and labour, including concrete pads for all floor mounted equipment.

.2 Install VFD(s) in locations as indicated on drawings, and connect all necessary wiring. Mount all VFD(s) as close to the motor as possible. Follow Manufacturer's recommendations for maximum distance between the VFD and the motor. The minimum clearance in front of VFD's is 1 m. See drawings attached. Where required, install longlead motor package.

.3 Extend analog input signal cable, analog speed indicating output cable, shutdown contact and drive fault contact from the drive to the BMS. Analog cable - No. 16 shielded twisted pair cable. Run control wiring in conduit separate from VFD supply and motor feeder conduits.

.4 Connect all interlocks including (but not limited to) vibration switch, freeze stats, and fire alarms to the VFD. These interlocks will be active in both the Hand (local) or Auto (remote) configurations.

.5 Ensure that all control and stop commands shut down the drive as per Manufacture's recommended procedure (example, ramp to stop, ramp and hold, or coast to stop). Contactors on the line or load side of the drive are not an approved method of control.

.6 Label MCC disconnect switch, VFD and motor isolation switch with proper shutdown procedures as follows:

"Caution"

"* Ensure VFD is stopped before operating this switch"

"* Record all faults before resetting"

.7 Run motor supply cables/conductors in conduits separate from supply feeders to line side of VFD. Do not tape or bundle conductors (supply or motor feeders) within the conduits.

.3 Field Quality Control

.1 Be responsible for complete Performance Verification of each VSD to satisfaction of the Contract Administrator. Allow for factory representative to completely calibrate all drive circuits after installation on Site.

.2 Be responsible to bring factory representative back to reset, repair, and verify proper operation of the VFD during the two year extended warranty period, if problems arise with the normal operation of the VFD. This work includes prevention of any motor shaft voltages exceeding 1.5 V when referenced to ground.

.4 VFD Check-list

.1 Upon receiving the Notice to Proceed, furnish a VFD check-list that is to be completed and submitted with the VFD Shop Drawings. An example of the VFD check-list is attached to these specifications.

.5 Software

.1 Provide VFD programming/troubleshooting software to the City.

.2 Provide VFD Parameter list "as programmed during Performance Verification" for each VFD.

.6 Equipment Identification.

.1 Provide labels/lamacoids on each VFD, MCC disconnect, isolation switch in accordance with Section 16010 – Electrical General Requirements.

.2 In addition provide signage as follows:

"Caution"

"* Ensure VFD is stopped before operating this switch"

"* Record all faults before resetting"

3.2 Training

.1 Provide Demonstration and Training on Equipment Operation and Maintenance in accordance with Section 01664 – Training, and Section 16990 – Electrical Equipment and Systems Demonstration and Instruction.

3.3 Extended Warranty

.1 The Manufacturer to provide warranty coverage for a period of two (2) years upon Total Performance when the warranty period has commenced.

.2 Review specifications of motors for application compatibility. Obtain and submit written approval from both the motor and VFD Manufacturer's confirming that both pieces of equipment are compatible when used together to maintain the required warranty.

.3 Indicate the level of local support detailing response time if a piece of equipment should fail or malfunction. Include estimated replacement part delivery times, as well as nearest parts depot location and a contact name and phone number.

.4 The manufacturer to certify that they are prepared to support the equipment for a period of at least ten (10) years from date of final acceptance

END OF SECTION

MOTOR CONTROL CENTRE

1. GENERAL

1.1 References

.1 CAN/CSA-Q9000, Quality Management and Quality Assurance Standards - Guidelines for Selection and Use.

1.2 Shop Drawings

.1 Submit shop drawings in accordance with Section 01300 – Submittals.

.2 Indicate:

.1 Outline dimensions

.2 Configuration of identified compartments

.3 Floor anchoring method and dimensioned foundation template

.4 Cable entry and exit locations

.5 Dimensioned position and size of busbars and details of provision for future extension

.6 Schematic and wiring diagrams.

1.3 Operation and Maintenance Data

.1 Provide O&M data for motor control centre for incorporation into manual specified in 01730 – Operation and Maintenance Manuals.

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

.3 Provide all software necessary to program and operate the internal components

1.4 Maintenance Materials

.1 Provide maintenance materials in accordance with Division 01 - Maintenance Materials, Special Tools and Spare Parts.

1.5 Source Quality Control

.1 Provide manufacturer's type test certificates including short circuit fault damage certification up to short circuit values specified under bus bracing.

.2 Contract Administrator to witness standard factory testing of complete motor control centre including operation of switches, circuit breakers, starters and controls.

.3 Manufacturer to provide proof of quality control program in accordance with CAN/CSA-Q9000.

2. PRODUCTS

2.1 Supply Characteristics

.1 600 V, 60 Hz, wye connected, 3 phase, 3 wire, grounded.

2.2 General Description

.1 Compartmentalized vertical sections with common power busbars.

.2 Metal enclosed, free standing, enclosed dead front.

.3 TVSS unit as described in Section 16480 – Power Surge Protectors to be installed in each MCC.

.4 Indoor EEMAC type 1A gasketed enclosure, front or back to back mounting as indicated on drawing.

.5 Class II Type B.

.6 Approved Manufacturers:

.1 Schneider Electric.

.2 Eaton Cutler Hammer.

.7 Double ended with tie breaker connection

.8 Back to back mounting with bus transition sections

.9 Control section complete with PLC, terminal blocks, power supplies as specified in Division 17.

2.3 Vertical Section Construction

.1 Independent vertical sections fabricated from rolled flat steel sheets bolted together to form rigid, completely enclosed assembly.

.2 Each vertical section divided into compartment units, minimum 165 mm high, as indicated.

.3 Each unit to have complete top and bottom steel plate for isolation between units.

.4 Horizontal wireways, equipped with cable supports, across top and bottom, extending full width of motor control centre, isolated from busbars by steel barriers.

.5 Vertical wireways c/w doors for load and control conductors extending full height of vertical sections, and equipped with cable tie supports. Installation wiring to units accessible with doors open and units in place.

.6 Openings, with removable coverplates, in side of vertical sections for horizontal wiring between sections.

.7 Incoming cables to enter at top or bottom as indicated.

.8 Provision for outgoing cables to exit via top or bottom.

.9 Removable lifting means.

.10 Provision for future extension of both ends of motor control centre including busbars without need for further drilling, cutting or preparation in field.

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

2.4 Sills

.1 Continuous 75 mm x 25 mm channel iron floor sills for mounting bases with 19 mm diameter holes for bolts.

2.5 Busbars

.1 Main horizontal and branch vertical, three phase high conductivity tin plated copper busbars in separate compartment bare self-cooled, extending entire width and height of motor control centre, supported on insulators and rated:

.1 Main horizontal busbars: as indicated.

.2 Branch vertical busbars: 300 A.

.2 Branch vertical busbars for distribution of power to units in vertical sections.

.3 No other cables, wires, equipment in main and branch busbar compartments.

.4 Brace buswork to withstand effects of short-circuit current of 65 kA rms symmetrical.

.5 Bus supports: with high dielectric strength, low moisture absorption, high impact material and long creepage, surface designed to discourage collection of dust.

2.6 Ground Bus

.1 Copper ground bus extending entire width of motor control centre.

.2 Vertical ground bus strap, full height of section, tied to horizontal ground bus, engaged by plug-in unit ground stab.

2.7 Motor Starters and Devices

.1 Equip the MCC with the combination starters as specified in Section 16811 - Motor Starters to 600 V, and as shown on the drawings.

.2 Control circuits for all starters are specified in Div 17. All starters are to be controlled and monitored by the WTP SCADA control system or the BMS as indicated on the Drawings. All control wiring to WTP SCADA control system shall be pre-wired internally from the starter to the control section and terminated at the PLC. All control wiring to the BMS system shall be pre-wired internally from the starter to the control section terminal blocks.

.3 Provide PC Windows based communications software for setting and monitoring all starter devices where necessary.

2.8 Starter Unit Compartments

.1 Units EEMAC size 5 and smaller, circuit breaker units 225 A and smaller, plug-in type with self-disconnect. Guide rail supports for units to ensure that stabs make positive contact with vertical bus. Provision for units to be installed or removed, off load, while buses energized.

.2 Unit mounting:

.1 Engaged position - unit stabbed into vertical bus.

.2 Withdrawn position - unit isolated from vertical bus but supported by structure. Terminal block accessible for electrical testing of starter.

.3 Provision for positive latching in either engaged or withdrawn position and padlocking in withdrawn position.

.4 Stab-on connectors free floating tin plated clips, self-aligning, backed up with steel springs.

.3 External operating handle of circuit switch interlocked with door to prevent door opening with switch in "on" position. Provision for one to four padlocks to lock operating handle in "off" position and lock door closed.

.4 Hinge unit doors on same side.

.5 Smart electronic overload relays manually or remotely reset from front with door closed.

.6 VFD graphic control panels shall be accessible from front with door closed.

.7 Pushbuttons, selector switches and indicating lights mounted on door front.

.8 Devices and components supplied by one manufacturer to facilitate maintenance.

.9 Pull-apart terminal blocks for power and control to allow removal of starter units without removal of field wiring.

2.9 Wiring Identification

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

2.10 Equipment Identification

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

.1 Motor control centre main nameplate: engraved as indicated.

.2 Individual compartment nameplates: engraved as indicated.

2.11 Finishes

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

.2 Paint motor control centre exterior light gray and interiors white.

3. EXECUTION

3.1 Installation

.1 Set and secure motor control centre in place on channel bases, rigid, plumb and square to building floor and wall.

.2 Make field power and control connections as indicated.

.3 Ensure correct overload elements are set.

.4 Some re-arrangement of compartments is permitted from that indicated to suit manufacturer’s standards, provided that re-arrangement gives approximately the spaces shown on the drawings. Submit arrangement drawings to the Contract Administrator before starting detailed drawings.

.5 Coordinate, with Division 03, concrete pad with bevelled edges as shown on the drawings, sized to suit MCC, install and level channel sills and mount MCC.

.6 Provide control centres with vertical sections, each 2286 mm high, 508 m deep and 508 mm wide, assembled into a group having a common power bus and forming an enclosure to which additional sections may be readily added.

.7 Provide main circuit carrying parts cable of withstanding, without damage, a line to line or line to ground shot circuit corresponding to a symmetrical RMS current of 65 KA

amperes, unless otherwise indicated. Brace main busses to withstand a similar short circuit.

.8 Design for all power and control connections to be made from the front. Make all bus and feeder bolted connections accessible from the front.

.9 Sections with horizontal wiring spaces top and bottom and with 102 mm full height vertical wiring spaces with cable tie supports. Insulate wireways from horizontal and vertical bus.

.10 Incorporate starters, circuit breakers, panels, etc. as detailed. Provide shop drawings for review before commencing fabrication.

.11 Provide all spaces complete with bussing hardware and other accessories required so that additional combination starter units can be readily installed. Provide barriers to isolate the space from all bus work.

.12 For each section of structure, provide a 3 phase horizontal bus rated as shown, and a 3 phase vertical bus rated 300 amperes. Tin plate vertical and horizontal bus at each joint. Provide a continuous copper ground bus in bottom of each section. Where indicated on MCC schedule, provide fully rated neutral. Bus - copper with labyrinth design insulation - isolation for vertical bus.

.13 Contain each complete control device within an individual metal enclosure completely isolated from all other equipment. Provide plug-in type units.

.14 Provide tin plated copper bus bar stabs reinforced with strong spring steel to ensure high contact pressure..

.15 Equip door of each individual unit with a removable plate replaceable with similar plate complete with pushbuttons, pilot lights or selector switches as required. Use pilot lights of push-to-test type and push button of heavy duty oil tight construction.

.16 Provide appropriate flanges and bus connections for incoming line and feeders.

.17 All joints and connections to be tin plated, galvanize all bolts, nuts and lock washers to resist corrosion.

.18 Provide pull apart terminal block plug in each starter for all external control connections, such that each starter unit may be easily removed. Identify all terminals.

.19 Provide barriers to isolate all buswork to prevent accidental contact when starter units are removed or spaces are provided. Also use barriers to provide phase to phase isolation of the vertical bus.

.20 Affix complete control wiring diagrams for each starter with conductor identification clearly shown to the interior cover of the starter section or provide a book of wiring diagrams for all starters in each MCC.

.21 Extend control wiring from each starter module to the Instrumentation Marshalling Panel in the same room. Install a multi unit style terminal block having screw type terminal connections on standoff supports on back plate.

.22 Number code all terminals, or otherwise suitably identified to indicate which section or module of the MCC they are associated with and their function.

3.2 Starter Verification

.1 Field check motor starters supplied prior to testing associated equipment. As a minimum, verify the following:

.1 Check of control circuits

.2 Direction of motor rotation

.3 Verify that overload relay installed in correctly sized for motor used

.4 Record overload relay size and motor nameplate amperage

.5 Visual inspection of fuses and contactors

.6 Ensure all connections are tight.

.2 Measure and record motor amps, under load conditions and compare with full load amps and motor service factor. Report any excessive readings and unbalance. Measure voltage as close to motor terminals as possible while motor is running.

.3 Set all motor circuit protectors to the minimum level which will consistently allow the motor to start under normal starting conditions.

3.3 Overload Relays

.1 For starters provided, select electronic smart overload relays with Device Net communications interface in accordance with relay and motor manufacturers' recommendations, considering motor service factors, ambient temperature, temperature differences between motor and starter locations. Monitor motor operation during start-up to ensure motor operation is satisfactory and relays provide proper protection. For side inlet fans and other long acceleration time motors, provide special overload relays to suit the start-up condition. Provide manufacturers' curves and data sheets where necessary to provide supporting data for motor protection.

3.4 Field Quality Control

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

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

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

3.5 Training

.1 Provide Demonstration and Training on Equipment Operation and Maintenance in accordance with Section 01664 – Training and Section 16990 – Electrical Equipment and Systems Demonstration and Instruction.

END OF SECTION

CONTROL DEVICES

1. GENERAL

1.1 Work Included

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

1.2 Shop Drawings

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

.2 Include schematic, wiring, interconnection diagrams.

2. PRODUCTS

2.1 AC Control Relays

.1 Convertible contact type: contacts field convertible from NO to NC, electrically held with sliding barrier to permit access to contacts only or coil only, 3-4 poles. Coil rating: 120 V. Contact rating: 120 V, min 3 A.

.2 Sealed contact type: electrically held with 3-4 poles and front mounted contact block. Coil rating: 120 V. Contact rating: 120 V, min 3 A.

.3 Universal pole type: electrically held with 3-4 poles, convertible from NO to NC by changing wiring connections. Coil rating:120 V. Contact rating: 120 V, min 3 A.

.4 Fixed contact type: heavy duty with 3-4 poles. Coil rating: 120 V. Contact rating: 120 V, min 3 A.

2.2 Relay Accessories

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

2.3 Sealed Contact Oiltight Limit Switches

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

.2 Push type switches: actuated by rod located on tip or side of operating head, spring return double pole, double throw. Contact rating: EEMAC B-600.

.3 Wobble stick cat whisker type switches: actuated by rod or stick extending from tip of operating head. Moving rod in any direction operates contacts. Double pole, double throw. Contact rating: EEMAC B-600.

.4 Lever operated: time delay switch: adjustable time delay from $^{1}/_{2}$ s to 15 s plus 25%. Contact rating: EEMAC B-600.

.5 Plug-in construction switches: CSA Type 4, lever or push type, contact rating: EEMAC A-600.

2.4 Solid State Timing Relays

.1 Construction: ac operated electronic timing relay with solid-state timing circuit to operate output contact. Timing circuit and output contact completely encapsulated to protect against vibration, humidity and atmospheric contaminants.

.2 Operation: on-delay or off-delay.

.3 Potentiometer: self contained to provide time interval adjustment.

.4 Supply voltage: 120 V, ac, 60 Hz.

.5 Temperature range: minus 20°C to 60°C.

.6 Output contact rating: maximum voltage 300 V AC or DC. Current: EEMAC B300.

.7 Timing ranges: as required.

2.5 Instantaneous Trip Current Relays

.1 Enclosure: CSA Type 1

.2 Contacts: NO, NC automatic reset with adjustable tripping point.

.3 Control: 3 wire, with provision for shorting contacts during accelerating period of motor.

.4 Contact rating: EEMAC B600.

2.6 Operator Control Stations

.1 Enclosure: CSA classification as required by Section 16010 – Electrical General Requirements, surface mounting:

2.7 Pushbuttons

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

2.8 Selector Switches

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

2.9 Indicating Lights

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

3. EXECUTION

3.1 Installation

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

3.2 Field Quality Control

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

.2 Depending upon magnitude and complexity, divide control system into convenient sections, energize one section at a time and check out operation of section.

.3 Upon completion of sectional test, undertake group testing.

.4 Check out complete system for operational sequencing.

.5 Submit to Contract Administrator one copy of test results.

END OF SECTION

LIQUID HEATERS

1. GENERAL (NOT USED)

2. PRODUCTS

2.1 Liquid Heaters

.1 Electric immersion heaters suitable for immersion in 50% sodium hydroxide. Sheath material shall be suitable for temperature range from 0ºC to 25ºC.

.2 Specification:

.1 24kW, 600V, 3 phase

.2 Flange size: 150 mm

.3 Flange material: 316 stainless steel

.4 Heating element sheath material: Monel, Inconel, or Hastelloy

.5 Heating element watt density: 2.3W/cm^2 (15W/in^2)

.6 Moisture resistant terminal box

.7 CSA certified

.8 Over temperature thermal cutout

.3 Manufactured by Chromalox.

2.2 Over Temperature Cutout

.1 Supply and Install thermal cutout device to open contactor if heater exceeds thermal limit.

2.3 Ground Fault Protection

.1 Supply and Install ground fault detection relay to provide personnel protection.

.2 Relay shall trip contractor on 150 mA of ground current

.3 Ground trip setting shall be adjustable from 150 mA to 5A.

3. EXECUTION

3.1 Installation

.1 Install heater in tank. Ensure heater element is supported internally in tank.

.2 Measure heater resistance and ensure values are within Manufacture's specified values.

.3 Program ground fault settings in protection relay

END OF SECTION

CONNECTIONS TO MECHANICAL EQUIPMENT

1. GENERAL

1.1 Related Work

.1 Mechanical: Division 15

.2 Section 16811 – Motor Starters to 600 V

1.2 Requirements

.1 Supply and Install 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 Contract. 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 Manufacture 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 3 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 Supply and Install terminations in starters and MCCs for control wiring so that starter control circuits may be extended. Where 120 V power is required for mechanical equipment, i.e., roll type filters, refrigerated aftercoolers, control cabinets, etc. wiring to the equipment terminals is the Work of this Division.

.11 Refer to Motor Control Equipment Schedule.

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

.1 Condenser Water Pumps, Chilled Water Pumps

.1 Provide all 120 V and 208 V wiring for this equipment. Provide all 120 V control wiring to chiller control panel to provide pump operation and interlocking as shown on the Drawings.

.2 Fans

.1 Provide all 120 V, 208 V and 600 V power wiring. Except where specifically noted otherwise, all control for fans is to be supplied, installed and wired from the starter control circuits to the equipment supplied as specified in Division 15. Fire alarm and smoke detection systems shall be wired to shut down fans by Division 15.

.3 Unit Heaters

.1 Supply and Install power wiring and starters for unit heater fans. Supply and Install line voltage thermostats. Where thermostats are low voltage or pneumatic, control wiring is specified in Division 15.

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. Enclosures shall be rated for the area as defined in Section 16010 – Electrical General Requirements. Switches to be HP rated, Westinghouse 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.

END OF SECTION

STARTING OF ELECTRICAL EQUIPMENT SYSTEMS

1. GENERAL

1.1 Related Work

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

1.2 Coordination

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

.1 Electrical equipment and systems specified in Division 16

.2 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 voltage and phase rotation.

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

3.2 Energizing Equipment

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

END OF SECTION

TESTING, ADJUSTING AND BALANCING OF ELECTRICAL EQUIPMENT AND SYSTEMS

1. GENERAL

1.1 Intent

.1 Except where otherwise specified, arrange and pay for testing, adjusting, balancing, and related requirements specified herein.

.2 If test results do not conform with applicable requirements, repair, replace, adjust or balance equipment and systems. Repeat testing as necessary until acceptable results are achieved.

.3 Provide all labour, materials, instruments and equipment necessary to perform the tests specified.

.4 All tests shall be witnessed by persons designated by the City, who shall also sign the test documentation.

.5 Submit procedures proposed in writing for approval two (2) weeks prior to test.

1.2 Related Work

.1 Section 16010 – Electrical General Requirements.

.2 Section 16960 – Starting of Electrical Equipment Systems.

1.3 Manufacturer's Production Test Records

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

1.4 Site Testing Reports

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

.2 Submit forms to Contract Administrator for approval prior to use.

.3 Submit completed test report forms as specified, immediately after tests are performed.

1.5 Reference Documents

.1 Perform tests in accordance with:

.1 The Contract Documents

.2 Requirements of authorities having jurisdiction

.3 Manufacturer's published instructions

.4 Applicable CSA, IEEE, IPCEA, EEMAC, and ASTM standards

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

1.6 Manufacturer's Site Services

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

.1 Specified, or

.2 Otherwise required to ensure that electrical equipment and systems are operational in full compliance with the Contract Documents.

1.7 Sequencing and Scheduling

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

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

2. PRODUCTS

2.1 Test Equipment

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

3. EXECUTION

3.1 Testing of Wiring and Wiring Devices

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

.2 Test service grounding conductors for ground resistance.

.3 Test all wiring devices for correct operation.

.4 Test all receptacles for proper polarity and circuitry.

3.2 Ground Resistance Testing

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

3.3 Load Balance Testing

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

.2 Turn on all possible loads.

.3 Test load balance on all feeders at distribution centres, MCC, and panelboards.

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

3.4 Voltage Testing and Adjusting

.1 Test voltage at all panelboards.

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

END OF SECTION

ELECTRICAL EQUIPMENT AND SYSTEMS DEMONSTRATIONS AND INSTRUCTION

1. GENERAL

1.1 Intent

.1 Provide demonstration and instruction sessions to familiarize City's O&M personnel with electrical systems and their O&M.

.2 Submit sign off sheets for each system listed prior to Substantial Performance.

.3 Complete a motor survey sheet for each motor and submit prior to Substantial Performance. Include a control wiring diagram for each motor neatly drawn in ladder form. Indicate all terminal and wire numbers. Identify all associated control components. Provide typed copies of these lists and diagrams in the O&M manuals. Include motor overload selection charts for each type and application of overload relay.

.4 All sign off and survey sheets shall be typewritten.

1.2 Manufacturer's Site Services

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

1.3 Contractor/City Coordination

.1 The Contract Administrator will chair demonstration and instruction sessions.

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

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 Systems Demonstration

.1 Demonstrate operation of following systems:

.1 Primary Distribution and Transformer

.2 600/347 V Electrical System

.3 208/120 V System

.4 Mechanical Equipment Connections and Controls

.5 Grounding System

.6 Future Connection Points and Conduit Stubs

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