

**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 Canadian Standards Association (CSA)
  - .1 CSA C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations
  - .2 CSA-C22.3 No. 1, Overhead Systems.
  - .3 CSA C22.3 No.7, Underground Systems.
  - .4 CSA CAN3-C235-83, Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
- .2 Institute of Electrical and Electronics Engineers (IEEE)
  - .1 IEEE SP1122, The Authoritative Dictionary of IEEE Standards Terms.
- .3 National Electrical Manufacturers Association (NEMA)
  - .1 NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

**1.2 DEFINITIONS**

- .1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 Submittal Procedures.
- .2 Shop drawings:
  - .1 Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure co-ordinated installation.
  - .2 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.
  - .3 Indicate of drawings clearances for operation, maintenance, and replacement of operating equipment devices.
  - .4 If changes are required, notify Departmental Representative of these changes before they are made.
  - .5 Departmental Representative will not assume the responsibility for searching out deviations in the Contractor's drawings.
- .3 Certificates:
  - .1 Provide CSA and/or cUL certified equipment and material. Where CSA certified equipment and material is not available, submit such equipment and material inspection authorities for special acceptance approval before delivery to Site.
  - .2 Submit test results of installed electrical systems and instrumentation.

- .3 Permits and fees: in accordance with General Conditions of contract.
- .4 Submit, upon completion of Work, load balance report as described in PART 3 - LOAD BALANCE.
- .5 Submit certificate of acceptance from Authority Having Jurisdiction upon completion of Work to Departmental Representative.

#### **1.4 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data:
  - .1 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.
  - .2 Operating instructions to include following:
    - .1 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
    - .2 Start up, proper adjustment, operating, lubrication, and shutdown procedures.
    - .3 Safety precautions.
    - .4 Procedures to be followed in event of equipment failure.
    - .5 Other items of instruction as recommended by manufacturer of each system or item of equipment.

#### **1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials indoors, off ground, and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: in accordance with Section 01 74 19 - Waste Management and Disposal.

### **Part 2 Products**

#### **2.1 DESIGN REQUIREMENTS**

- .1 Operating voltages: to CAN3-C235.
- .2 Electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.
  - .1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

## 2.2 MATERIALS AND EQUIPMENT

- .1 Provide material and equipment in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Equipment and material to be CSA certified. Where CSA certified equipment and/or material is not available, obtain special approval from Authority Having Jurisdiction before delivery to site and submit such approval as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
- .3 Factory assemble control panels and component assemblies.

## 2.3 WARNING SIGNS

- .1 Warning Signs: in accordance with requirements of Departmental Representative.
- .2 Lamacoid, red with white lettering, minimum size 175 x 250 mm.

## 2.4 WIRING TERMINATIONS

- .1 Ensure lugs, terminals, screws used for termination of wiring are suitable for either copper or aluminum conductors.

## 2.5 EQUIPMENT IDENTIFICATION

- .1 Identify electrical equipment with nameplates as follows:
  - .1 Nameplates: Lamacoid 3 mm thick plastic engraving sheet black face, white core, lettering accurately aligned and engraved into core mechanically attached with self-tapping screws.

- .2 Sizes as follows:

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

- .2 Wording on nameplates to be approved by Departmental Representative prior to manufacture.
- .3 Allow for minimum of twenty-five (25) letters per nameplate.
- .4 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .5 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .6 Terminal cabinets and pull boxes: indicate system and voltage.
- .7 Transformers: indicate capacity, primary and secondary voltages.

## 2.6 WIRING IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders, branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour coding: to CSA C22.1.
- .4 Use colour coded wires in communication cables, matched throughout system.

## 2.7 CONDUIT AND CABLE IDENTIFICATION

- .1 Colour code conduits, boxes and metallic sheathed cables.
- .2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.
- .3 Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour.

Type	Prime	Auxiliary
up to 250 V	Yellow	
up to 600 V	Yellow	Green
up to 5 kV	Yellow	Blue
up to 15 kV	Yellow	Red
Telephone	Green	
Other Communication Systems	Green	Blue
Fire Alarm	Red	
Emergency Voice	Red	Blue
Other Security Systems	Red	Yellow

- .4 Field verify the color coding conventions currently in use on the project site. Compare against the identification table above and advise engineer of any conflicts. Finalized color coding table to be submitted as part of the project shop drawings.

## 2.8 FINISHES

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
  - .1 Paint outdoor electrical equipment light gray finish.
  - .2 Paint indoor switchgear and distribution enclosures light gray.

## Part 3 Execution

### 3.1 INSTALLATION

- .1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.
- .2 Do overhead and underground systems in accordance with CAN/CSA-C22.3 No.1 except where specified otherwise.

### 3.2 GROUNDING

- .1 All circuits shall be installed with dedicated insulated ground wire.

### **3.3 DEDICATED NEUTRALS**

- .1 Each circuit shall have its own dedicated neutral wire. Shared neutral for more than 1 circuit shall not be permitted.

### **3.4 AREA CATEGORY AND CLASSIFICATION**

- .1 The building areas have the following electrical categories and classifications as defined in the CEC:

- .1 Tunnels: Category 1
- .2 Outside: Category 1

### **3.5 ENCLOSURES**

- .1 Dry/General NEMA 12
- .2 Wet/Outdoor NEMA 4
- .3 Transformers and CSTE NEMA 3R

### **3.6 NAMEPLATES AND LABELS**

- .1 Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.

### **3.7 CONDUIT AND CABLE INSTALLATION**

- .1 Install conduit and sleeves prior to pouring of concrete.
  - .1 Sleeves through concrete: schedule 40 steel pipe, sized for free passage of conduit, and protruding 50 mm.
- .2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
- .3 Install cables, conduits and fittings embedded or plastered over, close to building structure so furring can be kept to minimum.

### **3.8 LOCATION OF OUTLETS**

- .1 Locate outlets in accordance with Section 26 05 32 Outlet Boxes, Conduit Boxes and Fittings.
- .2 Do not install outlets back-to-back in wall; allow minimum 150 mm horizontal clearance between boxes.
  - .1 Grouped wiring devices maximum spacing 115 mm.
- .3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000 mm, and information is given before installation.
- .4 Locate light switches on latch side of doors.

### **3.9 MOUNTING HEIGHTS**

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.

- .2 If mounting height of equipment is not specified or indicated, verify with Departmental Representative before proceeding with installation.
- .3 Install electrical equipment at following heights unless indicated otherwise.
  - .1 Local switches: 1220 mm.
  - .2 Wall receptacles:
    - .1 General: 450 mm.
    - .2 Above top of continuous baseboard heater: 200 mm.
    - .3 Above top of counters or counter splash backs: 100 mm.
    - .4 In mechanical rooms: 1220 mm.
  - .3 Panelboards: as required by Code or as indicated.
  - .4 Telephone and interphone outlets: 450 mm.
  - .5 Wall mounted telephone and interphone outlets: 1500 mm.
  - .6 Fire alarm manual stations: 1200 mm.
  - .7 Fire alarm horn/strobes: 2100 mm.
  - .8 Wall mounted speakers: 2100 mm.

### **3.10 CO-ORDINATION OF PROTECTIVE DEVICES**

- .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.

### **3.11 FIELD QUALITY CONTROL**

- .1 Load Balance:
  - .1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
  - .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
  - .3 Provide upon completion of work, load balance report as directed in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS, phase and neutral currents on panelboards, dry-core transformers, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.
- .2 Conduct following tests in accordance with Section 01 45 00- Quality Control.
  - .1 Power distribution system including phasing, voltage, grounding and load balancing.
  - .2 Circuits originating from branch distribution panels.
  - .3 Lighting and its control.
  - .4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
  - .5 Systems:
    - .1 Fire Alarm.
    - .2 Security.

- .3 Communications.
- .6 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.
- .3 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

### **3.12 SYSTEM STARTUP**

- .1 Instruct Departmental Representative in operation, care and maintenance of systems, system equipment and components.

### **3.13 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for recycling or reuse in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCE STANDARDS**

- .1        Canadian Standards Association (CSA), Latest Edition
  - .1            CSA S350, Code of Practice for Safety in Demolition of Structures.

**1.2                DEFINITIONS**

- .1        Demolish: Detach items from existing construction and legally dispose of items off site, unless indicated as removed and salvaged, or removed and reinstalled.
- .2        Remove: Planned deconstruction and disassembly of electrical items from existing construction including removal of conduit, junction boxes, cabling and wiring from electrical component to panel taking care not to damage adjacent assemblies designated to remain; legally dispose of items off site, unless indicated as removed and salvaged, or removed and reinstalled.
- .3        Remove and Salvage: Detach items from existing construction and deliver them to Departmental Representative ready for reuse.
- .4        Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.
- .5        Existing to Remain: Existing items of construction that are not removed and that are not otherwise indicated as being removed and salvaged, or removed and reinstalled.
- .6        Hazardous Substances: Dangerous substances, dangerous goods, hazardous commodities and hazardous products may include asbestos, mercury and lead, PCB's, poisons, corrosive agents, flammable substances, radioactive substances, or other material that can endanger human health or wellbeing or environment if handled improperly as defined by Federal Hazardous Products Act (RSC 1985) including latest amendments.

**1.3                ACTION AND INFORMATIONAL SUBMITTALS**

- .1        Action Submittals: Provide in accordance with Section 01 33 00 – Submittal Procedures before starting work of this Section:
  - .1            Construction Waste Management Plan (CWM Plan): Submit plan addressing opportunities for reduction, reuse, or recycling of materials prepared in accordance with Section 01 74 19 – Construction Waste Management and Disposal.
  - .2            Landfill Records: Indicate receipt and acceptance of selective demolition waste and hazardous wastes by a landfill facility licensed to accept hazardous wastes.

**1.4                ADMINISTRATIVE REQUIREMENTS**

- .1        Coordination: Coordinate work of this Section to avoid interference with work by other Sections.

**Part 2 Products**

**2.1 NOT USED REPAIR MATERIALS**

- .1 Electrical Repair Materials: Use only new materials, CSA or ULC labelled as appropriate and matching components remaining after work associated with components identified for removal or demolition are completed.
- .2 Firestopping Repair Materials: Use firestopping materials compatible with existing firestopping systems where removal or demolition work affects rated assemblies, restore to match existing fire rated performance.

**2.2 SALVAGE AND DEBRIS MATERIALS**

- .1 Material Ownership: Demolished materials become Contractor's property and will be removed from Project site; except for items indicated as being reused, salvaged, reinstalled, or otherwise indicated to remain Departmental Representative's property.

**Part 3 Execution**

**3.1 EXAMINATION**

- .1 Verification of Existing Conditions: Visit site, thoroughly examine and become familiar with conditions that may affect work of this Section before tendering Bid; Departmental Representative will not consider claims for extras for work or materials necessary for proper execution and completion of contract that could have been determined by a site visit.

**3.2 PREPARATION**

- .1 Protection of Existing Systems to Remain: Protect systems and components indicated to remain in place during selective demolition operations and as follows:
  - .1 Prevent movement and install bracing to prevent settlement or damage of adjacent services and parts of existing buildings scheduled to remain.
  - .2 Notify Departmental Representative and cease operations where safety of buildings being demolished, adjacent structures or services appears to be endangered and await additional instructions before resuming demolition work specified in this Section.
  - .3 Prevent debris from blocking drainage inlets.
  - .4 Protect mechanical systems that will remain in operation.
- .2 Protection of Building Occupants: Sequence demolition work so that interference with use of the building by Departmental Representative and users is minimized and as follows:
  - .1 Prevent debris from endangering safe access to and egress from occupied buildings.
  - .2 Notify Departmental Representative and cease operations where safety of occupants appears to be endangered and await additional instructions before resuming demolition work specified in this Section.

### **3.3 EXECUTION**

- .1 Removal and demolition: Coordinate requirements of this Section with information contained in Drawings and as follows:
  - .1 Perform demolition work in a neat and workmanlike manner:
    - .1 Remove tools or equipment after completion of work and leave site clean and ready for subsequent renovation work.
    - .2 Repair and restore damages caused as a result of work of this Section to match existing materials and finishes.
  - .2 Place weatherproof blank cover plates on exterior outlet boxes remaining after demolition and removal activities.
  - .3 Remove existing conduits, boxes, cabling and wiring associated with removed luminaires, electrical devices and equipment.
  - .4 Grind off conduits and make flush with surface of concrete where conduits that are cast into concrete are being removed; seal open ends of conduit with silicone sealant and leave in place.
  - .5 Seal open ends of conduit with silicone sealant and leave in place where they are inaccessible or cannot be removed without damaging adjacent construction.

### **3.4 CLOSEOUT ACTIVITIES**

- .1 Demolition Waste Disposal: Arrange for legal disposal and remove demolished materials to accredited provincial landfill site or alternative disposal site (recycle centre) except where explicitly noted otherwise for materials being salvaged for re use in new construction in accordance with Section 02 42 00.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 CSA International (Latest Editions)
  - .1 CAN/CSA-C22.2 No.18, Outlet Boxes, Conduit Boxes and Fittings.
  - .2 CAN/CSA-C22.2 No.65, Wire Connectors (Tri-National Standard with UL 486A-486B and NMX-J-543-ANCE-03).
- .2 National Electrical Manufacturers Association (NEMA)
  - .1 C119.4 Connectors for Use between Aluminum-to-Aluminum and Aluminum-to-Copper, and Copper-to-Copper.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for wire and box connectors and include product characteristics, performance criteria, physical size, finish and limitations.

**1.3 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for wire and box connectors for incorporation into manual.

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials indoors off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect wire and box connectors from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

**Part 2 Products**

**2.1 MATERIALS**

- .1 Pressure type wire connectors to: CAN/CSA-C22.2 No.65, with current carrying parts of copper sized to fit copper conductors as required.

- .2 Fixture type splicing connectors to: CAN/CSA-C22.2 No.65, with current carrying parts of copper sized to fit copper conductors 10 AWG or less.
- .3 Bushing stud connectors: to NEMA to consist of:
  - .1 Connector body and stud clamp for stranded round conductors.
  - .2 Clamp for stranded round copper conductors.
  - .3 Stud clamp bolts.
  - .4 Bolts for copper conductors.

### **Part 3 Execution**

#### **3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for wire and box connectors installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

#### **3.2 INSTALLATION**

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

#### **3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCE STANDARDS**

- .1 Canadian Standards Association (CSA)
  - .1 CSA 22.1, Canadian Electrical Code (CEC), Part 1), Safety Standard for Electrical Installations,
  - .2 CSA C22.2 No. 0.3, Test Methods for Electrical Wires and Cables,
  - .3 CSA C22.2 No. 38, Thermoset-Insulated Wires and Cables,
  - .4 CSA 22.2 No. 131, Type TECK 90 Cable,

**1.2                PRODUCT DATA**

- .1 Provide product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Coordinate with Section 26 05 00 - Common Work Results for Electrical.
  - .1 Provide complete run lengths for all power cables from Equipment A to Equipment B.
    - .1 Provide cable type (i.e. RW90, Teck90, THWN etc.),
    - .2 Provide Conductor type (i.e. Aluminum or Copper)
    - .3 Provide Number of Conductors in cable, and size of conductors.
    - .4 Provide Number of Conductors per phase.

**1.3                DELIVERY, STORAGE AND HANDLING**

- .1 Packaging Waste Management: remove in accordance with Section 01 74 19 - Waste Management and Disposal.

**Part 2            Products**

**2.1                BUILDING WIRES**

- .1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.
- .2 Copper conductors: size as indicated, with 1000 V insulation of cross-linked thermosetting polyethylene material rated RWU90 XLPE or RW90 XLPE as indicated,
- .3 Copper conductors: size as indicated, with thermoplastic insulation type as indicated, rated at 600 V.

**2.2                TECK 90 CABLE**

- .1 Cable: in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Conductors:
  - .1 Grounding conductor: copper.
  - .2 Circuit conductors: Copper, size as indicated.

- .3 Insulation:
  - .1 Cross-linked polyethylene XLPE.
  - .2 Rating: 1000V.
- .4 Inner jacket: polyvinyl chloride.
- .5 Armour: interlocking aluminum.
- .6 Fastenings:
  - .1 One hole malleable iron straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.
  - .2 Channel type supports for two or more cables at
  - .3 Threaded rods: 6 mm diameter to support suspended channels.
- .7 Connectors:
  - .1 Watertight approved for TECK cable.

### **2.3 CONTROL CABLES**

- .1 Type: LVT: 2 soft annealed copper conductors, sized as indicated:
  - .1 Insulation: PVC.
- .2 Type: low energy 300 V control cable: solid, or stranded annealed copper conductors sized as indicated LVT: 2 soft annealed copper conductors, sized as indicated:
  - .1 Insulation: PVC, polyethylene.

## **Part 3 Execution**

### **3.1 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.

### **3.2 GENERAL CABLE INSTALLATION**

- .1 Lay cable in cable trays in accordance with Section 26 05 36 - Cable Trays for Electrical Systems.
- .2 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - (0-1000 V).
- .3 Cable Colour Coding: to Section 26 05 00 - Common Work Results for Electrical.
- .4 Conductor length for parallel feeders to be identical.
- .5 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.
- .6 Wiring in walls: typically drop or loop vertically from above to better facilitate future renovations. Generally wiring from below and horizontal wiring in walls to be avoided unless indicated.
- .7 Branch circuit wiring to be 2-wire circuits only. Common neutrals not permitted.

- .8 Provide numbered wire collars for control wiring. Numbers to correspond to control shop drawing legend. Obtain wiring diagram for control wiring.

### **3.3 INSTALLATION OF BUILDING WIRES**

- .1 Install wiring as follows:
  - .1 In conduit systems in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

### **3.4 INSTALLATION OF TECK90 CABLE (0 -1000 V)**

- .1 Group cables wherever possible on channels.
- .2 Install cables in conduit, cable troughs, or by direct burial as indicated on the Drawings.
- .3 Install cable securely supported by straps.

### **3.5 INSTALLATION OF ARMoured CABLES**

- .1 Group cables wherever possible on channels.

### **3.6 INSTALLATION OF CONTROL CABLES**

- .1 Install control cables in conduit, cable troughs, or by direct burial as indicated on the Drawings.
- .2 Ground control cable shield.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCE STANDARDS**

- .1    CSA Group, Latest Editions
  - .1    CSA C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.
  - .2    CSA C22.2 No.41, Grounding and Bonding Equipment (Tri-National Standard, with NMX-J-590ANCE and UL 467).
  - .3    CSA C22.2 No.65, Wire connectors (Tri-National Standard, with UL 486A-486B NMX-J-543-ANCE).

**1.2                ACTION AND INFORMATIONAL SUBMITTALS**

- .1    Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2    Product Data:
  - .1    Submit manufacturer's instructions, printed product literature and data sheets for connectors and terminations and include product characteristics, performance criteria, physical size, finish and limitations.
- .3    Certificates: obtain inspection certificate of compliance covering high voltage stress from Departmental Representative and include it with maintenance manuals.

**1.3                CLOSEOUT SUBMITTALS**

- .1    Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2    Operation and Maintenance Data: submit operation and maintenance data for connectors and terminations for incorporation into manual.

**1.4                DELIVERY, STORAGE AND HANDLING**

- .1    Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2    Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3    Storage and Handling Requirements:
  - .1    Store materials indoors, off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2    Store and protect connectors and terminations from nicks, scratches, and blemishes.
  - .3    Replace defective or damaged materials with new.

**Part 2 Products**

**2.1 CONNECTORS AND TERMINATIONS**

- .1 Long and short barrel copper compression connectors to CSA C22.2 No.65 and sized as required for conductors.

**Part 3 Execution**

**3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for connectors and terminations installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

**3.2 INSTALLATION**

- .1 Install stress cones, terminations, and splices in accordance with manufacturer's instructions.
- .2 Bond and ground as required to CSA C22.2No.41.

**3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1           General**

**1.1               REFERENCE STANDARDS**

- .1 American National Standards Institute /Institute of Electrical and Electronics Engineers (ANSI/IEEE)
  - .1 ANSI/IEEE 837 (Latest Edition), IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding.
- .2 CSA Group (CSA)
  - .1 CSA Z32 (Latest Edition), Electrical Safety and Essential Electrical Systems in Health Care Facilities.

**1.2               ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for grounding equipment and include product characteristics, performance criteria, physical size, finish and limitations.

**1.3               CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for grounding equipment for incorporation into manual.

**1.4               DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials off ground, indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect grounding equipment from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

**Part 2           Products**

**2.1               EQUIPMENT**

- .1 Grounding conductors: bare stranded copper, soft annealed, size as indicated.
- .2 Insulated grounding conductors: green, copper conductors, size as indicated.

- .3 Ground bus: copper, complete with insulated supports, fastenings, connectors.
- .4 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
  - .1 Grounding and bonding bushings.
  - .2 Protective type clamps.
  - .3 Bolted type conductor connectors.
  - .4 Thermit welded type conductor connectors.
  - .5 Bonding jumpers, straps.
  - .6 Pressure wire connectors.

### **Part 3 Execution**

#### **3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of the existing grounding provisions are in acceptable and compliant condition and performance.
  - .1 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .2 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

#### **3.2 INSTALLATION GENERAL**

- .1 Install connectors in accordance with manufacturer's instructions.
- .2 Protect exposed grounding conductors from mechanical injury.
- .3 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .4 Soldered joints not permitted.

#### **3.3 SYSTEM AND CIRCUIT GROUNDING**

- .1 Install system and circuit grounding connections to neutral of secondary system.

#### **3.4 EQUIPMENT GROUNDING**

- .1 Install grounding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, transformers, switchgear, duct systems, frames of motors, motor control centres, starters, control panels, building steel work, generators, elevators and escalators, distribution panels, outdoor lighting, cable trays.

#### **3.5 GROUNDING BUS**

- .1 Install copper grounding bus mounted on insulated supports on wall of electrical room and communication equipment room.
- .2 Ground items of electrical equipment in electrical room and IT equipment in communication equipment room to ground bus with individual bare stranded copper connections size 2/0AWG.

### **3.6 COMMUNICATION SYSTEMS**

- .1 Install grounding connections for telephone, sound, fire alarm, security systems, intercommunication systems as follows:
  - .1 Telephones: make telephone grounding system in accordance with telephone company's requirements.
  - .2 Sound, fire alarm, security systems, intercommunication systems as indicated.

### **3.7 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Departmental Representative and local authority having jurisdiction over installation.
- .3 Perform tests before energizing electrical system.
- .4 Disconnect ground fault indicator during tests.

### **3.8 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1            General**

**1.1                ACTION AND INFORMATIONAL SUBMITTALS**

- .1            Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2            Product Data:
  - .1            Submit manufacturer's instructions, printed product literature and data sheets for hangers and supports and include product characteristics, performance criteria, physical size, finish and limitations.

**1.2                DELIVERY, STORAGE AND HANDLING**

- .1            Deliver, store and handle materials in accordance with Section with manufacturer's written instructions 01 61 00 - Common Product Requirements.
- .2            Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3            Storage and Handling Requirements:
  - .1            Store materials indoors, off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2            Store and protect hangers and supports from nicks, scratches, and blemishes.
  - .3            Replace defective or damaged materials with new.

**Part 2            Products**

**2.1                SUPPORT CHANNELS**

- .1            U shape, size 41 x 41 mm, 2.5 mm thick, surface mounted or suspended.

**Part 3            Execution**

**3.1                EXAMINATION**

- .1            Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for hangers and supports installation in accordance with manufacturer's written instructions.
  - .1            Visually inspect substrate in presence of Departmental Representative.
  - .2            Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .3            Proceed with installation only after unacceptable conditions have been remedied.

**3.2                INSTALLATION**

- .1            Secure equipment to masonry, tile and plaster surfaces with lead anchors.
- .2            Secure equipment to poured concrete with expandable inserts.

- .3 Secure surface mounted equipment with twist clip fasteners to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment specified before installation.
- .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 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 diameter threaded rods and spring clips.
  - .2 Support 2 or more cables or conduits on channels supported by 6 mm diameter threaded rod hangers where direct fastening to building construction is impractical.
- .7 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .8 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .9 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .10 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Departmental Representative.
- .11 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

### **3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1           General**

**1.1               REFERENCE STANDARDS**

- .1   CSA Group (CSA) Latest Edition
  - .1    CSA C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.

**1.2               ACTION AND INFORMATIONAL SUBMITTALS**

- .1   Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2   Product Data:
  - .1    Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .3   Provide shop drawings: in accordance with Section 01 33 00 - Submittal Procedures.

**1.3               DELIVERY, STORAGE AND HANDLING**

- .1   Waste Management and Disposal:
  - .1    Separate waste materials for reuse or recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

**Part 2           Products**

**2.1               JUNCTION AND PULL BOXES**

- .1   Construction: welded steel enclosure.
- .2   Covers Flush Mounted: 25 mm minimum extension all around.
- .3   Covers Surface Mounted: screw-on flat or turned edge covers.

**2.2               CABINETS**

- .1   Construction: welded sheet steel hinged door, lockable handle,

**Part 3           Execution**

**3.1               JUNCTION, PULL BOXES AND CABINETS INSTALLATION**

- .1   Install pull boxes in inconspicuous but accessible locations.
- .2   Mount cabinets with top not higher than 2 m above finished floor except where indicated otherwise.
- .3   Only main junction and pull boxes are indicated. Install additional pull boxes as required by CSA C22.1.

**3.2 IDENTIFICATION**

- .1 Equipment Identification: to Section 26 05 00 - Common Work Results for Electrical.
- .2 Identification Labels: size 2 indicating voltage and phase or as indicated.

**END OF SECTION**

**Part 1           General**

**1.1               REFERENCE STANDARDS**

- .1   CSA Group (CSA), Latest Edition
  - .1    CSA C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.
  - .2    CSA C22.2 No. 18, Outlet Boxes, Conduit Boxes, Fittings, and Associated Hardware

**1.2               ACTION AND INFORMATIONAL SUBMITTALS**

- .1   Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

**1.3               DELIVERY, STORAGE AND HANDLING**

- .1   Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2   Waste Management and Disposal:
  - .1    Separate waste materials for recycling or reuse in accordance with Section 01 74 19 - Waste Management and Disposal.

**Part 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.
- .3   Gang boxes where wiring devices are grouped.
- .4   Blank cover plates for boxes without wiring devices.
- .5   347 V outlet boxes for 347 V switching devices.
- .6   Combination boxes with barriers where outlets for more than one system are grouped.

**2.2               GALVANIZED STEEL OUTLET BOXES**

- .1   One-piece electro-galvanized construction.
- .2   Single and multi-gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm or as indicated. 102 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.
- .3   Utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 102 x 54 x 48 mm.
- .4   102 mm square or octagonal outlet boxes for lighting fixture outlets.
- .5   Extension and plaster rings for flush mounting devices in finished plaster or tile walls.

**2.3 CONDUIT BOXES**

- .1 Cast FS and FD boxes with factory-threaded hubs and mounting feet for surface wiring of devices.

**2.4 FITTINGS - GENERAL**

- .1 Bushing and connectors with nylon insulated throats.
- .2 Knock-out fillers to prevent entry of debris.
- .3 Conduit outlet bodies for conduit up to 35 mm and pull boxes for larger conduits.
- .4 Double locknuts and insulated bushings on sheet metal boxes.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Support boxes independently of connecting conduits.
- .2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
- .3 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.
- .4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Do not install reducing washers.
- .5 Vacuum clean interior of outlet boxes before installation of wiring devices.
- .6 Identify systems for outlet boxes as required.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCE STANDARDS**

- .1    CSA Group (CSA), Latest Edition
  - .1    CAN/CSA C22.2 No. 18, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware, A National Standard of Canada.
  - .2    CSA C22.2 No. 45, Rigid Metal Conduit.
  - .3    CSA C22.2 No. 56, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
  - .4    CSA C22.2 No. 83, Electrical Metallic Tubing.
  - .5    CSA C22.2 No. 211.2, Rigid PVC (Unplasticized) Conduit.
  - .6    CAN/CSA C22.2 No. 227.3, Non-metallic Mechanical Protection Tubing (NMPT), A National Standard of Canada (February 2006).

**1.2                ACTION AND INFORMATIONAL SUBMITTALS**

- .1    Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2    Product data: submit manufacturer's printed product literature, specifications and datasheets.
- .3    Quality assurance submittals:
  - .1    Test reports: submit certified test reports.
  - .2    Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .3    Instructions: submit manufacturer's installation instructions.

**1.3                WASTE MANAGEMENT AND DISPOSAL**

- .1    Separate waste materials for recycling or reuse in accordance with Section 01 74 19 - Waste Management and Disposal.
- .2    Place materials defined as hazardous or toxic waste in designated containers.
- .3    Ensure emptied containers are sealed and stored safely for disposal away from children.

**Part 2            Products**

**2.1                CABLES AND REELS**

- .1    Provide cables on reels or coils.
  - .1    Mark or tag each cable and outside of each reel or coil, to indicate cable length, voltage rating, conductor size, and manufacturer's lot number and reel number.
- .2    Each coil or reel of cable to contain only one continuous cable without splices.
- .3    Identify cables for exclusively dc applications.

- .4 Reel and mark shielded cables rated 2,001 volts and above.

## **2.2 CONDUITS**

- .1 Rigid metal conduit: to CSA C22.2 No. 45, aluminium, or rigid galvanized steel threaded.
- .2 Epoxy coated conduit: to CSA C22.2 No. 45, with zinc coating and corrosion resistant epoxy finish inside and outside.
- .3 Electrical metallic tubing (EMT): to CSA C22.2 No. 83,
- .4 Rigid PVC conduit: to CSA C22.2 No. 211.2.
- .5 Flexible metal conduit: to CSA C22.2 No. 56, aluminum liquid-tight flexible metal.

## **2.3 CONDUIT FASTENINGS**

- .1 One hole malleable iron straps to secure surface conduits 50 mm and smaller.
  - .1 Two hole steel straps for conduits larger than 50 mm.
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for two or more conduits at 1 meter on centre
- .4 Threaded rods, 6 mm diameter, to support suspended channels.

## **2.4 CONDUIT FITTINGS**

- .1 Fittings: to CAN/CSA C22.2 No. 18, manufactured for use with conduit specified.  
Coating: same as conduit.
- .2 Ensure factory "ells" where 90 degrees bends for 27 mm and larger conduits.
- .3 Watertight connectors and couplings for EMT.
  - .1 Set-screws are not acceptable.

## **2.5 FISH CORD**

- .1 Polypropylene.

## **Part 3 Execution**

### **3.1 MANUFACTURER'S INSTRUCTIONS**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

### **3.2 INSTALLATION**

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 Conceal conduits except in mechanical and electrical service rooms.
- .3 Use rigid galvanized steel threaded conduit except where specified otherwise.

- .4 Use epoxy coated conduit underground.
- .5 Use electrical metallic tubing (EMT) except in cast concrete, above 2.4 m not subject to mechanical injury.
- .6 Use rigid PVC conduit in underground.
- .7 Use flexible metal conduit for connection to surface or recessed fluorescent fixtures, work in movable metal partitions, connection to recessed incandescent fixtures without prewired outlet box.
- .8 Minimum conduit size for lighting and power circuits: 21 mm.
- .9 Install rigid metal conduit from branch circuit panel to junction box in sub-floor immediately below panel.
  - .1 Run flexible conduit from junction box to outlet boxes for each computer in sub-floor.
- .10 Bend conduit cold:
  - .1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .11 Mechanically bend steel conduit over 21 mm diameter.
- .12 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .13 Install fish cord in empty conduits.
- .14 Remove and replace blocked conduit sections.
  - .1 Do not use liquids to clean out conduits.
- .15 Dry conduits out before installing wire.

### **3.3 SURFACE CONDUITS**

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
- .3 Run conduits in flanged portion of structural steel.
- .4 Group conduits wherever possible on surface or suspended channels.
- .5 Do not pass conduits through structural members except as indicated.
- .6 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

### **3.4 CONCEALED CONDUITS**

- .1 Run parallel or perpendicular to building lines.
- .2 Do not install horizontal runs in masonry walls.
- .3 Do not install conduits in terrazzo or concrete toppings.

### **3.5 CONDUITS IN CAST-IN-PLACE CONCRETE**

- .1 Locate to suit reinforcing steel.
  - .1 Install in centre one third of slab.

- .2 Protect conduits from damage where they stub out of concrete.
- .3 Install sleeves where conduits pass through slab or wall.
- .4 Provide oversized sleeve for conduits passing through waterproof membrane, before membrane is installed.
  - .1 Use cold mastic between sleeve and conduit.
- .5 Conduits in slabs: minimum slab thickness 4 times conduit diameter.
- .6 Encase conduits completely in concrete with minimum 25 mm concrete cover.
- .7 Organize conduits in slab to minimize cross-overs.

### **3.6 CONDUITS IN CAST-IN-PLACE SLABS ON GRADE**

- .1 Run conduits 27 mm and larger below slab and encase in 75 mm concrete envelope.
  - .1 Provide 50 mm of sand over concrete envelope below floor slab.

### **3.7 CONDUITS UNDERGROUND**

- .1 Slope conduits to provide drainage.
- .2 Waterproof joints (PVC excepted) with heavy coat of bituminous paint.

### **3.8 CLEANING**

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 CSA Group (CSA), Latest Editions
  - .1 CAN/CSA C22.1 No.126.1, Metal Cable Tray Systems.
  - .2 CAN/CSA C22.1 No.126.2, Non Metallic Cable Tray Systems.
- .2 National Electrical Manufacturers Association (NEMA), Latest Editions
  - .1 NEMA FG 1, Fibreglass and Cable Tray Systems.
  - .2 NEMA VE 1, Metal Cable Tray Systems.
  - .3 NEMA VE 2, Cable Tray Installation Guidelines.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: submit manufacturer's product data sheets for cable tray indicating dimensions, materials, and finishes, including classifications and certifications.
- .3 Shop Drawings: submit shop drawings showing materials, finish, dimensions, accessories, layout, and installation details.
- .4 Identify types of cabletroughs used.
- .5 Show actual cabletrough installation details and suspension system.

**1.3 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate waste materials for reuse or recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

**Part 2 Products**

**2.1 TRAY**

- .1 All tray mounted indoor shall be galvanized steel ladder type, Class C1 to CSA C22.2 No. 126.1 with 300 mm rung spacing, 150 mm side rails and width as required to prevent cable de-rating. The Contractor is responsible for increasing cable sizes due to de-rating factors from cable spacing.
- .2 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.
- .3 Provide stainless steel rod hanger clamps, rod hangers, wall mounting support brackets and all necessary accessories for complete installation.
- .4 Barriers where different voltage systems or electrical systems are in the same tray, or as indicated.

- .5 Unless otherwise approved by the Departmental Representative, provide cable trough 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 cable tray width and loading.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install complete cabletrough system.
- .2 Support cabletrough on both sides.
- .3 Remove sharp burrs or projections to prevent damage to cables or injury to personnel.

### **3.2 CABLES IN CABLETROUGH**

- .1 Install cables individually.
- .2 Lay cables into cabletrough. Use rollers when necessary to pull cables.
- .3 Secure cables in cabletrough at 6 m centres, with nylon ties.
- .4 Identify cables every 30 m with size 2 nameplates in accordance with Section 26 05 00.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCE STANDARDS**

- .1    CSA Group (CSA), Latest Edition
  - .1        CAN/CSA-Z809, Sustainable Forest Management.
- .2    Forest Stewardship Council (FSC)
  - .1        FSC-STD-01-001, FSC Principle and Criteria for Forest Stewardship.
- .3    Insulated Cable Engineers Association, Inc. (ICEA)
- .4    Sustainable Forestry Initiative (SFI)
  - .1        SFI Standard.

**1.2                ACTION AND INFORMATIONAL SUBMITTALS**

- .1    Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2    Product Data:
  - .1        Submit manufacturer's instructions, printed product literature and data sheets for cables and include product characteristics, performance criteria, physical size, finish and limitations.

**1.3                DELIVERY, STORAGE AND HANDLING**

- .1    Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2    Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3    Storage and Handling Requirements:
  - .1        Store materials indoors, off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2        Store and protect cables from nicks, scratches, and blemishes.
  - .3        Replace defective or damaged materials with new.

**Part 2            Products**

**2.1                CABLE PROTECTION**

- .1    38 x 140 mm planks pressure treated, clear.

**2.2                MARKERS**

- .1    Continuous marker tape warning of buried power or telephone cables.

**Part 3 Execution**

**3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for cable installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

**3.2 DIRECT BURIAL OF CABLES**

- .1 After sand bed in accordance with Section 31 23 33.01- Excavating, Trenching and Backfilling is in place, lay cables maintaining 75 mm clearance from each side of trench to nearest cable.
  - .1 Do not pull cable into trench.
- .2 Include offsets for thermal action and minor earth movements.
  - .1 Offset cables 150 mm minimum for each 60 m run, maintaining minimum cable separation and bending radius requirements.
- .3 Make termination and splice only as indicated leaving 0.6 meter minimum of surplus cable in each direction.
  - .1 Make splices and terminations in accordance with manufacturer's written recommendations using approved splicing kits.
- .4 Minimum permitted radius at cable bends for rubber, plastic or lead covered cables, 8 times diameter of cable or in accordance with manufacturer's written recommendations; for metallic armoured cables, 12 times diameter of cables or in accordance with manufacturer's instructions.
- .5 Cable separation:
  - .1 Maintain 75 mm minimum separation between cables of different circuits.
  - .2 Maintain 300 mm minimum horizontal separation between low and high voltage cables.
  - .3 When low voltage cables cross high voltage cables maintain 300 mm vertical separation with low voltage cables in upper position.
  - .4 At crossover, maintain 75 mm minimum vertical separation between low voltage cables and 150 mm between high voltage cables.
  - .5 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.
  - .6 Install treated planks on lower cables 0.6 m minimum in each direction at crossings.

- .6 After sand protective cover specified in Section 31 23 33.01- Excavating, Trenching and Backfilling, is in place, install continuous row of overlapping 38 x 140 mm pressure treated planks as indicated to cover length of run.

### **3.3 CABLE INSTALLATION IN DUCTS**

- .1 Install cables as indicated 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 multi conductor control cables reel off in same direction during installation.
- .6 Before pulling cable into ducts and until cables are properly terminated, seal ends of lead covered cables 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.

### **3.4 MARKERS**

- .1 Install marker tape at an elevation half way between the cable installation and grade level.

### **3.5 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Perform tests using qualified personnel.
  - .1 Include 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.
  - .1 Ensure resistance to ground of circuits is not less than 50 megohms.
- .5 Pre-acceptance tests:
  - .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.
  - .4 Leakage Current Testing:

- .1 Raise voltage in steps from zero to maximum values as specified by manufacturer for type of cable being tested.
- .2 Hold maximum voltage for specified time period by manufacturer.
- .3 Record leakage current at each step.
- .7 Provide Departmental Representative with list of test results showing location at which each test was made, circuit tested and result of each test.
- .8 Remove and replace entire length of cable if cable fails to meet any of test criteria.

### **3.6 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

### **3.7 PROTECTION**

- .1 Repair damage to adjacent materials caused by cables installation.

**END OF SECTION**

**Part 1            General**

**1.1                RELATED REQUIREMENTS**

**1.2                REFERENCE STANDARDS**

- .1    American National Standards Institute (ANSI), Latest Edition
  - .1        ANSI C39.1, Requirements, Electrical Analog Indicating Instruments.
- .2    CSA Group (CSA), Latest Edition
  - .1        CAN3-C17, Alternating - Current Electricity Metering.

**1.3                ACTION AND INFORMATIONAL SUBMITTALS**

- .1    Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2    Product Data:
  - .1        Submit manufacturer's instructions, printed product literature and data sheets for metering and switchboard instruments and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2        Include meter, instrument, outline dimensions, panel drilling dimensions and installation cutout template.

**1.4                DELIVERY, STORAGE AND HANDLING**

- .1    Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2    Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3    Storage and Handling Requirements:
  - .1        Store materials indoors, off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2        Store and protect metering and switchboard instruments from nicks, scratches, and blemishes.
  - .3        Replace defective or damaged materials with new.

**Part 2            Products**

**2.1                METER**

- .1    Kilowatt-hour, polyphase, element, energy and demand recording and indicating meter: to CAN3-C17.
- .2    Register: self-contained, instrument transformer operated, pulse contacts for transmitting signal.
- .3    Allow for remote sensing.

## **2.2 METER SOCKET**

- .1 Weatherproof metre sockets to suit meters with automatic current transformer shorting devices when metre removed.

## **2.3 METER CABINET**

- .1 Sheet steel CSA enclosure 3R

## **2.4 METERING INSTRUMENT TRANSFORMER CABINET**

- .1 Sheet steel CSA enclosure 3R transformers.

## **2.5 TEST TERMINAL BLOCKS**

- .1 Test terminal blocks: as required.

## **2.6 INDICATING INSTRUMENTS**

- .1 Indicating instruments: ANSI C39.1, 1 % accuracy, switchboard mounting:
  - .1 Ammeter: range as indicated.
  - .2 Voltmeter: range as indicated.
  - .3 Wattmeter: range as indicated.
  - .4 Varmeter: range as indicated.
  - .5 Frequency meter: range as indicated.
  - .6 Power factor meter: range as indicated.
  - .7 Synchroscope: range as indicated.

## **2.7 INSTRUMENT SELECTOR SWITCHES**

- .1 Voltmeter and Ammeter selector switches: rotary, multi-position, maintained contacts, panel mounting, round notched handle, rated to suit instruments, nameplate marked as indicated to coincide with each rotary position. Ammeter selector switches designed to preclude opening of current circuits.
- .2 Four position ammeter selector switches identified "off-A-B-C".
- .3 Four position voltmeter selector switches identified "A-B, B-C, C-A, off".
- .4 Seven position voltmeter selector switches identified "A-B, B-C, C-A, off, A-N, B-N, C-N".

## **2.8 RECORDING INSTRUMENTS**

- .1 Recording instruments: 1 % accuracy switchboard mounting:
  - .1 Ammeter: range as indicated.
  - .2 Voltmeter: range as indicated.
  - .3 Wattmeter: range as indicated.
  - .4 Varmeter: range as indicated.
  - .5 Frequency meter: range as indicated.
  - .6 Power factor meter: range as indicated.

## **2.9 SHOP INSTALLATION**

- .1 Install meters and instrument transformers in separate compartment of switchboard.
- .2 Install instruments on panel.
- .3 Ensure adequate spacing between current transformers installed on each phase.
- .4 Verify correctness of connections, polarities of meters, instruments, potential and current transformers, transducers, signal sources, electrical supplies.

## **Part 3 Execution**

### **3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for metering and switchboard instruments installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

### **3.2 METERING INSTALLATION**

- .1 Install instruments and meters in location free from vibration and shock.
- .2 Make connections in accordance with diagrams.
- .3 If applicable, ensure power factor corrective equipment connected on load side of meter.
- .4 Connect metre and instrument transformer cabinets to ground.
- .5 Locate meters within 9 m of instrument transformers.
  - .1 Use 32 mm conduit for interconnections.
  - .2 Use separate conduit for each set of current transformer connections, exclusive for metering.

### **3.3 FIELD QUALITY CONTROL**

- .1 Conduct tests in accordance with Section 26 05 00 - Common Work Results for Electrical and in accordance with manufacturer's recommendations.
- .2 Perform simulated operation tests with metering, instruments disconnected from permanent signal and other electrical sources.
- .3 Verify correctness of connections, polarities of meters, instruments, potential and current transformers, transducers, signal sources and electrical supplies.
- .4 Perform tests to obtain correct calibration.
- .5 Do not dismantle meters and instruments.

### **3.4 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

### **3.5 PROTECTION**

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by metering and switchboard instrument installation.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 CSA International
  - .1 CAN/CSA-C22.2 No.47, Air-Cooled Transformers (Dry Type).
  - .2 CSA C9, Dry-Type Transformers.
  - .3 CAN/CSA-C802.2, Minimum Efficiency Values for Dry Type Transformers.
- .2 National Electrical Manufacturers Association (NEMA)

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for dry type transformers and include product characteristics, performance criteria, physical size, finish and limitations.

**1.3 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for dry type transformers for incorporation into manual.

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials off ground, indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect dry type transformers from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

**1.5 QUALITY AND ENVIRONMENTAL ASSURANCE**

- .1 On-Site Testing Qualifications: Accredited by NETA.
- .2 Certified ISO 9001 Quality Management System.
- .3 Certified ISO 14001 Environmental System.

**Part 2 Products**

**2.1 DESIGN DESCRIPTION**

- .1 General: dry type, air-cooled, self-ventilated, code gauge steel, complete with ventilation openings, removable access panels, mounting brackets, and solderless primary and

secondary cable connectors. Enclosures to have zinc chromate prime coat and enamel finish coat per Section 16. Transformers to be single- or 3-phase as noted on the Drawings.

.2 Design:

- .1 3-phase, kVA and voltages as indicated on the Drawings, 60 Hz.
- .2 Voltage primary taps: 2.5% full capacity above and below normal.
- .3 Insulation: Class H.
- .4 Basic Impulse Level (BIL): 10 kV B.I.L.
- .5 Hipot: 4 kV.
- .6 Low-Sound-Level Requirements: Maximum sound levels when factory tested according to NEMA ST 20-2014, applied to all transformers, including those with K-factor ratings up to 20, as follows:
  - .1 9.00 kVA and less: 40 dBA.
  - .2 9.01 to 30.00 kVA: 42 dBA.
  - .3 30.01 to 50.00 kVA: 42 dBA.
  - .4 50.01 to 150.00 kVA: 47 dBA.
  - .5 150.01 to 300.00 kVA: 52 dBA
  - .6 300.01 to 500.00 kVA: 57 dBA.
  - .7 500.01 to 700.00: 59 dBA.
  - .8 700.01 to 1000.00: 61 dBA.
  - .9 1000.01 to 1500.00 kVA: 64 dBA.
- .7 Factory Sound-Level Tests: Conduct sound level tests on equipment. Provide data for each serial number upon request.
- .8 Test each transformer for required noise limit. Type testing is not acceptable.
- .9 Impedance at 170°C: 6.0% maximum up to 112.5 kVA; 5.5% maximum above 112.5 kVA.
- .10 Finish: In accordance with Section 26.
- .11 Three Phase Windings: arrange with three primary windings connected in delta and three secondary windings connected in wye.
- .12 Max. Winding Temperature: 150°C rise with temperature continuous full load.
- .13 Max. Lead Connection: 55°C rise with temperature continuous full load.
- .14 Copper winding.
- .15 All connections are front accessible only and taps.

**2.2 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 - Common Work Results for Electrical.
- .2 Label size: 7.

**Part 3 Execution**

**3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for dry type transformers installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

**3.2 INSTALLATION**

- .1 Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.
  - .1 Proceed with installation only after unsatisfactory conditions have been corrected.
  - .2 Ensure adequate clearance around transformer for ventilation.
  - .3 Construct concrete bases according to Section 03 "Cast-in-Place Concrete" or "Miscellaneous Cast-in-Place Concrete" and anchor floor-mounted transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 16 "Hangers and Supports for Electrical Systems."
  - .4 Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
  - .5 Secure transformer to concrete base according to manufacturer's written instructions.
  - .6 Rear Clearance: UL Listed for 2-inch (51-mm) clearance from wall, with clearance indicated on nameplate.
  - .7 Enclosure: NEMA 3R for outdoor applications, removable metal front panel.
  - .8 Do not install dry type transformers indoors in Category 1 or Category 2 areas.
- .2 Coordinate installation of floor, wall-mounted, and structure-hanging supports with actual transformer provided.
  - .1 Mounting: up to 45 kVA suitable for wall or floor mounting; and above 45 kVA suitable for floor mounting unless otherwise shown.
    - .1 Brace wall-mounted transformers as specified in Section 16 "Seismic Controls for Electrical Systems."
    - .2 Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer from design drawings showing acceptable installation location.
  - .2 Install transformers in level upright position.

- .3 Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- .4 Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.
- .3 Remove shipping supports only after transformer is installed and just before putting into service. Remove shipping bolts, blocking, and wedges.
- .4 Loosen isolation pad bolts until no compression is visible.
- .5 Make primary and secondary connections in accordance with wiring diagram.
- .6 Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.
- .7 Energize transformers after installation is complete.
- .8 Make conduit entry into bottom 1/3 of transformer enclosure.
- .9 Verify that ground connections are in place and requirements in Section 26 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- .10 Install transformer nameplates with specific transformer data. Nameplates and label products are specified in Section 26 "Identification for Electrical Systems."

### **3.3 PROTECTION**

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by dry type transformers installation.

### **3.4 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 CSA Group (CSA), Latest Edition
  - .1 CSA C22.2 No.29, Panelboards and Enclosed Panelboards.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for panelboards and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Include on drawings:
    - .1 Electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

**1.3 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for panelboards for incorporation into manual.

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials indoors, off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect panelboards from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

**Part 2 Products**

**2.1 PANELBOARDS**

- .1 Panelboards: to CSA C22.2 No.29 and 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 600V panelboards: bus and breakers rated for: as indicated
- .3 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.
- .4 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.
- .5 Minimum of 2 flush locks for each panel board.
  - .1 Two keys for each panelboard and key panelboards alike.
- .6 Copper bus with neutral of same ampere rating of mains.
- .7 Mains: suitable for bolt-on breakers.
- .8 Trim with concealed front bolts and hinges.
- .9 Trim and door finish: baked enamel.
- .10 Isolated ground bus.

## 2.2 **BREAKERS**

- .1 Breakers: to Section 26 28 16.02 - 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 Provide Spare Lock-on device for one 1P, one 2P and one 3P breakers. Turn over unused lock-on devices to Owner.
- .5 Provide Lock-on devices for
  - .1 Fire alarm circuit (paint this circuit red) and lock in the "On" position.
  - .2 Emergency circuits.
  - .3 Security System circuits.

## 2.3 **EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Nameplate for each panelboard size 4 engraved or as indicated.
- .3 Nameplate for each circuit in distribution panelboards size 2 engraved or as indicated.
- .4 Complete circuit directory with typewritten legend showing location and load of each circuit, mounted in plastic envelope at inside of panel door.

**Part 3 Execution**

**3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for panelboards installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

**3.2 INSTALLATION**

- .1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.
- .2 Mount panelboards to height specified in Section 26 05 00 - Common Work Results for Electrical or as indicated.
- .3 Connect loads to circuits.
- .4 Connect neutral conductors to common neutral bus with respective neutral identified.

**3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for recycling or reuse in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**3.4 PROTECTION**

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by panelboards installation.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCE STANDARDS**

- .1    CSA Group (CSA), Latest Edition
  - .1    CAN/CSA C22.2 No.94.1, Enclosures for Electrical Equipment, Non Environment Considerations.
- .2    National Electrical Manufacturers Association (NEMA)
  - .1    NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

**1.2                ACTION AND INFORMATIONAL SUBMITTALS**

- .1    Submit in accordance with Section 01 33 00- Submittal Procedures.
- .2    Product Data:
  - .1    Submit manufacturer's instructions, printed product literature and data sheets for electrical cabinets and enclosures and include product characteristics, performance criteria, physical size, finish and limitations.
- .3    Shop Drawings:
  - .1    Submit shop drawings in accordance with Section 26 05 00 – Common Work Results for Electrical.

**1.3                CLOSEOUT SUBMITTALS**

- .1    Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2    Operation and Maintenance Data: submit operation and maintenance data for electrical cabinets and enclosures for incorporation into manual.

**1.4                DELIVERY, STORAGE AND HANDLING**

- .1    Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2    Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3    Storage and Handling Requirements:
  - .1    Store materials off ground, indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2    Store and protect electrical cabinets and enclosures from nicks, scratches, and blemishes.
  - .3    Replace defective or damaged materials with new.

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**Part 2            Products**

**2.1                MATERIALS**

- .1    Enclosure constructed with 2.7 mm thick minimum steel, with weather and corrosion resistant finish to CAN/CSA C22.2, NEMA 250, size as indicated.
- .2    Entire enclosure to be capable of withstanding maximum impact force of 86 MN/m<sup>2</sup> area without rupture of material.
- .3    Removable enclosure panels with formed edges, galvanized steel external fasteners removable only from inside enclosure.
- .4    Equip enclosure with hot dipped galvanized mounting rails 1 m adjustable horizontally and vertically to enable mounting of equipment at any location within housing.
  - .1        Rails: 14 mm holes and 50 x 14 mm slots on 100 mm centres for horizontal adjustment.
  - .2        Holes in side panel flanges in 60 mm increments for vertical adjustment.
- .5    Cover: tamperproof, bolt-on, domed to shed water.
- .6    Door: 3 point latching, with padlocking means.
- .7    Ventilation panel constructed to allow air circulation yet preventing entry of foreign objects, wild life, and vermin.
- .8    Enclosure construction such as to allow configuration of single or ganged enclosures.
- .9    Enclosure capable of being shipped in knocked-down condition.

**Part 3            Execution**

**3.1                EXAMINATION**

- .1    Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for electrical cabinet and enclosure installation in accordance with manufacturer's written instructions.
  - .1        Visually inspect substrate in presence of Departmental Representative.
  - .2        Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .3        Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

**3.2                INSTALLATION**

- .1    Assemble enclosure in accordance with manufacturer's instructions and securely mount on building structure with channels, supports and fastenings.
- .2    Mount equipment in enclosure.
- .3    Label electrical cabinets and enclosure to Section 26 05 00 - Common Work Results for Electrical.

**3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for recycling or reuse in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCE STANDARDS**

- .1    National Electrical Manufacturers Association (NEMA)
  - .1        NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
  - .2        NEMA ICS 6, Industrial Control and Systems: Enclosures.
- .2    Canadian Standards Association (CSA)
  - .1        C22.2 NO. 42 - General use receptacles, attachment plugs, and similar wiring devices
  - .2        C22.2 NO. 42.1 - Cover plates for flush-mounted wiring devices (Bi-national standard, with UL 514D)
  - .3        C22.2 NO. 55 - Special use switches
  - .4        C22.2 NO. 111 - General-use snap switches (Bi-national standard, with UL 20)

**1.2                ACTION AND INFORMATIONAL SUBMITTALS**

- .1    Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2    Product Data:
  - .1        Submit manufacturer's instructions, printed product literature and data sheets for wiring devices and include product characteristics, performance criteria, physical size, finish and limitations.

**1.3                CLOSEOUT SUBMITTALS**

- .1    Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2    Operation and Maintenance Data: submit operation and maintenance data for wiring devices for incorporation into manual.

**1.4                DELIVERY, STORAGE AND HANDLING**

- .1    Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2    Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3    Storage and Handling Requirements:
  - .1        Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2        Store and protect wiring devices from nicks, scratches, and blemishes.
  - .3        Replace defective or damaged materials with new.

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**Part 2            Products**

**2.1                Switches**

- .1    120 V - 277 V, 20A, single pole, double pole, three-way and four-way
- .2    Manually-operated general purpose AC switches with following features:
  - .1    Terminal holes approved for No. 10 AWG wire.
  - .2    Silver alloy contacts.
  - .3    Urea or melamine moulding for parts subject to carbon tracking.
  - .4    Suitable for back and side wiring.
- .3    Switches of one manufacturer throughout project.

**2.2                Receptacles**

- .1    Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, to: CSA C22.2 No.42 with following features:
  - .1    Ivory urea moulded housing.
  - .2    Suitable for No. 10 AWG for back and side wiring.
  - .3    Break-off links for use as split receptacles.
  - .4    Eight back wired entrances, four side wiring screws.
  - .5    Triple wipe contacts and riveted grounding contacts.
- .2    Single receptacles CSA type 5-15 R, 125 V, 15 A, U ground with following features:
  - .1    Ivory urea moulded housing.
  - .2    Suitable for No. 10 AWG for back and side wiring.
  - .3    Four back wired entrances, 2 side wiring screws.
- .3    Other receptacles with ampacity and voltage as indicated.
- .4    Receptacles of one manufacturer throughout project.

**2.3                Cover Plates**

- .1    Cover plates for wiring devices to: CSA C22.2 No.42.1.
- .2    Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.
- .3    Provide coverplates for all wiring devices.
- .4    Use sheet steel utility box cover for wiring devices installed in surface mounted utility boxes.
- .5    Use stainless steel 1 mm thick coverplates on all wiring devices mounted in flush-mounted outlet boxes unless otherwise specified.
- .6    Weatherproof double lift spring-loaded cast aluminum coverplates, complete with gaskets for single receptacles or switches.
- .7    Weatherproof spring-loaded cast aluminum coverplates complete with gaskets for single receptacles or switches.

## **2.4 Source Quality Control**

- .1 Cover plates from one manufacturer throughout project.

## **Part 3 Execution**

### **3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for wiring devices installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

### **3.2 INSTALLATION**

- .1 Switches:
  - .1 Install single throw switches with handle in "UP" position when switch closed.
  - .2 Install switches in gang type outlet box when more than one switch is required in one location.
  - .3 Mount toggle switches at height in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Receptacles:
  - .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
  - .2 Mount receptacles at height in accordance with Section 26 05 00 - Common Work Results for Electrical.
  - .3 Where split receptacle has one portion switched, mount vertically and switch upper portion.
  - .4 Install GFI type receptacles as indicated.
- .3 Cover plates:
  - .1 Install suitable common cover plates where wiring devices are grouped.
  - .2 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

### **3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

- .3 Waste Management: separate waste materials for recycling or reuse in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**3.4 PROTECTION**

- .1 Protect installed products and components from damage during construction.
- .2 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
- .3 Repair damage to adjacent materials caused by wiring device installation.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCE STANDARDS**

- .1    CSA Group (CSA), Latest Edition
  - .1    CSA C22.2 No. 5, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, and NMX-J-266-ANCE-2010).

**1.2                ACTION AND INFORMATIONAL SUBMITTALS**

- .1    Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2    Product Data:
  - .1    Submit manufacturer's instructions, printed product literature and data sheets for circuit breakers and include product characteristics, performance criteria, physical size, finish and limitations.
- .3    Include time-current characteristic curves for breakers.
- .4    Certificates:
  - .1    Prior to installation of circuit breakers in either new or existing installation, Contractor must submit 3 copies of a production certificate of origin from the manufacturer. Production certificate of origin must be duly signed by factory and local manufacturer's representative certifying that circuit breakers come from this manufacturer and are new and meet standards and regulations.
    - .1    Production certificate of origin must be submitted to Departmental Representative for approval.
  - .2    Delay in submitting production of certificate of origin will not justify any extension of contract and additional compensation.
  - .3    Any work of manufacturing, assembly or installation to begin only after acceptance of production certificate of origin by Departmental Representative. Unless complying with this requirement, Departmental Representative reserves the right to mandate manufacturer listed on circuit breakers to authenticate new circuit breakers under the contract, and to Contractor's expense.
  - .4    Production certificate of origin must contain:
    - .1    Manufacturer's name and address and person responsible for authentication. Person responsible must sign and date certificate.
    - .2    Licensed dealer's name and address and person of distributor responsible for Contractor's account.
    - .3    Contractor's name and address and person responsible for project.
    - .4    Local manufacturer's representative name and address. Local manufacturer's representative must sign and date certificate.

### **1.3 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store circuit breakers off ground, indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect circuit breakers from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

## **Part 2 Products**

### **2.1 BREAKERS GENERAL**

- .1 Moulded-case circuit breakers, Circuit breakers, and Ground-fault circuit-interrupters, Fused circuit breakers, and Accessory high-fault protectors: to CSA C22.2 No. 5
- .2 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation.
- .3 Common-trip breakers: with single handle for multi-pole applications.
- .4 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.
  - .1 Trip settings on breakers with adjustable trips to range from 3 (three) to 8 (eight) times current rating.
- .5 Circuit breakers with interchangeable trips as indicated.
- .6 Circuit breakers to have minimum symmetrical rms interrupting capacity rating as indicated.

### **2.2 THERMAL MAGNETIC BREAKERS**

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

### **2.3 MAGNETIC BREAKERS**

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

### **2.4 OPTIONAL FEATURES**

- .1 Include:
  - .1 Shunt trip.
  - .2 Auxiliary switch.
  - .3 Motor-operated mechanism c/w time delay unit.

- .4 Under-voltage release.
- .5 On-off locking device.
- .6 Handle mechanism.

## **2.5 OPTIONAL FEATURES**

- .1 Include:
  - .1 Shunt trip.
  - .2 Auxiliary switch.
  - .3 Motor-operated mechanism c/w time delay unit.
  - .4 Under-voltage release.
  - .5 On-off locking device.
  - .6 Handle mechanism.

## **Part 3 Execution**

### **3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

### **3.2 INSTALLATION**

- .1 Install circuit breakers as indicated on Drawings and specified herein.
- .2 Install circuit breakers in panelboards to satisfy branch circuit requirements under the Scope of Work of this Contract.

### **3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for recycling or reuse in accordance with Section 01 74 19 - Waste Management and Disposal.

**END OF SECTION**

**Part 1           General**

**1.1               REFERENCE STANDARDS**

- .1 Canadian Standards Association (CSA International).
  - .1 CAN/CSA C22.2 No.4, Enclosed Switches.
  - .2 CSA C22.2 No.39-13, Fuseholder Assemblies.
- .2 National Electrical Manufacturers Association (NEMA):
  - .1 NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
  - .2 NEMA ICS 6, Industrial Control and Systems: Enclosures.

**1.2               ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00- Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for disconnect switches - fused and non-fused and include product characteristics, performance criteria, physical size, finish and limitations.

**1.3               DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials indoors, off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect disconnect switches - fused and non-fused from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

**Part 2           Products**

**2.1               Disconnect Switches**

- .1 Fusible, non-fusible, horsepower rated disconnect switch sized as indicated.
- .2 Provision for padlocking in on-off switch position by locks.
- .3 Mechanically interlocked door to prevent opening when handle in ON position.
- .4 Fuses: size as indicated, in accordance with CEC.
- .5 Fuseholders: to CSA C22.2 No.39 suitable without adaptors, for type and size of fuse indicated.

- .6 Quick-make, quick-break action.
- .7 ON-OFF switch position indication on switch enclosure cover.
- .8 Auxiliary control signal contact shall have early break.

## **2.2 Equipment Identification**

- .1 Provide equipment identification in accordance with Section 26 - Common Work Results for Electrical.
- .2 Indicate name of load controlled on size 4 nameplate.

## **Part 3 Execution**

### **3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for disconnect switches - fused and non-fused installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

### **3.2 INSTALLATION**

- .1 Install disconnect switches complete with fuses if applicable.

### **3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCE STANDARDS**

- .1    CSA Group
  - .1    CSA G40.20/G40.21, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
- .2    Institute of Electrical and Electronic Engineers (IEEE)
  - .1    IEEE 484, IEEE Recommended Practices for Installation Design and Installation of Vented Lead-Acid Batteries for Stationary Applications.
  - .2    IEEE 485, IEEE Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications.
  - .3    IEEE 450, Recommended Practice for Maintenance, Testing and Replacement of Vented Lead-Acid Batteries for Stationary Applications.
- .3    Underwriters Laboratories Inc. (UL)
  - .1    UL 94, Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

**1.2                ACTION AND INFORMATIONAL SUBMITTALS**

- .1    Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2    Product Data:
  - .1    Submit manufacturer's instructions, printed product literature and data sheets.
  - .2    Submit 2 copies of WHMIS MSDS in accordance with Section 01 35 43 - Environmental Procedures.
- .3    Shop Drawings:
  - .1    Dimensioned sketch showing battery rack, individual battery cells, recommended aisle space, headroom, assembly and anchoring of rack.
  - .2    Shipping weights.
  - .3    Individual battery cells, type, size, A.h capacity
  - .4    Specific gravity at full charge and 25 degrees C.
  - .5    Cell charge and discharge curves of voltage, current, time and capacity.
  - .6    Derating factor for temperature range (minus 10 degrees C to minus 30 degrees C).
  - .7    Maximum short circuit current.
  - .8    Maximum charging current recommended for fully discharged condition.
  - .9    Full charge voltage per cell.
  - .10   Fully discharged voltage per cell.
  - .11   Hydrogen generation and ventilation requirements.

### **1.3 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for storage batteries and racks for incorporation into manual.
  - .1 Operation and maintenance instructions concerning design elements, construction features, component functions and maintenance requirements to permit effective operation, maintenance and repair.
  - .2 Installation details of battery rack, individual cells, inter-cell connectors.
  - .3 Replacement instructions for individual cells.
  - .4 Electrolyte handling.
  - .5 Parts lists with catalogue numbers, and names and addresses of suppliers.
  - .6 Factory test records.

### **1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect battery racks from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

## **Part 2 Products**

### **2.1 MATERIALS**

- .1 Steel for battery racks: to CSA G40.20.

### **2.2 LEAD ACID BATTERIES**

- .1 Type: Valve Regulated Lead Acid (VRLA)
- .2 Electrolyte level lines: high and low on container surfaces.
- .3 Cover: one piece molded plastic, flame retardant to UL 94.
- .4 Inter-cell connectors: lead plated copper, bolted to battery posts.
  - .1 Bolt holes slightly oversized to facilitate cell replacement.
  - .2 Connectors, bolts and nuts: corrosion resistant.
- .5 Cells: of identical construction and from same production run.
- .6 Batteries: in clean state with no evidence of electrolyte on outside of cell containers.

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**Part 3 Execution**

**3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for battery rack installation in accordance with manufacturer's written instructions.
  - .1 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .2 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

**3.2 INSTALLATION**

- .1 Locate and erect battery rack.
- .2 Install battery cells on rack.
- .3 For nickel cadmium batteries, arrange vent flaps to open away from access side when cells placed in battery rack.
- .4 Clean posts and connectors and apply no-oxide grease.
- .5 Install inter-cell and inter-tier connectors, and hand tighten nuts in accordance with manufacturer's instructions.
- .6 Using torque wrenches, tighten nuts in accordance with manufacturer's recommended value.
- .7 Connect battery to load circuit.

**3.3 FIELD QUALITY CONTROL**

- .1 Check battery voltage and voltage of each cell in accordance with manufacturer's instructions.
- .2 Discharge battery at rated load for the length of time specified by the manufacturer.
- .3 Check battery voltage at terminals and voltage of each cell.
- .4 Recharge battery to full charge.
- .5 Check battery voltage and voltage of each cell.
- .6 Leave battery in fully charged state.

**END OF SECTION**

**Part 1        General**

**1.1            STANDARDS**

- .1    CSA International
  - .1    CAN/CSA-C813.1, Performance Test Method for Uninterruptible Power Supplies.

**1.2            ACTION AND INFORMATIONAL SUBMITTALS**

- .1    Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2    Product Data: include information as follows:
  - .1    Catalogue information.
  - .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    Full load kVA output at 0.8% lagging power factor.
  - .6    Battery:
    - .1    Number of batteries.
    - .2    Maximum and minimum voltages.
    - .3    Type of battery.
    - .4    Catalogue data with battery trade name and type.
    - .5    Size and weight of each battery.
    - .6    Battery charge and discharge curves of voltage, current, time and capacity.
    - .7    Derating factor for specified temperature range.
    - .8    Nominal ampere hour capacity of each battery.
    - .9    Maximum short circuit current.
    - .10   Maximum charging current expected for fully discharged condition.
    - .11   Recommended low voltage limit for fully discharged condition.
    - .12   Expected life.
  - .7    Inverter:
    - .1    Type and catalogue number.
    - .2    DC current at minimum battery voltage to produce full load AC output.
  - .8    Rectifier:
    - .1    Type and capacity, with catalogue number.

- .2 Battery charging sequence.
- .3 Current-time data for Silicon Controlled Rectifier (SCR) protective devices.
- .4 Guaranteed noise level.
- .5 Estimated life.
- .6 Metering.
- .7 Alarms.
- .9 Manufacturer's field experience with UPS of similar ratings including engineering expertise, manufacturing facilities and listing of UPS units manufactured and installed during last 5 years including model, customer, location and installation dates.
- .10 Evaluation of Canadian content.
- .11 Heat losses at no load, 25%, 50%, 75% and 100% of rated output, in kW.
- .12 Cooling air required in m<sup>3</sup>/s.
- .13 List of recommended spare parts, tools and instruments with catalogue numbers and current prices.
- .14 Typical operation and maintenance manual.
- .15 Description of factory test facilities.
- .16 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.
- .17 Manufacturer's written installation recommendations.
- .3 Shop Drawings:
  - .1 Include outline schematics showing arrangement of cubicles, meters, controls, recommended aisle spaces, battery rack, battery arrangement and dimensions.

## **Part 2 Products**

### **2.1 SYSTEM DESCRIPTION**

- .1 System to consist of:
  - .1 Input /Output Cubicle.
  - .2 Rectifier/Invertor/Battery Cubicle.
  - .3 Bypass/Isolate Switch Cubicle.
  - .4 Controls and meters.
- .2 Ensure system uses normal power supply mains and battery to provide continuous, regulated AC power to isolated load.
- .3 Equipment: capable of operating continuously and unattended.
- .4 Ensure that Uninterruptible Power Systems (UPS) is compatible with equipment that it feeds and with source from which it is fed.

## 2.2 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 Internal Static Bypass operation:
  - .1 Ensure system can be bypassed for maintenance purposes, 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 UNINTERRUPTIBLE POWER SYSTEM

- .1 Input power:
  - .1 Three phase, 120/208VAC
  - .2 Normal supply from AC mains.

- .2 Output power:
  - .1 Single phase, 120VAC
  - .2 Full load output at 0.8 power factor lagging
  - .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, 0.3 Hz maximum.
    - .3 Drift from set value - after two months normal operation within ambient temperature range of 0 degrees to 40 degrees C, not to exceed 0.6 Hz.
  - .5 Duration of full load output after mains failure not less than 90 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 3Hz.
    - .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.

## 2.4 ELECTRICAL REQUIREMENTS

- .1 In accordance with Section 26 05 00 - Common Work Results for Electrical and the Drawings.
- .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 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 2.5 mm minimum thick, CSA Enclosure 12.
- .2 Access 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.
  - .1 Doors formed wrap-around type, rigid, to open and close smoothly, locking type handle with 2 keys.
  - .2 Hinges to permit doors to be lifted off cubicle.
- .5 Cubicle height: 1.8 m maximum.
- .6 External cable connections at top of cubicle through bolted plate for drilling at site to suit.
- .7 Ambient temperature range during operation -20 degrees C to +40 degrees C. Natural or forced ventilation as required.
  - .1 For forced ventilation power from inverter output and fan directly driven by single phase motor mounted on vibration isolators.
  - .2 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 metre with A weighting and slow response, at distance of 1.8m.

- .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 moulded case three pole air circuit breaker, quick make, quick break type for manual or automatic operation, temperature compensated for 40 degrees 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 Metres, 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 hours.
  - .3 Automatic equalize charging circuit to initiate equalize charging of battery for 24 hours after discharge of 5% of ampere hour battery rating.
  - .4 Manually initiated equalize charging feature with automatic timer adjustable from 0 to 24 hours 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 moulded case, single pole, circuit breaker, quick make, quick break type, for manual or automatic operation, temperature compensated for 40 degrees 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 silicon-controlled rectifier (SCR). Components, solid state devices capable of satisfactory operation under ambient conditions of -35 degrees C to +55 degrees 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 ammeter: switchboard type, accuracy +/-2% of full scale, to measure inverter output current with 4 position selector switch to select 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, moulded case, single pole circuit breaker, quick make, quick break type, for manual or automatic operation, temperature compensated for 40 degrees C ambient, magnetic instantaneous trip element.
- .9 Meters and controls: grouped on front panel.

## **2.8 BATTERY**

- .1 Battery rack: in accordance with Section 26 33 16 - Battery Racks.
- .2 Battery type and electrical characteristics: in accordance with Section 26 33 16 - Battery Racks.
  - .1 Discharge current to supply inverter at full load output, for 90 minutes.

## **2.9 STATIC BYPASS SWITCH**

- .1 Two solid state closed circuit automatic transfer switches.
- .2 Logic unit with three normal source voltage sensors, which monitor overvoltage undervoltage 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: undervoltage 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 pushbutton.
- .8 Transfer test switch.
- .9 Alternate power source monitor light.
- .10 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 metre indicating accumulated time of battery discharge in minutes non-reset type, zero to 99,999.9 minutes.

- .3 Elapsed time metre 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 Overtemperature 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 min of battery duration.
- .3 Alarms: audible alarm when any mode light shows red. Silence pushbutton not to extinguish trouble light.

## **2.11 FABRICATION**

- .1 Shop assemble:
  - .1 Rectifier unit.
  - .2 Inverter unit.
  - .3 Bypass switch unit.
  - .4 Battery rack and battery.

## **2.12 FINISHES**

- .1 Apply finishes in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Cubicles:
  - .1 Inside finish: white.
  - .2 Exterior finish: manufacturers standard colour.

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

## **2.13 EQUIPMENT IDENTIFICATION**

- .1 Identify equipment in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .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.

## **2.14 SOURCE QUALITY CONTROL**

- .1 Test procedures:
  - .1 Prepare blank forms and check sheet with spaces for recording data.
  - .2 Mark check sheet and record test data on forms in duplicate as test proceeds. Attach metre recordings.
  - .3 Deliver duplicate of test results to Departmental Representative at end of test.
  - .4 Include information from original test as part of Operations and Maintenance Manual.
- .2 Test equipment:
  - .1 Instruments used during test, including indicating meters installed as part of system to have recent calibration certificate.
- .3 Tests:
  - .1 Visual inspection to determine:
    - .1 Materials, workmanship, and assembly conform with 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 are correct.
    - .7 Proper size fuses are installed.
    - .8 Metres have suitable range.
    - .9 Accessories are present.
    - .10 Portable metres for acceptance tests are suitable and instrument transformers connected correctly.
  - .2 Demonstrate:
    - .1 System start-up and shut down.
    - .2 Operation during mains power failure, recording output during failure and return of mains power, using oscilloscope and camera attachment. Repeat several times.

- .3 Adjustable settings.
- .4 Record values measured at test points using oscilloscope, digital multimeter, visicorder and camera attachment.
- .5 Protective devices and indications function as designed. Record actual settings, and note operation of remote indications and transfer to bypass. Tests to include:
  - .1 Annunciator lights correct indication.
  - .2 Overcurrent on inverter output.
  - .3 Over voltage and under voltage of inverter output.
  - .4 DC input voltage to inverter too low. Gradually reduce DC input voltage to inverter while delivering full load output and load to transfer automatically to bypass and inverter shut down. Record input and output values.
- .6 Simulate over temperature by applying heat to sensor with hot air blower.
- .7 Simulate fuse blowing to test indication response.
- .8 Simulate fan failure.
- .9 Bypass switch automatic operations. Record with camera/oscilloscope absence of load disturbance during automatic bypass switching.
- .10 Over voltage of rectifier DC output.
- .3 Harmonic test:
  - .1 With system fully loaded, one-half loaded, and at no load, determine total harmonic content with harmonic distortion metre at output terminals.
  - .2 Determine each harmonic magnitude with harmonic wave analyzer.
  - .3 Measure phase to neutral at 0.8 lagging power factor.
- .4 Transients:
  - .1 With normal power input, apply full load to system.
  - .2 Remove one half load.
  - .3 Reapply one half load instantly.
- .5 Steady load:
  - .1 Switch system onto AC mains, start inverter and connect dummy 0.8 power factor load.
  - .2 Operate system at full rated load for 24 hours and at 125% load for 10 minutes in ambient temperature of 40 degrees C.
  - .3 Record data at start of test and at half hour intervals thereafter; including:
    - .1 Input frequency.
    - .2 Input voltage.
    - .3 Input current.
    - .4 Input kW.
    - .5 Output voltage.
    - .6 Output current.

- .7 Output kW.
- .8 Temperature of ventilating air-in.
- .9 Temperature of ventilating air-out.
- .10 Temperature at critical zones.
- .11 DC voltage to inverter.
- .12 DC current to inverter.
- .13 Rectifier DC current.
- .6 Varying loads:
  - .1 Take one set of readings as above of no load, 25% load, 50% load, 75% load and 125% load.
  - .2 Calculate efficiencies of rectifier, inverter, and complete system.
- .7 Battery:
  - .1 Charge battery to ensure cells fully charged. When voltage reaches steady value at end of charge, record:
    - .1 Ambient temperature.
    - .2 Temperature of each cell.
    - .3 Voltage of each cell.
    - .4 Voltage of battery.
    - .5 Charging current.
    - .6 Specific gravity of each cell (lead acid battery only).
  - .2 Discharge battery by operating uninterruptible power system with AC mains open, at full rated output for duration quoted in design requirements. Record, at 5 minutes intervals:
    - .1 Voltage of battery.
    - .2 Current.
    - .3 Voltage of 10% random cells.
    - .4 Ambient temperature.
    - .5 Battery temperature.
    - .6 Specific gravity of 10% random cells (lead acid only).
  - .3 Recharge battery automatically by closing AC mains supply to system for 4 hours period, with dummy load connected. Record at 15 minutes intervals.
    - .1 Battery voltage.
    - .2 Charging current.
  - .4 At start and finish of charge record ambient and battery temperatures, and specific gravity of each cell (lead acid only).
  - .5 Repeat discharge test and readings to prove battery was at least 95% recharged in 4 hours charge period.
  - .6 Recharge battery.

**Part 3 Execution**

**3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for uninterruptible power systems static (UPS) installation in accordance with manufacturer's written instructions.
  - .1 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .2 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

**3.2 INSTALLATION**

- .1 Locate UPS cubicles, battery rack and battery as indicated.
- .2 Locate and install remote mode lights and alarm cabinets as indicated.
- .3 Assemble and interconnect components to provide complete UPS as specified.
- .4 Connect AC mains to main input terminal.
- .5 Connect UPS output to load.
- .6 Start-up UPS and make preliminary tests to ensure satisfactory performance.

**3.3 TESTING**

- .1 Perform tests in accordance with Section CAN/CSA-C813.1 and 26 05 00 - Common Work Results for Electrical.
- .2 Provide:
  - .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 Departmental Representative 10 working 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 hours 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 hours and record readings of voltage of each cell.

**3.4 PROTECTION**

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by UPS installation.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCE STANDARDS**

- .1 American National Standards Institute (ANSI):
  - .1 C78.377: Chromaticity of Solid-State Lighting Products.
  - .2 C81.10: Electric Lamp Bases and Holders, Screw-Shell Types.
  - .3 C81.20: Electric Lamp Bases and Holders, Fluorescent types.
  - .4 C82.1 and Supplement C82.1a: Fluorescent Lamp Ballasts.
  - .5 C82.4: High Intensity Discharge and Low-Pressure Sodium Lamps.
  - .6 C82.5: High Intensity Discharge Lamp Reference Ballasts.
- .2 Canadian Standards Association (CSA):
  - .1 C22.1: Canadian Electrical Code Part I (CEC) as amended by provincial, territorial or municipal authority having jurisdiction. References to CEC elsewhere in this document shall include reference to such amendments.
  - .2 C22.2 No. 137: Electric Luminaires for Use in Hazardous Locations
  - .3 C22.2 No. 141: Emergency Lighting Equipment
  - .4 C22.2 No. 250.0: Luminaires
- .3 Design Lights Consortium (DLC)
- .4 National Model Construction Codes:
  - .1 National Building Code of Canada (NBCC) as amended by provincial, territorial or municipal authority having jurisdiction. References to NBCC elsewhere in this document shall include reference to such amendments.
  - .2 National Fire Code of Canada (NFC).
  - .3 National Energy Code for Buildings (NECB).
- .5 Underwriters' Laboratories, Inc., (UL):
  - .1 773: Standard for Plug-In Locking Type Photo Controls for use with Area Lighting.
  - .2 773A: Nonindustrial Photo Electric Switches for Lighting Control.
  - .3 844: Standard for Electric Lighting Fixtures for Use in Hazardous (Classified) Locations.
  - .4 924: Standard for Emergency Lighting and Power Equipment.
  - .5 935: Standard for Fluorescent Lamp Ballasts.
  - .6 1029: Standard for Safety High Intensity Discharge lamp Ballasts.
  - .7 1598: UL Standard for Safety Luminaires
  - .8 8750: Light Emitting Diode (LED) Equipment for Use in Lighting Products.
- .6 Illuminating Engineering Society of North America (IESNA or IES):
  - .1 LM-79: IESNA Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products

- .2 LM-80: IESNA Approved Method for Measuring Lumen Maintenance of LED Light Sources
- .7 Canadian Electrical Code
  - .1 CSA C22.1

## **1.1 SUBMITTALS**

- .1 Submit shop drawings, samples, and product data in accordance with Section 01 33 00, Submittal Procedures.
- .2 Submit shop drawings for all products as follows:
  - .1 Submit manufacturer's data for each fixture provided. Include detailed information for each luminaire showing wattage, voltage, and full load amp draw for each.
  - .2 Provide complete, fully dimensioned detail drawings including all major components and details of fabrication and installation instructions, special handling criteria, installation sequence, and cleaning procedures.
  - .3 Include photometric laboratory test data to show that luminaires proposed are of same type, construction and quality as those indicated. Luminaires are to be listed and labeled cUL or CSA.
  - .4 Submit photometric calculations based on maintained lighting foot candle levels for areas where lighting fixtures are substituted. Substituted fixtures must provide similar lighting performance and energy usage as those scheduled and must be constructed of similar quality and materials.
  - .5 All fixtures shall have the appropriate frame that is compatible with the ceiling type into which they are installed. Verify all ceiling types at the shop drawing review.
  - .6 Provide appropriate accessories for proper mounting of all fixtures. For example, include plaster frames for plaster ceiling. For fixtures in rated ceiling, provide firestop protection as specified elsewhere. For fixtures suspended from ceiling, provide pendants or aircraft cables complete with accessories to complete the installation as indicated on the drawings.
  - .7 Recessed luminaires shall be of the pre-wired type with the junction box and, where applicable, the ballast forming an integral part of the assembly with satisfactory access.
  - .8 All light fixtures operating in excess of 150V to ground shall be provided with a local line voltage disconnecting device between the branch circuit conductors and the luminaire ballast.

## **1.2 QUALITY ASSURANCE**

- .1 Provide in accordance with Section 01 and as specified.
- .2 Lighting fixtures to be provided with dedicated supporting systems.
- .3 Comply with the National Building Code and all local energy laws and regulations.
- .4 Operate each fixture after installation and connection. Each fixture shall be inspected for proper connection and operation.

- .5 Verify that all lenses, louvres, baffles, fixture trim cones, diffusers, and other parts are thoroughly cleaned in a manner recommended by the manufacturer.

### **1.3 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets crates padding and packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
- .4 Clean in accordance with Section 01 74 11 – Cleaning.
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .5 Divert unused metal materials from landfill to metal recycling facility.
- .6 Disposal and recycling of fluorescent lamps as per local regulations.
- .7 Disposal of old PCB filled ballasts.

## **Part 2 Products**

### **2.1 GENERAL**

- .1 Metal Parts: Free from burrs, sharp corners, and edges.
- .2 Sheet Metal Components: Steel, except as indicated. Form and support to prevent warping and sagging.
- .3 Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position.
- .4 Reflecting Surfaces: Minimum reflectance as follows, except as otherwise indicated:
  - .1 White Surfaces: 85 percent.
  - .2 Specular Surfaces: 83 percent.
  - .3 Diffusing Specular Surfaces: 75 percent.
  - .4 Laminated Silver Metallized Film: 90 percent.
- .5 Lenses, Diffusers, Covers, and Globes: 100 percent virgin acrylic plastic or water white, annealed crystal glass, except as otherwise indicated.
  - .1 Plastic: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
  - .2 Lens Thickness: 0.125 inches (3 mm) minimum; except where greater thickness is indicated.

- .6 Fixture Support Components:
  - .1 Single Stem Hangers: 1/2 inches (12 mm) steel tubing with swivel ball fitting and ceiling canopy. Finish same as fixture.
  - .2 Twin Stem Hangers: Two, 1/2-inch (12 mm) steel tubes with single canopy arranged to mount a single fixture. Finish same as fixture.
  - .3 Rod Hangers: 3/8 inch (9.5 mm) minimum diameter, zinc plated, threaded steel rod.
  - .4 Hook Hanger: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking type plug.
- .7 Provide filters in each light fixture mounted in shielded enclosures.
  - .1 Filters shall be integral to the fixture assembly with one filter per ballast.
  - .2 Filters shall suppress electromagnetic interference in the AM radio band from 500 to 1700 kHz.

## 2.2 LED FIXTURES

- .1 Provide fixtures on the DesignLights Consortium (DLC) Qualified Products List.
- .2 Thermal Management: Liquids or other moving parts shall be clearly indicated in submittals and shall be consistent with product testing.
- .3 Color Rendering Index (CRI): >70.
- .4 Correlated Color Temperature: 4000K.
- .5 Minimum luminaire efficacies: 85 lumens per watt. Nominal input wattage shall account for nominal applied voltage and any reduction in driver efficiency due to sub-optimal driver loading.
- .6 Fully enclosed wiring and LED diodes enclosed to prevent penetration of dust, insects, and other debris into the lamp and driver compartment.
- .7 Driver/LED combined system shall have rated life based on IESNA LM-80-2008 (or latest) of 50,000 hrs at 70% lumen maintenance.
- .8 Driver is high efficiency type with THD < 20 percent and power factor > 0.90.
- .9 Provide fixtures as provided on the drawings.

## 2.3 LIGHTING CONTROLS

- .1 Occupancy Sensors:
  - .1 Sensor type, PIR wide view.
  - .2 Manual-adjusting, 180-degree pattern, with load rating of 1800 watts at 120V.
  - .3 Includes manual off-on control.
  - .4 Delay off settings for 10, 20, or 30 minutes and 30 second test setting.
  - .5 LED indicator flashes when sensor detects motion.
  - .6 For Wall mount: As indicated on the drawings.
  - .7 For Ceiling Mount: As indicated on the drawings.

## **2.4 FINISHES**

- .1 Light fixture finish and construction to meet cUL listings and/or CSA certifications related to intended installation.

## **2.5 OPTICAL CONTROL DEVICES**

- .1 As indicated in luminaire schedule.

## **2.6 LUMINAIRES**

- .1 As indicated in luminaire schedule.

## **Part 3 Execution**

### **3.1 LUMINAIRES AND LAMPS**

- .1 Confirm all ceiling depths against the final architectural ceiling plans and sections to ensure that recessed fixtures can be installed in all ceiling conditions and advise the Departmental Representative immediately of any discrepancies prior to ordering of the fixtures or proceeding with the work. Prior to order of modified fixtures for non-standard ceiling depths, confirm with the Departmental Representative.
- .2 Install types and sizes indicated, complete. Deliver lamps of proper type, wattage and voltage rating to site and install in luminaires prior to completion of project. Provide adequate support to suit ceiling system.
- .3 Install all luminaires to comply with applicable provisions of CSA C22.1, Part 1, Canadian Electrical Code. Suspend pendant luminaires by means of suitable outlet box cover-type aligners, each having flexible joint permitting unit to hang plumb.
  - .1 Provide hangers capable of supporting twice the combined weight of fixtures supported by hangers.
  - .2 Single-unit suspended fixtures shall have twin-stem hangers.
  - .3 Multiple-unit or continuous row fixtures shall have a tubing or stem for wiring at one point and a tubing or rod suspension provided for each unit length of chassis, including one at each end.
  - .4 Rods shall be a minimum 3/8-inch (9.5 mm) diameter.
- .4 Use aligners of shock absorbing type, where indicated.
- .5 Use vaportight aligners with vaportight luminaires.
- .6 Install luminaires with adjustable fittings to permit alignment with ceiling panels. Install luminaires in fire-resistive type of suspended ceiling construction, equipped with fireproofing boxes constructed of materials of same fire rating as ceiling panels. Materials in conformance with cUL/CSA approved building materials list.
- .7 Support for Recessed and Semi-recessed Grid Type Fixtures: Support Units from suspended ceiling support system. Install ceiling support system rods or wires at minimum of 4 rods or wires for each fixture, located not more than 6 inches (150 mm) from fixture corners.

- .1 Install support clips for recessed fixtures, securely fastened to ceiling grid members, at or near each fixture corner.
- .2 Fixtures Smaller than Ceiling Grid: Install minimum of 4 rods or wires for each fixture and locate at corner of ceiling grid where fixture is located. Do not support fixtures by ceiling acoustical panels.
- .3 Fixtures of Sizes Less than Ceiling Grid: Center in acoustical panel. Support fixtures independently with at least two 3/4-inch (20 mm) metal channels spanning and secured to ceiling tees.
- .8 Install accessories such as straps, mounting plates, nipples, or brackets necessary for proper installation.
- .9 Connect emergency light units to the unswitched branch circuit powering the luminaires in the same space. Furthermore, all lighting in tunnels is to also be backed up by battery/emergency power upon loss of power.
- .10 Within 30 days of substantial completion, re-lamp all fixtures (excluding LED type fixtures).
- .11 In general locations, equipment shall be of Sprinkler-Proof enclosure in accordance with 26 05 00- Common Work Results for Electrical.
- .12 Install lighting fixtures true to the surface in or to which they are mounted, and except where otherwise indicated on the Drawings, align correctly with building or room walls as the case directs. Mount wall fixtures at elevations specified or as shown on Architectural or Electrical Drawings. Where no elevation is shown, confirm mounting height with the Departmental Representative prior to rough-in.
- .13 Where lighting fixtures are chain-suspended, use solid conductor in armored cable or flexible conduit and secure to the chain with white or clear nylon cable ties, as specified elsewhere.

### **3.2 WORKMANSHIP**

- .1 Connect luminaires to lighting circuits:
  - .1 Install flexible or rigid conduit for luminaires as indicated.
- .2 Provide suitable extension couplings for wall-mounted luminaires.
- .3 Hang and mount luminaires to prevent distorting frame, housing, sides, or lens frame and permit correct alignment of several luminaires in a row.
- .4 Support luminaires as indicated on the Drawings and in accordance with local inspection requirements, level and plumb, and turn with structure and other equipment in horizontal or vertical position as intended. Install wall or side bracket mounted luminaire housing rigidly and adjust to neat flush fit with mounting surface.
- .5 Install ceiling canopies to cover suspension attachments and fit tightly to ceiling without restricting alignment of hangar.
- .6 Align luminaires mounted in continuous rows to form straight uninterrupted line.
- .7 Align luminaires mounted individually parallel or perpendicular to building grid lines.

**3.3 LAMPS USED FOR TEMPORARY LIGHTING**

- .1 Fluorescent and other lighting may be used for temporary light and lamps used for this purpose will be accepted for construction purposes only before completion and turn over to the Owner. Spot faulty or burned out lamps and replace as required for safe work, without additional cost to Owner.

**3.4 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCE STANDARDS**

- .1        CSA Group (CSA), Latest Edition
  - .1        CSA C22.2 No.141, Emergency Lighting Equipment.

**1.2                ACTION AND INFORMATIONAL SUBMITTALS**

- .1        Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Product Data:
  - .1        Submit manufacturer's instructions, printed product literature and data sheets for emergency lighting and include product characteristics, performance criteria, physical size, finish and limitations.

**1.3                CLOSEOUT SUBMITTALS**

- .1        Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2        Operation and Maintenance Data: submit operation and maintenance data for emergency lighting for incorporation into manual.

**1.4                DELIVERY, STORAGE AND HANDLING**

- .1        Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2        Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3        Storage and Handling Requirements:
  - .1        Store materials indoors, off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2        Store and protect emergency lighting from nicks, scratches, and blemishes.
  - .3        Replace defective or damaged materials with new.

**Part 2            Products**

**2.1                EQUIPMENT**

- .1        Emergency lighting equipment: to CSA C22.2 No.141.
- .2        Supply voltage: 120VAC.
- .3        Output voltage: 24VDC.
- .4        Operating time: 60 minutes.
- .5        Battery: sealed, maintenance free.

- .6 Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01 V for plus or minus 10% input variations.
- .7 Solid state transfer circuit.
- .8 Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.
- .9 Signal lights: solid state, for 'AC Power ON' and 'High Charge'.
- .10 Lamp heads: integral on unit, 345 degrees horizontal and 180 degrees vertical adjustment.  
Lamp type: LED MR16
- .11 Lamp type: LED, 7 W, minimum 582 lumen minimum output.
- .12 Cabinet: suitable for direct or shelf mounting to wall and c/w knockouts for conduit.  
Removable or hinged front panel for easy access to batteries.
- .13 Auxiliary equipment:
  - .1 Test switch.
  - .2 Time delay relay.
  - .3 Battery disconnect device.
  - .4 AC input and DC output terminal blocks inside cabinet.
  - .5 RFI suppressors.

### **Part 3 Execution**

#### **3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for emergency lighting installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

#### **3.2 INSTALLATION**

- .1 Install unit equipment and remote mounted fixtures.
- .2 Direct heads in direction of means of egress.
- .3 Connect exit lights to unit equipment.

#### **3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.

- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for recycling or reuse in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

### **3.4 PROTECTION**

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by emergency lighting installation.

**END OF SECTION**

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**Part 1            General**

**1.1                REFERENCE STANDARDS**

- .1    CSA Group, Latest Edition
  - .1    CSA C22.2 No.141, Emergency Lighting Equipment.
  - .2    CSA C860, Performance of Internally-Lighted Exit Signs.
- .2    National Fire Protection Association (NFPA), Latest Edition
  - .1    NFPA 101, Life Safety Code.
- .3    International Organization for Standardization (ISO), Latest Editions
  - .1    ISO 3864-1, Graphical symbols - Safety colours and safety signs - Part 1: Design principles for safety signs and safety markings.
  - .2    ISO 7010, Safety colours and safety signs - Registered safety signs.

**1.2                ACTION AND INFORMATIONAL SUBMITTALS**

- .1    Provide submittals in accordance with Section 01 33 00- Submittal Procedures.
- .2    Product Data:
  - .1    Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .3    Submit WHMIS MSDS - Material Safety Data Sheets in accordance with code.
- .4    Quality Assurance Submittals: submit following in accordance with Section 01 45 00 - Quality Control.
  - .1    Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, cleaning procedures.

**1.3                WASTE MANAGEMENT AND DISPOSAL**

- .1    Separate waste materials for recycling or reuse in accordance with Section 01 74 19 - Waste Management and Disposal.

**Part 2            Products**

**2.1                STANDARD UNITS**

- .1    Exit lights: to CSA C22.2 No.141 and CSA C860.
- .2    Housing: extruded aluminum housing, brush aluminum finish.
- .3    Face plates: extruded aluminum.
- .4    Lamps: multiple - LED-12W, 120V, 50,000 hours.
- .5    Operation: designed for 50,000 hours, hours of continuous operation without relamping.

.6 Graphics: Green pictogram and white graphical symbol and directional arrows to ISO 3864-1. Dimensions to ISO 7010.

.7 Face plate to remain captive for relamping.

## **2.2 SELF-POWERED UNITS**

.1 Exit lights: to CSA C22.2 No.141 and CSA C860.

.2 Housing: extruded aluminum housing, brush aluminum finish.

.3 Face plates: extruded aluminum.

.4 Lamps: multiple - LED-12W, 120V, 50,000hours.

.5 Operation: designed for 50,000 hours, hours of continuous operation without relamping.

.6 Supply voltage: 120VAC

.7 Output voltage: 24VDC.

.8 Operating time: 30 minutes minimum.

.9 Recharge time: 24 hours

.10 Battery: sealed, maintenance free.

.11 Charger: solid state, voltage/current regulated, inverse temperature compensated, short circuit protected, with regulated output of plus or minus 0.01 V for plus or minus 10% V input variation.

.12 Solid state transfer circuit.

.13 Signal lights: solid state, for 'High Charge', 'AC Power ON' condition.

.14 Lamp heads: integral on unit, 345 degrees horizontal and 180 degrees vertical adjustment.

.1 Lamp type: MR16

.15 Mounting: suitable for universal mounting directly on junction box and c/w knockouts for conduit.

.1 Removable or hinged front panel for easy access to batteries.

.16 Auxiliary equipment:

.1 Test switch.

.2 Time delay relay.

.3 Battery disconnect device.

.4 AC input and DC output terminal blocks inside cabinet.

.5 RFI suppressors.

## **Part 3 Execution**

### **3.1 MANUFACTURER'S INSTRUCTIONS**

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

### **3.2 INSTALLATION**

- .1 Install exit lights to manufacturer's recommendations, listing requirements, NFPA standard, local regulatory requirements, and in accordance to the latest edition of the National Building Code of Canada.
  - .1 Notwithstanding 3.2.1, exit signs located in the tunnels are to be installed above egress doors leading into buildings (from which exiting is provided) and at egress stairs or ladders provided to above grade service buildings for tunnel systems.
  - .2 Installation of guidance signage on tunnel walls and distance to exits is also to be provided. Signage may be photo luminescent, permanent, and to be installed on the midway portion of the wall in case of flooding or smoke obscuration.
- .2 Connect fixtures to exit light circuits.
- .3 Connect emergency lamp sockets to emergency circuits.
- .4 Lock exit light circuit breaker in on position.

### **3.3 CLEANING**

- .1 Proceed in accordance with Section 01 74 11- Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 Aluminum Association (AA)
  - .1 DAF 45-03(R2009), Designation System for Aluminum Finishes.
- .2 CSA Group (CSA)
  - .1 CSA B651-12, Accessible Design for the Built Environment.
- .3 International Standards Organization (ISO)
  - .1 ISO 3864-1-11, Graphic Symbols - Safety Colours and Safety Signs - Part 1: Design Principles for Safety Signs and Safety Markings.
  - .2 ISO 7010-11, Graphic Symbols - Safety Colours and Safety Signs - Registered Safety Signs.
- .4 Intertek
  - .1 ETL Listed Mark.
- .5 National Research Council Canada (NRC)
  - .1 National Building Code of Canada 2015 (NBC).
- .6 National Fire Protection Association (NFPA)
  - .1 NFPA 101-12, Life Safety Code.
- .7 Underwriters Laboratories' of Canada (ULC)
  - .1 CAN/ULC-S572-10, First Edition Standard for Photoluminescent and Self-Luminous Exit Signs and Path Markings.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for photoluminescent wayfinding exit signs and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Samples:
  - .1 Submit 1 full size sample of each type and pattern of photoluminescent wayfinding exit sign.
  - .2 Submit 1 sample of each frame material and finish.
- .4 Certificates: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
  - .1 ULC certification.

### **1.3 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Submit manufacturer's cleaning procedures and schedule for periodic visibility inspections.

### **1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials off ground, in dry location, indoors, and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect photoluminescent wayfinding exit signs from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: as specified 01 74 19 - Waste Management and Disposal.

## **Part 2 Products**

### **2.1 SYSTEM DESCRIPTION**

- .1 Design Criteria:
  - .1 Interior wayfinding exit signs: ULC listed and labelled to CAN/ULC-S572.

### **2.2 MATERIALS**

- .1 Aluminum sheet to AA1100.
  - .1 Finish: brushed with AA-A31 clear anodizing green colour baked enamel to DAF 45.
- .2 Photoluminescent material (PLM): strontium aluminate.

### **2.3 PHOTOLUMINESCENT EXIT SIGN FABRICATION**

- .1 Photoluminescent (PLM) exit sign to CAN/ULC-S572, aluminum recyclable, non-toxic, ULC listed for indoor locations, complete with mounting bracket, single face, thin, low profile design.
- .2 Interior visibility: 15.24m minimum.
- .3 Letters: size to be in accordance with CAN/ULC-S572.
  - .1 Colour: red on visibility green.
  - .2 Directional chevrons: 2 per side.
  - .3 Running person: to CAN/ULC-S572.
  - .4 Directional indicator: arrows 2 per side.

- .5 Mounting: surface assembly kit.
- .6 Frame: frameless.
- .7 Charging: minimum 54 lux of light on faces of sign at all times during building occupation.

## 2.4 PLM WAYFINDING EXIT SIGN

- .1 Screen printed exit sign:
  - .1 Language: English EXIT and French SORTIE.
  - .2 15.24 m viewing visibility.
  - .3 Red lettering.
  - .4 Single face.
  - .5 No frame.
  - .6 Wall mount.
  - .7 Arrows/Chevrons: both directions.
  - .8 Durability: explosion proof.
  - .9 Location: at every tunnel 10m mark and at every tunnel branch location and every branch 10m mark for TBU43, 44, 88, 89, NTBU 43, and NTBU44.
  - .10 Example:



(distance to  
nearest exit)

(tunnel name and  
10 meter mark)

(distance to  
nearest exit)

## Part 3 Execution

### 3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for PLM exit sign installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.

- .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied.

### **3.2 MANUFACTURER'S INSTRUCTIONS**

- .1 Compliance: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

### **3.3 INSTALLATION**

- .1 Install components in accordance with manufacturer's written recommendations.
- .2 Install in locations indicated on drawings and in accordance with NBC.
- .3 Install level, square, plumb and with surface.
- .4 Upon completion of installation verify performance of PLM wayfinding exit signs.

### **3.4 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
  - .1 Clean PLM exit sign face with a non-abrasive cloth dampen with water. Do not use chemical solvents.

### **3.5 PROTECTION**

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by PLM exit sign installation

**END OF SECTION**