

**Part 1 General****1.1 RELATED REQUIREMENTS**

- .1 Sections of Divisions 01.
- .2 Sections of Divisions 26 and 28.

**1.2 REFERENCES**

- .1 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.
- .2 Reference Standards:
  - .1 CSA Group
    - .1 Ontario Electrical Safety Code (26nd Edition) consisting of CSA C22.1-15, Canadian Electrical Code, Part 1 (23nd Edition), Safety Standard for Electrical Installations and Ontario Amendments to CSA C22.1-15, Canadian Electrical Code, Part I.
    - .2 CAN3-C235-83(R2010), Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
  - .2 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)
    - .1 IEEE SP1122-2000, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.

**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 and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 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 Submit the required quantity of copies of 600 x 600 mm minimum size drawings and product data to inspection authorities.
  - .5 If changes are required, notify Departmental Representative of these changes before they are made.

- .4 Certificates:
  - .1 Provide CSA certified of equipment and material.
  - .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: submit operation and maintenance data for incorporation into manual.
  - .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.
  - .3 Print or engrave operating instructions and frame under glass or in approved laminated plastic.
  - .4 Post instructions where directed.
  - .5 For operating instructions exposed to weather, provide weather-resistant materials or weatherproof enclosures.
  - .6 Ensure operating instructions will not fade when exposed to sunlight and are secured to prevent easy removal or peeling.

#### **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 off ground indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

## **Part 2 Products**

### **2.1 DESIGN REQUIREMENTS**

- .1 Operating voltages: to CAN3-C235.
- .2 Motors, 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.
- .3 Language operating requirements: provide identification nameplates for control items in English and in French.
- .4 Use one nameplate for both languages.

### **2.2 MATERIALS AND EQUIPMENT**

- .1 Provide material and equipment in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Material and equipment to be CSA certified.
- .3 Factory assemble control panels and component assemblies.

### **2.3 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS**

- .1 Verify installation and co-ordination responsibilities related to motors, equipment and controls, as indicated.

### **2.4 WARNING SIGNS**

- .1 Warning Signs: in accordance with requirements of inspection authorities.
- .2 Decal signs, minimum size 175 x 250 mm.

### **2.5 WIRING TERMINATIONS**

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

### **2.6 EQUIPMENT IDENTIFICATION**

- .1 Identify electrical equipment with nameplates as follows:
  - .1 Nameplates: lamicoid 3 mm melamine, 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 Labels: embossed plastic labels with 6 mm high letters unless specified otherwise.
- .3 Wording on nameplates and labels to be approved by Departmental Representative prior to manufacture.
- .4 Lamicoid Informations: equipment details, from which panel the equipment is fed and what the equipment is feeding if applicable.
- .5 Nameplate shall include Environment Canada equipment number as identified on drawing legend. Obtain equipment number from Departmental Representative for any new unidentified equipment in schedule on drawing legend.
- .6 Allow for minimum of twenty-five (25) letters per nameplate.
- .7 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .8 Identify equipment with Size 3 labels engraved "ASSET INVENTORY NO. (\_\_\_\_)" as directed by Departmental Representative.
- .9 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .10 Terminal cabinets and pull boxes: indicate system and voltage.
- .11 Transformers: indicate capacity, primary and secondary voltages.

**2.7 WIRING IDENTIFICATION**

- .1 Identify wiring with permanent indelible identifying markings, numbered on both ends of phase conductors of feeders and 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.

**2.8 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.

	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

## 2.9 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.
- .2 Paint indoor switchgear and distribution enclosures light gray.

## 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 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.

### 3.3 NAMEPLATES AND LABELS

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

### 3.4 CONDUIT AND CABLE INSTALLATION

- .1 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.

- .2 Install cables, conduits and fittings embedded or plastered over, close to building structure so furring can be kept to minimum.

### **3.5 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.
- .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.
  - .1 Locate disconnect devices in mechanical and elevator machine rooms on latch side of floor.

### **3.6 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 before proceeding with installation.
- .3 Install electrical equipment at following heights unless indicated otherwise.
  - .1 Refer to the drawings for equipments mounting height.
  - .2 Panelboards: as required by Code or as indicated.

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

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

### **3.8 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 and motor control centres, 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: fire alarm and the UPS.
- .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 Carry out tests in presence of Departmental Representative.
- .4 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

### **3.9 SYSTEM STARTUP**

- .1 Instruct in the preference language of the Departmental Representative and operating personnel in operation, care and maintenance of systems, system equipment and components.
- .2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.
- .3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with aspects of its care and operation.

### **3.10 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 in accordance with Section 01 74 21 - Construction/Demolition 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 RELATED REQUIREMENTS**

- .1 Section 26 05 00 – Common Work Results for Electrical.

**1.2 REFERENCES**

- .1 CSA International
  - .1 CAN/CSA-C22.2 No.18-2012, Outlet Boxes, Conduit Boxes and Fittings.
  - .2 CAN/CSA-C22.2 No.65-2013, Wire Connectors (Tri-National Standard with UL 486A-486B and NMX-J-543-ANCE).
- .2 National Electrical Manufacturers Association (NEMA)

**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 wire and box connectors and include product characteristics, performance criteria, physical size, finish and limitations.

**1.4 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.

**1.5 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 off ground indoors 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.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

**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 round copper conductors.
  - .2 Clamp for round copper conductors.
  - .3 Stud clamp bolts.
  - .4 Bolts for copper conductors.
  - .5 Sized for conductors as indicated.
- .4 Clamps or connectors for armoured cable, TECK cable, flexible conduit under metallic sheathed, as required to: CAN/CSA-C22.2 No.18.

**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 cables 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 recycling in accordance with Section 01 74 21 - Construction/Demolition 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 RELATED REQUIREMENTS**

- .1 Section 26 05 00 – Common Work Results for Electrical.

**1.2 PRODUCT DATA**

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

**1.3 DELIVERY, STORAGE AND HANDLING**

- .1 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials in accordance with Section 01 74 21 - Construction/Demolition 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 600 V insulation of cross-linked thermosetting polyethylene material rated RW90 XLPE, Non Jacketted.

**2.2 ARMOURED CABLES**

- .1 Conductors: insulated, copper, size as indicated.
- .2 Type: AC90.
- .3 Armour: interlocking type fabricated from aluminum strip.
- .4 Type: ACWU90 PVC jacket over thermoplastic armour and compliant to applicable Building Code classification for this project wet locations.
- .5 Connectors: anti short connectors.

**Part 3 Execution****3.1 FIELD QUALITY CONTROL**

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

**3.2 GENERAL CABLE INSTALLATION**

- .1 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - (0-1000 V).

- .2 Cable Colour Coding: to Section 26 05 00 - Common Work Results for Electrical.
- .3 Conductor length for parallel feeders to be identical.
- .4 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.
- .5 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.
- .6 Branch circuit wiring for surge suppression receptacles and permanently wired computer and electronic equipment to be 2-wire circuits only, i.e. common neutrals not permitted.
- .7 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 ARMoured CABLES**

- .1 Group cables wherever possible on channels.
- .2 The run shall be limited to 3 m maximum at each final connection.

**END OF SECTION**

**Part 1            General****1.1                RELATED REQUIREMENTS**

- .1            Section 26 05 00 – Common Work Results for Electrical.

**1.2                WASTE MANAGEMENT AND DISPOSAL**

- .1            Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2            Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3            Collect and separate for disposal paper, plastic, polystyrene, corrugated, cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4            Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative.
- .5            Fold up metal banding, flatten and place in designated area for recycling.

**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                INSTALLATION**

- .1            Secure equipment to hollow or solid masonry, tile and plaster surfaces with lead anchors.
- .2            Secure equipment to poured concrete with expandable inserts.
- .3            Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
- .4            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.
- .5            Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.

- .6 Fasten exposed conduit or cables to building construction or support system using straps.
  - .1 One-hole steel straps to secure surface conduits and cables 50 mm and smaller.
  - .2 Two-hole steel straps for conduits and cables larger than 50 mm.
  - .3 Beam clamps to secure conduit to exposed steel work.
- .7 Suspended support systems.
  - .1 Support individual cable or conduit runs with 6 mm dia threaded rods and spring clips.
  - .2 Support 2 or more cables or conduits on channels supported by 6 mm dia threaded rod hangers where direct fastening to building construction is impractical.
- .8 For surface mounting of two or more conduits use channels at 1.5 m on centre spacing.
- .9 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .10 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .11 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .12 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.
- .13 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

**END OF SECTION**



**Part 1            General**

**1.1               RELATED REQUIREMENTS**

- .1       Section 26 05 00 – Common Work Results for Electrical.

**1.2               REFERENCES**

- .1       Canadian Standards Association (CSA International)
  - .1       Ontario Electrical Safety Code (26th Edition) consisting of CSA C22.1-15, Canadian Electrical Code, Part 1 (23rd Edition), Safety Standard for Electrical Installations and Ontario Amendments to CSA C22.1-15, Canadian Electrical Code, Part I.

**1.3               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.

**1.4               DELIVERY, STORAGE AND HANDLING**

- .1       Waste Management and Disposal:
  - .1       Separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

**Part 2           Products**

**2.1               SPLITTERS**

- .1       Construction: sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.
- .2       Terminations: main and branch lugs to match required size and number of incoming and outgoing conductors as indicated.

## **2.2 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 turned edge covers.

## **2.3 CABINETS**

- .1 Construction: welded sheet steel, as indicated, hinged door, handle.
- .2 Type E Empty: surface return flange and flush overlapping sides mounting, as indicated.
- .3 Type T Terminal: surface return flange and flush overlapping sides mounting, as indicated containing sheet steel 19 mm backboard.

## **Part 3 Execution**

### **3.1 SPLITTER INSTALLATION**

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

### **3.2 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 Install terminal block as indicated in Type T cabinets.
- .4 Only main junction and pull boxes are indicated. Install additional pull boxes as required by CSA C22.1.

### **3.3 IDENTIFICATION**

- .1 Equipment Identification: to Section 26 05 00 - Common Work Results for Electrical.
- .2 Identification Labels: size 2 indicating system name, admissible current, voltage and number of phase or as indicated.

**END OF SECTION**

**Part 1 General**

**1.1 RELATED REQUIREMENTS**

- .1 Section 26 05 00 – Common Work Results for Electrical.

**1.2 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 Ontario Electrical Safety Code (26th Edition) consisting of CSA C22.1-15, Canadian Electrical Code, Part 1 (23rd Edition), Safety Standard for Electrical Installations and Ontario Amendments to CSA C22.1-15, Canadian Electrical Code, Part I.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.4 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 in accordance with Section 01 74 21 - Construction/Demolition 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 walls.

### **2.3 MASONRY BOXES**

- .1 Electro-galvanized steel masonry single and multi gang boxes for devices flush mounted in exposed block walls.

### **2.4 CONCRETE BOXES**

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

### **2.5 CONDUIT BOXES**

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

### **2.6 FITTINGS - GENERAL**

- .1 Bushing and connectors with nylon insulated throats.
- .2 Knock-out fillers to prevent entry of debris.
- .3 Conduit outlet bodies for conduit up to 35mm 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 RELATED REQUIREMENTS**

- .1 Section 26 05 00 – Common Work Results for Electrical.

**1.2 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CAN/CSA-C22.2 No.18-2012, Outlet Boxes, Conduit Boxes and Fittings.
  - .2 CSA C22.2 No. 56-13, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
  - .3 CSA C22.2 No. 83-M1985(R2013), Electrical Metallic Tubing.
  - .4 CSA C22.2 No. 211.2-06(R2011), Rigid PVC (Unplasticized) Conduit.

**1.3 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition 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.

**2.2 CONDUITS**

- .1 Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with couplings and with expanded ends.
- .2 Rigid pvc conduit: to CSA C22.2 No. 211.2.
- .3 Flexible metal conduit: to CSA C22.2 No. 56, liquid-tight flexible metal aluminum.

**2.3 CONDUIT FASTENINGS**

- .1 One hole steel straps to secure surface conduits 50 mm and smaller.
- .2 Two hole steel straps for conduits larger than 50 mm.
- .3 Beam clamps to secure conduits to exposed steel work.

- .4 Channel type supports for two or more conduits at 1.5 m on centre.
- .5 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 25 mm and larger conduits.
- .3 Watertight steel connectors and couplings (compression) for EMT.
  - .1 Set-screws are not acceptable.

## **2.5 EXPANSION FITTINGS FOR RIGID CONDUIT**

- .1 Weatherproof expansion fittings with internal bonding assembly suitable for 100 or 200 mm linear expansion.
- .2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection.
- .3 Weatherproof expansion fittings for linear expansion at entry to panel.

## **2.6 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 Use electrical metallic tubing (EMT) throughout unless otherwise indicated.
- .3 Use rigid pvc conduit outside, in corrosive areas.
- .4 Use flexible metal conduit for connection to motors in dry areas, connection to surface or recessed fluorescent fixtures, work in movable metal partitions.
- .5 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations.
- .6 Minimum conduit size for lighting and power circuits: 19 mm.

- .7 Bend conduit cold:
  - .1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .8 Mechanically bend steel conduit over 19 mm diameter.
- .9 Install fish cord in empty conduits.
- .10 At each ends, provide and install for telecommunication and security conduits plastic bushings.
- .11 Remove and replace blocked conduit sections.
  - .1 Do not use liquids to clean out conduits.
- .12 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 suspended and/or surface 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 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 SUMMARY****.1 Section Includes:**

- .1 Seismic restraint systems for statically supported and vibration isolated equipment and systems including electrical building system, light fixtures, transformers, communications, equipment and systems, both vibration isolated and statically supported.

**1.2 RELATED SECTIONS**

- .1 Section 26 05 00 - Common Work Results for Electrical.

**1.3 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA G40.20/G40.21-13, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).
- .3 National Building Code of Canada (NBC) – 2015.

**1.4 DEFINITIONS**

- .1 Priority Two (P2) Buildings: buildings in which life safety is of paramount concern. It is not necessary that P2 buildings remain operative during or after earthquake activity.
- .2 SRS: acronym for Seismic Restraint System.

**1.5 SYSTEM DESCRIPTION**

- .1 SRS fully integrated into, and compatible with:
  - .1 Noise and vibration controls specified elsewhere.
  - .2 Structural, mechanical, electrical design of project.
- .2 During seismic event, SRS to prevent systems and equipment from causing personal injury and from moving from normal position.
- .3 Designed by Professional Engineer specializing in design of SRS and registered in Province of Ontario. This section is responsible to hire his professional Engineer and pay all costs.

**1.6 ACTION AND INFORMATION SUBMITTALS**

- .1 Submittals: in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario.

- .3 Submit design data including:
  - .1 Full details of design criteria.
  - .2 Working drawings (prepared to same standard of quality and size as documents forming these tender documents), materials lists, schematics, full specifications for components of each SRS to be provided.
  - .3 Design calculations (including restraint loads resulting from seismic forces in accordance with National Building Code, detailed work sheets, tables).
  - .4 Separate shop drawings for each SRS and devices for each system, equipment.
  - .5 Identification of location of devices.
  - .6 Schedules of types of SRS equipment and devices.
  - .7 Details of fasteners and attachments to structure, anchorage loadings, attachment methods.
  - .8 Installation procedures and instructions.
  - .9 Design calculations including restraint loads to NBC 2012 and Supplement.
  - .10 Detailed work sheets, tables. Simplified, conservative assumptions may be acceptable.
  - .11 Detailed design of SRS including complete working drawings prepared to same standard of quality and size as Contract Documents, materials lists, design calculations, schematics, specifications.
- .4 Submit additional copy of shop drawings and product data to Structural Engineer for review of connection points to building structure.
- .5 Quality assurance submittals: submit following in accordance with Section 01 33 00 – Submittal Procedures.
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .2 Instructions: submit manufacturer's installation instructions.
    - .1 The Departmental Representative will make available 1 copy of systems supplier's installation instructions.
- .6 Closeout Submittals:
  - .1 Provide maintenance data including monitoring requirements for incorporation into manuals specified in Section 01 78 00 –Closeout Submittals.

## **1.7 QUALITY ASSURANCE**

- .1 Health and Safety:
  - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

## **1.8 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
  - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

**1.9 WASTE MANAGEMENT AND DISPOSAL:**

- .1 Construction/Demolition Waste Management and Disposal: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

**Part 2 Products****2.1 SRS MANUFACTURER**

- .1 SRS from one manufacturer regularly engaged in SRS production.

**2.2 GENERAL**

- .1 SRS to provide gentle and steady cushioning action and avoid high impact loads.
- .2 SRS to restrain seismic forces in every direction.
- .3 Fasteners and attachment points to resist same load as seismic restraints.
- .4 SRS of Piping systems compatible with:
  - .1 Expansion, anchoring and guiding requirements.
  - .2 Equipment vibration isolation and equipment SRS.
- .5 SRS utilizing cast iron, threaded pipe, other brittle materials not permitted.
- .6 Attachments to RC structure:
  - .1 Use high strength mechanical expansion anchors.
  - .2 Drilled or power driven anchors not permitted.
- .7 Seismic control measures not to interfere with integrity of firestopping.

**2.3 SRS FOR STATIC EQUIPMENT, SYSTEMS**

- .1 Floor-mounted equipment, systems:
  - .1 Anchor equipment to equipment supports.
  - .2 Anchor equipment supports to structure.
  - .3 Use size of bolts scheduled in approved shop drawings.
- .2 Suspended equipment, systems:
  - .1 Use one or combination of following methods:
    - .1 Install tight to structure.
    - .2 Cross-brace in every direction.
    - .3 Brace back to structure.
    - .4 Slack cable restraint system.
  - .2 SCS to prevent sway in horizontal plane, "rocking" in vertical plane, sliding and buckling in axial direction.
  - .3 Hanger rods to withstand compressive loading and buckling.

**2.4 SRS FOR VIBRATION ISOLATED EQUIPMENT**

- .1 Floor mounted equipment, systems:
  - .1 Use one or combination of following methods:
    - .1 Vibration isolators with built-in snubbers.
    - .2 Vibration isolators and separate snubbers.
    - .3 Built-up snubber system approved by the Departmental Representative, consisting of structural elements and elastomeric layer.
  - .2 SRS to resist complete isolator unloading.
  - .3 SRS not to jeopardize noise and vibration isolation systems. Provide 4-8 mm clearance between seismic restraint snubbers and equipment during normal operation of equipment and systems.
  - .4 Cushioning action: gentle and steady by utilizing elastomeric material or other means in order to avoid high impact loads.
- .2 Suspended equipment, systems:
  - .1 Use one or combination of following methods:
    - .1 Slack cable restraint system.
    - .2 Brace back to structure via vibration isolators and snubbers.

**2.5 SLACK CABLE RESTRAINT SYSTEM (SCS)**

- .1 Use elastomer materials or similar to avoid high impact loads and provide gentle and steady cushioning action.
- .2 SCS to prevent sway in horizontal plane, "rocking" in vertical plane, sliding and buckling in axial direction.
- .3 Hanger rods to withstand compressive loading and buckling.

**2.6 SERVICE UTILITIES ENTRANCE INTO BUILDING**

- .1 Provide flexibility to prevent breakage in the event of earthquake activity.

**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 datasheet.

**3.2 INSTALLATION**

- .1 Attachment points and fasteners:
  - .1 To withstand same maximum load that seismic restraint is to resist and in every direction.
- .2 Slack Cable Systems (SCS):
  - .1 Connect to suspended equipment so that axial projection of wire passes through centre of gravity of equipment.

- .2 Use appropriate grommets, shackles, other hardware to ensure alignment of restraints and to avoid bending of cables at connection points.
- .3 Piping systems: provide transverse SCS at 10 m spacing maximum, longitudinal SCS at 20 m maximum or as limited by anchor/slack cable performance.
- .4 Small pipes may be rigidly secured to larger pipes for restraint purposes, but not reverse.
- .5 Orient restraint wires on ceiling hung equipment at approximately 90 degrees to each other (in plan), tie back to structure at maximum of 45 degrees to structure.
- .6 Adjust restraint cables so that they are not visibly slack but permit vibration isolation system to function normally.
- .7 Tighten cable to reduce slack to 40 mm under thumb pressure. Cable not to support weight during normal operation.
- .3 Install SRS at least 25 mm from equipment, systems, services.
- .4 Miscellaneous equipment not vibration-isolated:
  - .1 Bolt through house-keeping pad to structure.
- .5 Co-ordinate connections with other disciplines.

### **3.3 FIELD QUALITY CONTROL**

- .1 Manufacturer's Field Services:
  - .1 Arrange with manufacturer's representative to review work of this Section and submit written reports to verify compliance with Contract Documents.
  - .2 Manufacturer's Field Services: consisting of product use recommendations and periodic site visits to review installation, scheduled as follows:
    - .1 After delivery and storage of Products.
    - .2 After preparatory work is complete but before installation commences.
    - .3 Twice during the installation, at 25% and 60% completion stages.
    - .4 Upon completion of installation.
  - .3 Submit manufacturer's reports to Departmental Representative within 3 days of manufacturer representative's review.
- .2 Inspection and Certification:
  - .1 SRS: inspected and certified by Seismic Engineer upon completion of installation.
  - .2 Provide written report to the Departmental Representative with certificate of compliance.
- .3 Commissioning Documentation:
  - .1 Upon completion and acceptance of certification, hand over to Departmental Representative complete set of construction documents, revised to show "as-built" conditions.

**END OF SECTION**



**Part 1 General****1.1 RELATED REQUIREMENTS**

- .1 Section 26 05 00 - Common Work Results - Electrical.

**1.2 REFERENCES**

- .1 CSA International
  - .1 CSA C22.2 No.29-15, Panelboards and Enclosed Panelboards.

**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 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.

**1.4 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.

**1.5 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 off ground indoors 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.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

**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.
- .2 600 V panelboards: bus and breakers rated for 25KA for EP-100 and EP-95 and 50KA for DP-29 (symmetrical) interrupting capacity or as indicated.
- .3 250 V panelboards: bus and breakers rated for 10A (symmetrical) interrupting capacity or as indicated
- .4 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.
- .5 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.
- .6 Minimum of 2 flush locks for each panel board.
- .7 Two keys for each panelboard and key panelboards alike.
- .8 Copper bus with neutral of double ampere rating of mains.
- .9 Mains: suitable for bolt-on breakers.
- .10 Trim with concealed front bolts and hinges.
- .11 Trim and door finish: baked enamel.
- .12 Include grounding busbar with 3 of terminals for bonding conductor equal to breaker capacity of the panel board.
- .13 Acceptable material: The only acceptable materials are Schneider (Square D).

**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 Lock-on devices for 10% of 15 to 30 A breakers installed as indicated. Turn over unused lock-on devices to Departmental Representative.
- .4 Lock-on devices for stairway and night lighting circuits located on and under the exterior mezzanine.
- .5 Acceptable material: The only acceptable materials are Schneider (Square D).

**2.3            EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Nameplate for each panelboard size 4 engraved as indicated.



- .3 Nameplate for each circuit in distribution panelboards size 2 engraved as indicated.
- .4 Complete circuit directory with typewritten legend showing location and load of each circuit, mounted in plastic envelope at inside of panel door.
- .5 For modified electric panels, supply a new updated typewritten list.

### **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 - 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 in accordance with Section 01 74 21 - Construction/Demolition 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 RELATED REQUIREMENTS**

- .1 Section 26 05 00 – Common Work Results - Electrical.

**1.2 REFERENCES**

- .1 CSA International
  - .1 CSA C22.2 No.42-10, General Use Receptacles, Attachment Plugs and Similar Devices.
  - .2 CAN/CSA C22.2 No.42.1-13, Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).
  - .3 CSA C22.2 No.55-15, Special Use Switches.
  - .4 CSA C22.2 No.111-10, General-Use Snap Switches (Bi-national standard, with UL 20).

**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 wiring devices and include product characteristics, performance criteria, physical size, finish and limitations.

**1.4 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.

**1.5 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 off ground, indoors, 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.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

**Part 2            Products****2.1                SWITCHES**

- .1        15 or/and 20 A, 120 V or/and 347 V, single pole, double pole, three-way, four-way switches to: CSA C22.2 No.55 .
- .2        Manually-operated grade industrial (Industrial Specification Grade) 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.
  - .5        White toggle.
- .3        Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads heating loads.
- .4        Switches of one manufacturer throughout project.

**2.2                RECEPTACLES**

- .1        Duplex receptacles, industrial grade (Industrial Specification Grade), CSA type 5-15 R, 125 V, 15 A, U ground, to: CSA C22.2 No.42 with following features:
  - .1        White 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 rivetted grounding contacts.
- .2        Duplex receptacles, industrial grade (Industrial Specification Grade), CSA type 5-20 R, 125 V, 20 A, U ground, to: CSA C22.2 No.42 with following features:
  - .1        White 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 rivetted grounding contacts.
- .3        Self-contained with CSA type 5-20 R, 125 V, 20 A, GFIC, U ground, circuit interrupter and duplex receptacle, industrial grade (Industrial Specification Grade), complete with:
  - .1        Solid state ground sensing device.
  - .2        Facility for testing and reset.
  - .3        CSA Enclosure 1, flush mounted with stainless steel face plate.
- .4        Other receptacles with ampacity and voltage as indicated.
- .5        Receptacles of one manufacturer throughout project.

**2.3 SPECIAL WIRING DEVICES**

- .1 Special wiring devices:
  - .1 Pilot lights as indicated, with neon type 0.04 W, 125 V lamp and red plastic lense flush type.
- .2 Pin & Sleeve mechanical interlock configuration (above cold room) - North American:
  - .1 AC horsepower ratings:
    - .1 At rated voltage, 5 HP (for 125V) and 25 Hp (for 600V).
  - .2 Power:
    - .1 30A – 125V - 1 Phase – 2 Poles – 3 Wires. Identification shall be added on to the equipment to indicated “USE WITH 20A BREAKER”.
    - .2 20A - 600V - 3 Phases – 3 Poles – 4 Wires.
  - .3 Current Interrupting: Certified for current interrupting at full rated current.
  - .4 Endurance: 6 000 cycles inductive motor type load.
  - .5 Enclosure: 3R type.
  - .6 Housing, cover with arm, locking ring, handle and locking mechanism material: Valox 357.
  - .7 Cover Eyelet: Nickel-Plated Brass.
  - .8 Gasket material: Chloroprene.
  - .9 Actuator material: Zinc-Coated.
  - .10 Contact Carrier: Nylon.
  - .11 Phase and ground Sleeves, Ground Contacts and Switch Terminal Contacts: Brass.
  - .12 Conduit Grounding Plate: Zinc-Coated Steel.
  - .13 Switch material: Reinforced Nylon.
  - .14 Switch Contacts: Cadmium-Free Silver Alloy.
  - .15 Internal Screws: Zinc-plated steel.
  - .16 Housing Screws: Stainless Steel.
  - .17 For 125 Volts:
    - .1 Ground Terminal: Plated Brass/Steel;
    - .2 Ground Terminal Block: Nylon;
    - .3 Neutral Terminal: Plated Brass/Steel;
    - .4 Neutral Terminal Block: Nylon;
    - .5 Terminal Shaft Key: Die-Cast Aluminum.
  - .18 Color: Yellow (for 125V) and Black (for 600V).
  - .19 Standards and Certifications: CSA 22.2.
- .3 Pin & Sleeve watertight Plugs (inside cold room and above cold room) - North American Rated:
  - .1 Power:
    - .1 20A – 125V - 1 Phase – 2 Poles – 3 Wires
    - .2 20A – 600V - 3 Phases – 3 Poles – 4 Wires

- .2 Dielectric Voltage: 2000V (for 125V) and 3000V (for 600V) both for 1 min.
  - .3 Insulation Resistance: 500V for 1 min;  $\geq 5M\Omega$ .
  - .4 Endurance: Up to 5000 connects and disconnects, under load, at full rated current and voltage.
  - .5 Current Interrupting: Certified for current interrupting at full rated current.
  - .6 Grade: Industrial.
  - .7 Flammability: Rated V-2 per UL94
  - .8 Corrosion Resistance: Ferrous parts immersed in 20°C, 10 percent ammonium chloride solution for 10 min.
  - .9 Moisture Resistance: Per UL 1682, immersed for 24 hours in 5cm of 25°C water.
  - .10 IP rating: IP67, Watertight.
  - .11 Body, locking Ring, External Cord Clamp Assembly and Gland Cap: Valox 357.
  - .12 Internal Cord Clamp Assembly: Thermoplastic.
  - .13 Grommet/Gasket: Chloroprene.
  - .14 Contact Carrier: Nylon.
  - .15 Phase and Ground Pins: Brass.
  - .16 Internal Screws: Zinc-plated steel.
  - .17 Terminal Screws: Steel.
  - .18 External Screws: Acid-Proof S/S.
  - .19 Cable Secureness: Force: 15.6kg, Torque: 0.0553 kgf-m, Max Disp:  $\leq 2.38$  mm.
  - .20 Impact Resistance: Drop from 30" 8 times after conditioning to -25°C for 6 hrs.
  - .21 Cord range: .350 - .860
  - .22 Color: Yellow (for 125V) and Black (for 600V).
  - .23 Standards and Certifications: CSA 22.2 No 182.1.
- .4 Pin & Sleeve watertight Connectors (inside cold room) - North American Rated:
- .1 Power:
    - .1 20A – 125V - 1 Phase – 2 Poles – 3 Wires
    - .2 20A – 600V - 3 Phases – 3 Poles – 4 Wires
  - .2 Dielectric Voltage: 2000V (for 125V) and 3000V (for 600V) both for 1 min.
  - .3 Insulation Resistance: 500V for 1 min;  $\geq 5M\Omega$ .
  - .4 Endurance: Up to 5000 connects and disconnects, under load, at full rated current and voltage.
  - .5 Current Interrupting: Certified for current interrupting at full rated current.
  - .6 Grade: Industrial.
  - .7 Flammability: Rated V-2 per UL94
  - .8 Corrosion Resistance: Ferrous parts immersed in 20°C, 10 percent ammonium chloride solution for 10 min.
  - .9 Moisture Resistance: Per UL 1682, immersed for 24 hours in 5cm of 25°C water.
  - .10 IP rating: IP67, Watertight.
  - .11 Body, External Cord Clamp Assembly, Gland Cap and Cover and Arm: Valox 357.

- .12 Internal Cord Clamp Assembly: Thermoplastic.
- .13 Grommet/Gasket: Chloroprene.
- .14 Arm Spring: Performance Grade Stainless Steel.
- .15 Cover Eyelet: Nickel-plated brass.
- .16 Contact Carrier: Nylon.
- .17 Phase and Ground Sleeves: Brass.
- .18 Sleeve Spring: Stainless Steel.
- .19 Terminal Screws: Steel.
- .20 Internal Screws: Zinc-plated steel.
- .21 External Screws: Acid-Proof S/S.
- .22 Cable Secureness: Force: 15.6kg, Torque: 0.0553 kgf-m, Max Disp:  $\leq 2.38$  mm.
- .23 Impact Resistance: Drop from 30" 8 times after conditioning to -25°C for 6 hrs.
- .24 Cord range: .350 - .860
- .25 Color: Yellow (for 125V) and Black (for 600V).
- .26 Standards and Certifications: CSA 22.2 No 182.1.

## **2.4 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 Stainless steel, 1 mm thick cover plates for wiring devices mounted in flush-mounted outlet box.
- .4 Sheet metalcast cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.
- .5 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles as indicated.
- .6 Weatherproof spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches.

## **2.5 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 - 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 - 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 The adhesive marker shall be made with a label printer. It shall have black lettering on clear substrate, normal 16 points lettering. The information shall be the circuit number and panel identification.

### 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 in accordance with Section 01 74 21 - Construction/Demolition 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 RELATED REQUIREMENTS**

- .1 Section 26 05 00 - Common Work Results - Electrical.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Provide fuse performance data characteristics for each fuse type and size. Performance data to include: average melting time-current characteristics.

**1.3 DELIVERY, STORAGE AND HANDLING**

- .1 Ship fuses in original containers.
- .2 Do not ship fuses installed in switchboard.
- .3 Store fuses in original containers in storage cabinet.
- .4 Waste Management and Disposal:
  - .1 Separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

**1.4 EXTRA MATERIALS**

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Three spare fuses of each type and size installed.

**Part 2 Products****2.1 FUSES - GENERAL**

- .1 Fuse type references L1, L2, J1, R1, etc. have been adopted for use in this specification.
- .2 Fuses: product of one manufacturer.
- .3 Motor and transformer circuits
  - .1 Class J form I, double element, time delayed.
- .4 For other circuits
  - .1 0 to 600 A; class J, form I, quick action;
  - .2 601 to 2000 A; class L, form I, quick action.

**2.2 FUSE TYPES**

- .1 Class L fuses.
  - .1 Type L1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
  - .2 Type L2, fast acting.
- .2 Class J fuses.
  - .1 Type J1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
  - .2 Type J2, fast acting.
- .3 Class R -R fuses.
  - .1 Type R1, (UL Class RK1), time delay, capable of carrying 500% of its rated current for 10 s minimum, to meet UL Class RK1 maximum let-through limits.
  - .2 Type R2, time delay, capable of carrying 500% of its rated current for 10 s minimum.
  - .3 Type R3, (UL Class RK1), fast acting Class R, to meet UL Class RK1 maximum let-through limits.
- .4 Class C fuses.

**Part 3 Execution****3.1 INSTALLATION**

- .1 Install fuses in mounting devices immediately before energizing circuit.
- .2 Ensure correct fuses fitted to physically matched mounting devices.
  - .1 Install rejection clips for Class R fuses.
- .3 Ensure correct fuses fitted to assigned electrical circuit.
- .4 Where UL Class RK1 fuses are specified, install warning label "Use only UL Class RK1 fuses for replacement" on equipment.

**END OF SECTION**

**Part 1 General****1.1 RELATED REQUIREMENTS**

- .1 Section 26 05 00 - Common Work Results - Electrical.

**1.2 REFERENCES**

- .1 CSA International
  - .1 CSA C22.2 No. 5-2013, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, and NMX-J-266-ANCE-2013).

**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 circuit breakers and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Include time-current characteristic curves for breakers with interrupting capacity of 22,000 A symmetrical (rms) and over at system voltage.
- .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.

- .5 Name and address of building where circuit breakers will be installed:
  - .1 Project title: (\_\_\_\_\_)
  - .2 End user's reference number: (\_\_\_\_\_)
  - .3 List of circuit breakers: (\_\_\_\_\_)

#### **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 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.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials as specified in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

### **Part 2 Products**

#### **2.1 BREAKERS GENERAL**

- .1 Moulded-case circuit breakers: to CSA C22.2 No. 5
- .2 Bolt-on moulded case circuit breaker: quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.
- .3 Common-trip breakers: with single handle for multi-pole applications.
- .4 Circuit breakers to have symmetrical rms interrupting capacity rating as indicated.
- .5 Acceptable material: The only acceptable materials are Schneider (Square D).

#### **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.

**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.

**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 in accordance with Section 01 74 21 - Construction/Demolition 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 RELATED REQUIREMENTS**

- .1 Section 26 05 00 - Common Work Results for Electrical.

**1.2 REFERENCES**

- .1 CSA Group
  - .1 CAN/CSA-C22.2 No.4-16, Enclosed and Dead-Front Switches (Tri-National Standard, with NMX-J-162-ANCE-2016 and UL 98).
  - .2 CSA C22.2 No.39-13, Fuseholder Assemblies.

**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 disconnect switches – fused and non-fused and include product characteristics, performance criteria, physical size, finish and limitations.

**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 disconnect switches – fused and non-fused from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

**Part 2 Products****2.1 DISCONNECT SWITCHES**

- .1 Fusible or non-fusible, disconnect switch in CSA enclosure as indicated, to CAN/CSA-C22.2 No.4, size as indicated.
- .2 Provision for padlocking in on-off switch position by 3 locks.

- .3 Mechanically interlocked door to prevent opening when handle in ON position.
- .4 Fuses: size as indicated, in accordance with Section 26 28 13.01 - Fuses - Low Voltage.
- .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.

## **2.2 MAINTENANCE SWITCHES**

- .1 Reference standards
  - .1 Safety switches conforming to CSA C22.2 n°94.
  - .2 CSA type 2, 3, 4 and 4 enclosures conforming to CSA.
- .2 Supplied by the same and only manufacturer.
- .3 Without fuse in a NEMA type 4X non-metallic enclosure.
- .4 Complete with facility to lock the lever in the "closed" or "open" position with three (3) padlocks.
- .5 "Closed" position would not be possible to engage if the door is open.
- .6 With quick make, quick break mechanism.
- .7 Heavy duty construction.

## **2.3 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 00 - 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 recycling in accordance with Section 01 74 21 - Construction/Demolition 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 RELATED REQUIREMENTS**

- .1 Section 26 05 00 – Common Work Results for Electrical.

**1.2 REFERENCES**

- .1 CSA International
  - .1 CAN/CSA-C813.1-14(R2014), Performance Test Method for Uninterruptible Power Supplies.

**1.3 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 Estimate with supporting data for Mean Time to Repair factor (MTTR).
  - .6 Full load kVA output at 0.9% lagging power factor.
  - .7 Efficiency of system at 25%, 50%, 75% and 100% rated load.
  - .8 Type of ventilation: natural or forced.
  - .9 Battery:
    - .1 Number of batteries.
    - .2 Maximum and minimum voltages.
    - .3 Type of battery.
    - .4 Type of plates.
    - .5 Catalogue data with battery trade name and type.
    - .6 Size and weight of each battery.
    - .7 Battery charge and discharge curves of voltage, current, time and capacity.
    - .8 Derating factor for specified temperature range.
    - .9 Nominal ampere hour capacity of each battery.
    - .10 Maximum short circuit current.
    - .11 Maximum charging current expected for fully discharged condition.

- .12 Recommended low voltage limit for fully discharged condition.
- .13 Expected life.
- .10 Inverter:
  - .1 Type and catalogue number.
  - .2 DC current at minimum battery voltage to produce full load AC output.
- .11 Rectifier:
  - .1 Type and capacity, with catalogue number.
  - .2 Battery charging sequence.
  - .3 Current-time data for Silicon Controlled Rectifier (SCR) protective devices.
  - .4 Guaranteed noise level.
  - .5 Estimated life.
  - .6 Metering.
  - .7 Alarms.
- .12 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.
- .13 Evaluation of Canadian content.
- .14 Heat losses at no load, 25%, 50%, 75% and 100% of rated output, in kW.
- .15 Cooling air required in m<sup>3</sup>/s.
- .16 List of recommended spare parts, tools and instruments with catalogue numbers and current prices.
- .17 Typical operation and maintenance manual.
- .18 Description of factory test facilities.
- .19 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.
- .20 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.

#### **1.4 PROTECTION OF SYSTEMS**

- .1 Circuit breakers in system used to isolate it from load and from mains for safe working on equipment, and for manual blocking of bypass automatic control to prevent inadvertent operation of bypass during Work on inverter.
- .2 Automatic circuit breakers and protection included in:
  - .1 AC input to rectifier.

- .2 Battery input.
- .3 Bypass circuit input.
- .4 Inverter output.
- .3 Surge suppressors:
  - .1 To protect system against supply voltage switching transients.
  - .2 To protect internal circuits where necessary against voltage transients.
- .4 Current limiting devices, with panel front indication of device operation, to protect inverter SCR's.
- .5 Suitable devices, with panel front indication of device operation, to protect rectifier diodes.
- .6 Failure of circuit or component not to cause equipment to operate in dangerous or uncontrolled mode.

## **1.5 QUALITY ASSURANCE**

- .1 Submit for approval records, indicating and recording instruments calibration certificates, including meters installed as part of system, in accordance with Section 01 33 00 - Submittal Procedures.

## **1.6 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for uninterruptible power systems static (UPS) for incorporation into manual.
- .3 Submit interim, draft final, and final Operation and Maintenance (OM) Manual. Final manual approved by Departmental Representative. Submit interim copies before notification of factory test date.
- .4 Operation and Maintenance Manual to include:
  - .1 Operation and maintenance instructions concerning design elements, construction features, component functions and maintenance requirements to permit effective operations maintenance and repair.
  - .2 Technical data:
    - .1 Approved shop drawings.
    - .2 Characteristic curves for automatic circuit breakers and protective devices.
    - .3 Project data.
    - .4 Technical description of components.
    - .5 Parts lists with names and addresses of suppliers.

## **1.7 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: Crating:
  - .1 Adequately enclosed and protected from weather and shipping damage by use of minimum 12 mm plywood with vapour barrier inside.
  - .2 For rail or sea shipment use double layer of vapour barrier and 19 mm plywood covering.
  - .3 Subassemblies may be packed separately.
  - .4 Label crates:
    - .1 Shipping address.
    - .2 Weight and dimensions.
    - .3 Serial number of unit and brief description of contents.
    - .4 Stencilled with durable paint on at least two sides of each crate.
  - .5 List of contents:
    - .1 In weatherproof envelope stapled on outside of each crate.
    - .2 Copy placed inside each crate.
  - .6 Store materials off ground and protected from exposure to harmful weather conditions and at temperature conditions recommended by manufacturer.

## **1.8 EXTENDED WARRANTY**

- .1 For the work of this Section 26 33 53 - Uninterruptible Power Systems Static (UPS), the 12 month warranty period is extended to 24 months

## **1.9 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Submit maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Include:
  - .1 4 sets of each type and size of fuses used.
  - .2 4 sets indicating lamps.

## **Part 2 Products**

### **2.1 SYSTEM DESCRIPTION**

- .1 System to consist of:
  - .1 Input Cubicle.
  - .2 Rectifier/Invertor Cubicle.
  - .3 Wrap-Around Bypass 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 System performance and reliability:
    - .1 Consider any deviation from the required output power waveform as failure in UPS.
    - .2 Submit estimate, with supporting calculations, of Mean Time Between Failures (MTBF) expressed in hours.
- .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, 120/208 V, 4 wires, grounded neutral, 60 Hz.
  - .2 Normal supply from AC mains.
  - .3 Emergency supply from standby automatic diesel-electric unit.
  - .4 Equipment feeder: direct connection.
- .2 Output power:
  - .1 Three phase, 120/208 V, 4 wires, grounded neutral, 60 Hz.
  - .2 Full load output at 0.9 power factor lagging 6KVA.
  - .3 Integrated three power receptacles, L5-20R configuration.
  - .4 Overload capability: 125% of rated full load current at 0.9 power factor and rated voltage for 10 minutes.
  - .5 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.
  - .6 Duration of full load output after mains failure not less than 15 minutes
  - .7 Output voltage control:
    - .1 Continuously adjustable on load at least 5% from rated value.
    - .2 Voltage regulation: voltage not to change by more than 2% as load increases gradually from zero to 100%, or for specified duration of full load after mains failure.
    - .3 Transient voltage change not to exceed +/-10% of rated voltage upon 50% sudden load change, loss or return of AC input voltage to system when fully loaded or transfer of full load from inverter to bypass and vice versa, and return to normal within 3 Hz.
    - .4 Harmonics over entire load range:
      - .1 Total RMS value not to exceed 5% RMS value of total output voltage.
      - .2 Single harmonic not to exceed 3% of total output voltage.
    - .5 Proper angular phase relation maintained within 4 electrical degrees at up to 20% load unbalance.
  - .8 Efficiency: Overall system efficiency at rated load with battery fully charged not less than 75 %.

- .9 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.
- .2 Bring out test points to protected coded pin jacks at convenient locations to permit testing without hazard, including:
  - .1 Inverter output ahead of output switch, 3 phase and neutral.
  - .2 Mains power 3 phase and neutral.
  - .3 Voltage across each SCR.
  - .4 Points requiring monitoring for on-site alignment, for determination of faulty sub-assemblies or printed circuit cards, including indication of oscillator pulse and operation of voltage control.
- .3 No battery other than main battery incorporated in design.
- .4 Wires number tagged or colour coded with same designation on drawings. Tags: non deteriorating type.
- .5 Variable resistors: fine adjustment, rheostat type.
- .6 Phasing marked on input and output terminals, viewed from front of equipment:
  - .1 Left to right.
  - .2 Top to bottom.
  - .3 Front to back.
- .7 Indicator lamps: long life incandescent or neon, rated for continuous duty, with sockets having adequate heat dissipation of lamps and dropping resistor if used.
- .8 Solid state circuits used where more reliable than mechanical timers or control relays.
- .9 Standard components available from commercial sources used throughout, with 10 years minimum shelf life.
- .10 Arrangement to permit easy removal of defective components to facilitate servicing, by replacing with stock spares.
- .11 Small components, related to specific function, removable plug-in modular sub-assembly or printed circuit card.
- .12 Heavy sub-assemblies easily accessible, or slide on runners of anti-friction material, and have flexible leads and bolted connections.
- .13 Components and sub-assemblies accurately made for interchangeability.

**2.5 RECTIFIER**

- .1 Input power supply from:
  - .1 AC mains.
  - .2 Automatic diesel engine driven generating unit.
- .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  $\pm 2\%$  of full scale, to measure rectifier output voltage.
  - .2 DC ammeter, switchboard type, accuracy  $\pm 2\%$  of full scale, to measure rectifier output current.
- .9 Adjustments and controls:
  - .1 Line voltage adjusting taps to allow for  $\pm 10\%$  variation from nominal.
  - .2 Manual adjustment of float voltage with range of  $\pm 5\%$ .
  - .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  $\pm 1\%$  of setting, no load to full load, during mains voltage variations up to  $\pm 10\%$ .
  - .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.

**2.6 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 each phase and off.
  - .3 Wattmeter: switchboard type, accuracy +/-2% of full scale to measure inverter load.
  - .4 Frequency meter: switchboard type, scale 58 to 62 Hz, pointer type, to measure inverter output frequency.
  - .5 Synchroscope: with switch to check inverter output potential against supply mains potential.
- .8 Output disconnect: bolt-on, moulded case, three 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.

## **2.7 BATTERY**

- .1 Battery type and electrical characteristics:
  - .1 Discharge current to supply inverter at full load output, for 15 minutes.

## **2.8 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.

## 2.9 OPERATING DEVICES

- .1 Operating accessories:
  - .1 Counter for number of failures of normal mains AC power: non-reset type, zero to 99,999 operations.
  - .2 Elapsed time meter indicating accumulated time of battery discharge in minutes non-reset type, zero to 99,999.9 minutes.
  - .3 Elapsed time meter indicating accumulated time of inverter operation in hours, non-reset type, zero to 99,999.9 hours.
- .2 Mode lights mounted on front panel to indicate:
  - .1 AC output on inverter - green.
  - .2 AC input available - green.
  - .3 Inverter and AC input synchronized - green.
  - .4 Inverter and AC input not synchronized - amber.
  - .5 Static bypass switch in bypass position - red.
  - .6 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.

## 2.10 FABRICATION

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

**2.11 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.

**2.12 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.

**2.13 SOURCE QUALITY CONTROL**

- .1 Complete system including rectifier, inverter, bypass switch, remote annunciator panel, controls and battery factory tested in presence of Departmental Representative.
- .2 Notify Departmental Representative:
  - .1 One week in advance of date of factory test.
  - .2 That system has had preliminary testing and has met design requirements satisfactorily.
- .3 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 meter recordings.
  - .3 Collect Departmental Representative's signature on form to indicate concurrence in results reported.
  - .4 Deliver duplicate of test results to Departmental Representative at end of test.
  - .5 Include information from original test as part of Operations and Maintenance Manual.
- .4 Test equipment:
  - .1 Instruments used during test, including indicating meters installed as part of system to have recent calibration certificate.
  - .2 Dummy load for testing, adjustable to 150% of system rated output at 0.9 power factor lagging. Load on each phase adjustable from zero to 100% so that unbalanced output maybe tested for 3 phase systems.



.5 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 meter 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 from each phase.
  - .3 Reapply one half load instantly.
  - .4 Record voltages and currents using camera oscilloscopes.
- .5 Steady load:
  - .1 Switch system onto AC mains, start inverter and connect dummy 0.9 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 each phase.
    - .3 Input current each phase.
    - .4 Input kW.
    - .5 Output voltage phase to phase, phase to neutral.
    - .6 Output current each phase.
    - .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 Unbalanced loads:
  - .1 Adjust loads on inverter to full load on two phases, 80% load on third phase.
  - .2 Adjust loads on inverter to zero load on two phases, 20% load on third phase.
  - .3 For both cases, record phase and line voltages and currents with phase angles to prove that phase relation remains unchanged with unbalanced loads.
- .8 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.
- .9 Operating sound level:
  - .1 Operator to take reading by placing meter in front of him with microphone pointed at right angles to path of travel of generated sound, positioned at height of 1.5 m and distance of 1 m from equipment to be tested.
  - .2 Measure sound level during low ambient sound level.

**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 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 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 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 START-UP**

- .1 Arrange with Departmental Representative:
  - .1 For factory service engineer to supervise start-up of system, checking, adjusting and testing on site.
  - .2 For instruction of 5 personnel on theory, construction, installation, operation and maintenance of system:
    - .1 After installation and during site testing.
    - .2 At factory during shop testing.
- .2 Advise on:
  - .1 Expected failure rate of equipment.
  - .2 Type of expected failures.
  - .3 Estimated time between major overhauls based on 20 year equipment life.
  - .4 Estimated cost of major overhaul based on current costs and excluding travelling expenses.
  - .5 Type and cost of test equipment needed for fault isolating and performing preventive maintenance.

**3.5 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 in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**3.6 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 RELATED REQUIREMENTS**

- .1 Section 26 05 00 – Common Work Results - Electrical.

**1.2 REFERENCES**

- .1 Reference Standards – Devices
  - .1 Photometric tests in accordance with IES LM-79 Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products.
  - .2 Light depreciation determined according to IES LM-80 Approved Method: Measuring Lumen Maintenance of LED Light Sources.
  - .3 Long-term light depreciation determined according to IES TM-21 *Projecting Long Term Lumen Maintenance of LED Light Sources*.
  - .4 UL 8750 Light Emitting Diode Equipment for Use in Lighting Products.
- .2 Reference Standards – Drivers
  - .1 UL 1310 Class 2 Power Units or equivalent CSA.
  - .2 ANSI C62.41 Category A IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
  - .3 FCC Title 47 CFR Part 18 Electronic Code of Federal Regulations – Telecommunication – Industrial, Scientific, and Medical Equipment.
- .3 All LED devices and their components must, at minimal meet all reference standards listed above.
- .4 Each fixture must be equipped with a compatible factory installed driver. Everything must be approved for plenum use.
- .5 Supply units shall be equipped with colour connectors determined in accordance with the standard requirements ANSI C82.11.
- .6 Driver technical data:
  - .1 120 V  $\pm 5$  %, 60 Hz.
  - .2 Power factor: 90 % minimum.
  - .3 Total harmonic distortion: 20 % maximum.
  - .4 Class A nominal sound volume.
  - .5 Operation ambient temperature: 10 to 40 °C, 90 % R.H.
  - .6 The housing temperature: 0 at 62 °C, 90 % H.R.
  - .7 Must tolerate without damage a condition of open circuit or short circuit without of fuses or other external protection devices.
  - .8 Must not contain any PCB.

- .7 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE)
  - .1 ANSI/IEEE C62.41-1991, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
- .8 ASTM International Inc.
  - .1 ASTM F1137-00(2006), Standard Specification for Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners.
- .9 Canadian Standards Association (CSA International)
- .10 ICES-005-07, Radio Frequency Lighting Devices.
- .11 Underwriters' Laboratories of Canada (ULC)

### **1.3 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.

### **1.4 QUALITY ASSURANCE**

- .1 Provide mock-ups in accordance with Section 01 45 00 - Quality Control.

### **1.5 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, packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .4 Divert unused metal materials from landfill to metal recycling facility.

### **1.6 WARRANTY**

- .1 12 month warranty period.

## **Part 2 Products**

### **2.1 LUMINAIRE TYPE LED1 (control room and vestibule)**

- .1 Lamp
  - .1 4000K and 82 CRI wired in parallel-series.
  - .2 LM79 projected life of over 130,000 hours at 50°C.



- .3 Tested in accordance with LM-80.
- .4 Nominal Input Watts: 39.
- .5 Nominal Delivered Lumens: 3909.
- .6 Voltage: 120 - 277 V
- .2 Construction
  - .1 Marine grade heat treated extruded aluminum.
  - .2 Chemically primed and finished with robotically applied polyester powder coat.
  - .3 Fixture dimensions: 961.9 mm (length) x 222.25 mm (width) x 100.58 mm (depth).
  - .4 Color: White.
- .3 Lens
  - .1 Extruded UV stabilized opal polycarbonate with integral prisms.
  - .2 Maximum wall thickness 4.064 mm.
  - .3 Secured to housing with die cast aluminum clamps and stainless steel slotted screws instead of TORX® head screws.
  - .4 Opal type.
- .4 End Caps
  - .1 Die-cast marine grade aluminum with conduit knockouts that are visible from interior of end cap.
- .5 Driver
  - .1 Constant current driver 100-277V.
- .6 Mounting
  - .1 Surface.
- .7 Certification
  - .1 cUL listed, CSA, Damp Standard.
  - .2 LM79 / LM80 Compliant.

## **2.2 LUMINAIRE TYPE LED2 (above cold room)**

- .1 Lamp
  - .1 4000K and 82 CRI wired in parallel-series.
  - .2 LM79 projected life of over 130,000 hours at 50°C.
  - .3 Tested in accordance with LM-80.
  - .4 Nominal Input Watts: 52.
  - .5 Nominal Delivered Lumens: 5215.  
Voltage: 347 V (including the quick connect as per code).
- .2 Construction
  - .1 Marine grade heat treated extruded aluminum.
  - .2 Chemically primed and finished with robotically applied polyester powder coat.

- .3 Fixture dimensions: 1261.87 mm (length) x 222.25 mm (width) x 100.58 mm (depth).
- .4 Color: White.
- .3 Lens
  - .1 Extruded UV stabilized opal polycarbonate with integral prisms.
  - .2 Maximum wall thickness 4.064 mm.
  - .3 Secured to housing with die cast aluminum clamps and stainless steel slotted screws instead of TORX® head screws.
  - .4 Opal type.
- .4 End Caps
  - .1 Die-cast marine grade aluminum with conduit knockouts that are visible from interior of end cap.
- .5 Driver
  - .1 Constant current driver 100-277V.
- .6 Mounting
  - .1 Surface and /or suspended.
- .7 Certification
  - .1 cUL listed, CSA, Damp Standard.
  - .2 LM79 / LM80 Compliant.

## **2.3 LUMINAIRE TYPE LED3 (Inside cold room)**

- .1 Lamp
  - .1 4000K and 82 CRI wired in parallel-series.
  - .2 LM79 projected life of over 130,000 hours at 50°C.
  - .3 Tested in accordance with LM-80.
  - .4 Nominal Input Watts: 52.
  - .5 Nominal Delivered Lumens: 5215.
  - .6 Voltage: 120 - 277 V
- .2 Construction
  - .1 Marine grade heat treated extruded aluminum.
  - .2 Chemically primed and finished with robotically applied polyester powder coat.
  - .3 Fixture dimensions: 1261.87 mm (length) x 222.25 mm (width) x 100.58 mm (depth).
  - .4 Silicone and neoprene gasketing for wet location.
  - .5 Color: White.
- .3 Lens
  - .1 Extruded UV stabilized opal polycarbonate with integral prisms.
  - .2 Maximum wall thickness 4.064 mm.

- .3 Secured to housing with die cast aluminum clamps and stainless steel slotted screws instead of TORX® head screws.
  - .4 Opal type.
- .4 End Caps
  - .1 Die-cast marine grade aluminum with conduit knockouts that are visible from interior of end cap.
- .5 Driver
  - .1 Constant current driver 100-277V.
- .6 Mounting
  - .1 Surface.
- .7 Certification
  - .1 cUL listed, CSA, Damp Standard.
  - .2 LM79 / LM80 Compliant.
  - .3 Wet location.

## **2.4 LUMINAIRE TYPE LED4 (tanks area)**

- .1 Lamp
  - .1 4000K and 82 CRI wired in parallel-series.
  - .2 LM79 projected life of over 130,000 hours at 50°C.
  - .3 Tested in accordance with LM-80.
  - .4 Nominal Input Watts: 52.
  - .5 Nominal Delivered Lumens: 5215.  
Voltage: 20 - 277 V.
- .2 Construction
  - .1 Marine grade heat treated extruded aluminum.
  - .2 Chemically primed and finished with robotically applied polyester powder coat.
  - .3 Fixture dimensions: 1261.87 mm (length) x 222.25 mm (width) x 100.58 mm (depth).
  - .4 Color: White.
- .3 Lens
  - .1 Extruded UV stabilized opal polycarbonate with integral prisms.
  - .2 Maximum wall thickness 4.064 mm.
  - .3 Secured to housing with die cast aluminum clamps and stainless steel slotted screws instead of TORX® head screws.
  - .4 Opal type.
- .4 End Caps
  - .1 Die-cast marine grade aluminum with conduit knockouts that are visible from interior of end cap.

- .5 Driver
  - .1 Constant current driver 100-277V.
- .6 Mounting
  - .1 Surface and /or suspended.
- .7 Certification
  - .1 cUL listed, CSA, Damp Standard.
  - .2 LM79 / LM80 Compliant.

## **2.5 LUMINAIRE TYPE LED5 (Outside mounted on the wall)**

- .1 Lamp
  - .1 5000K @ 65 CRI.
  - .2 Maintain greater than 90% of initial light output after 72,000 hours of operation.
  - .3 Integral LED electronic driver incorporates surge protection.
  - .4 120-277V 50/60Hz model. Power consumption 79 W - 0.67A @ 120V.
  - .5 Delivered Lumens: 7 079.
- .2 Construction
  - .1 Slim, low-profile LED design with rugged one-piece, die-cast aluminum hinged removable door and back box.
  - .2 Secure lock hinge feature allows for safe and easy tool-less electrical connections with the supplied push-in connectors.
  - .3 Back box includes four (4) 16 mm, NPT threaded conduit entry points.
  - .4 Key hole gasket allows for adaptation to junction box or wall.
  - .5 External fin design extracts heat from the fixture surface.
  - .6 One-piece silicone gasket seals door and back box. Minimum 5" wide pole for site lighting application.
  - .7 Three (3) 16 mm NPT threaded conduit entry points allow for thru-branch wiring.
  - .8 Deep Back box is an authorized electrical wiring compartment.
  - .9 Fixture dimensions:
    - .1 Fixture w/ deep back box: 279 mm (height) x 222 mm (width) x 178 mm (depth).
  - .10 Color: Carbon Bronze.
- .3 Optics
  - .1 Silicone sealed optical LED chamber incorporates a custom engineered mirrored anodized reflector providing high-efficiency illumination.
  - .2 (Full cutoff model) Optical assembly includes impact-resistant tempered glass and meets IESNA requirements for full cutoff compliance.
- .4 Finish
  - .1 Protected with a super durable TGIC carbon bronze polyester powder coat paint.

- .2 Super durable TGIC powder coat paint finishes withstand extreme climate conditions while providing optimal color and gloss retention of the installed life.
- .5 Control
  - .1 Photocontrol @ 120V, factory installed.
- .6 Drivers
  - .1 LED driver is mounted to the die-cast housing for optimal heat sinking.
  - .2 LED thermal management system incorporates both conduction and natural convection to transfer heat rapidly away from the LED source.
- .7 Mounting
  - .1 Surface.
- .8 Certification
  - .1 cUL listed.
  - .2 LM79 / LM80 Compliant.
  - .3 IP66 Rated.

## **2.6 FINISHES**

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

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Locate and install luminaires as indicated.

### **3.2 WIRING**

- .1 Connect luminaires to lighting circuits:
  - .1 Install flexible seal tight or rigid conduit for luminaires as indicated.

### **3.3 LUMINAIRE SUPPORTS**

- .1 For suspended ceiling installations support luminaires independently of ceiling.

### **3.4 LUMINAIRE ALIGNMENT**

- .1 Align luminaires mounted in continuous rows to form straight uninterrupted line.
- .2 Align luminaires mounted individually parallel or perpendicular to building grid lines.

**3.5 CLEANING**

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

**END OF SECTION**

**Part 1 General****1.1 RELATED REQUIREMENTS**

- .1 Section 26 05 00 – Common Work Results for Electrical.

**1.2 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA C22.2 No.141-15, Unit Equipment for Emergency Lighting.
  - .2 CSA C860-11(R2016), Performance of Internally-Lighted Exit Signs.
- .2 National Fire Protection Association (NFPA)
  - .1 NFPA 101-2006, Life Safety Code.

**1.3 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 Quality Assurance Submittals: submit following in accordance with Section 01 45 00 - Quality Control.

**1.4 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

**Part 2 Products****2.1 EX1 UNITS**

- .1 Exit lights: to CSA C22.2 No.141-10 standard for pictogram exit signs.
- .2 Housing: The equipment shall be certified for NEMA- 4X and designed specifically for high abuse areas, wet locations, and cold weather applications. The equipment frame shall be of industrial grade polyvinyl chloride with a gasket around lenses and canopy.
- .3 Electrical connection: The pictogram Exit Sign shall operate with universal 2-wire AC input voltage of 120 to 347VAC at less than 2.5W and universal 2-wire DC input voltage from 6 to 24VDC at less than 1W for single and double face signs.
- .4 Color finish: Factory white.
- .5 Face plates: The faceplate(s) shall be constructed of heavy-duty vandal-resistant polycarbonate and feature an even illuminated legend. Each face plate shall come standard with two legend films for pictogram and direction selection.

- .6 Lamps: LED 120 to 347 V. The light source shall be white light-emitting diodes (LED) and shall provide even illumination in normal and emergency operation. Suitable for cold weather: -40°C for AC/DC.

## **2.2 DESIGN EX1**

- .1 Wall or end to wall or ceiling mounting, as indicated.
- .2 Single or Double face, as indicated.
- .3 Arrow: right or left or no arrow, as indicated.

## **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 and local regulatory requirements.
- .2 Connect fixtures to exit light circuits.
- .3 Ensure that exit light circuit breaker is locked 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 RELATED REQUIREMENTS**

- .1 Section 26 05 00 – Common Work Results for Electrical.

**1.2 REFERENCES**

- .1 CSA International
  - .1 CSA C22.2 No.46-13, Electric Air-Heaters.
- .2 National Electrical Manufacturers Association (NEMA)
  - .1 NEMA 250-08, Enclosures for Electrical Equipment (1000 V Maximum).

**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 unit heaters and include product characteristics, performance criteria, physical size, finish and limitations.

**1.4 CLOSEOUT SUBMITTALS**

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

**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 off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect unit heaters from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

**1.6 EXTENDED WARRANTY**

- .1 For the work covered under articles 2.1 and 2.2, the 12 month warranty period is extended to 24 months.

**Part 2 Products****2.1 UNIT HEATERS**

- .1 Unit heater: to CSA C22.2 No.46, horizontal discharge complete with adjustable louvers finished to match cabinet.
- .2 Fan type unit heaters with built-in high-heat limit protection with automatic reset.
- .3 Fan motor: totally enclosed, permanently lubricated ball bearing type with resilient mount.
  - .1 Built-in fan motor thermal overload protection.
- .4 Hangers: wall or ceiling mounted with universal mounting bracket (included), as indicated.
- .5 Elements: nichrome element producing instant heat.
- .6 Cabinet: heavy-duty, 18 gauge thick steel, adjustable louvers and protective screen.
  - .1 Finish: Epoxy-polyester powder coat in almond colour.

**2.2 CONTROLS**

- .1 Wall mounted sensor by mechanical division. Low voltage including contactor and control transformer 600 / 24Vac.

**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 radiant heating electrical cables 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 Suspend unit heaters from ceiling or mount on wall as indicated.
- .2 Make power and control connections.

**3.3 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Test cut-out protection when air movement is obstructed.
- .3 Test fan delay switch to assure dissipation of heat after element shut down.

- .4 Test unit cut-off when fan motor overload protection has operated.
- .5 Ensure heaters and controls operate correctly.

### **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 recycling in accordance with Section 01 74 21 - Construction/Demolition 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 unit heaters installation.

**END OF SECTION**



**Part 1 General****1.1 RELATED REQUIREMENTS**

- .1 Section 26 05 00 – Common Work Results for Electrical.

**1.2 REFERENCES**

- .1 UL515 – Electrical Resistance Heat Tracing for Commercial Applications.
- .2 IEEE 515.1-2012 Standard for the Testing, Design, Installation & Maintenance of Electric Resistance Trace Heating for Commercial Applications.
- .3 CSA Standard C22.2 No. 130-16 Requirements for Electrical Resistance Heating Cables & Heating Device Sets.
- .4 NFPA 70 - National Electrical Code.
- .5 Ontario Electrical Safety Code (26nd Edition) consisting of CSA C22.1-15, Canadian Electrical Code, Part 1 (23rd Edition), Safety Standard for Electrical Installations and Ontario Amendments to CSA C22.1-15, Canadian Electrical Code, Part I.

**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;
  - .2 Heating electrical cables data sheet;
  - .3 CSA approval certificates for freeze protection for aboveground water lines;
  - .4 Pipe freeze protection design guide;
  - .5 System installation and operation manual;
  - .6 System installation details;
  - .7 Connection kits and accessories data sheet;
  - .8 Controller data sheet;
  - .9 Controller wiring diagram.
- .3 Shop Drawings:
  - .1 Provide heat tracing circuit layout drawings indicating power connections, tees, end seal, cable length and circuit cable length.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Source Limitations: Obtain all heat tracing system cable & components from a single source from a single manufacturer.

- .6 Qualifications
  - .1 Manufacturers:
    - .1 Manufacturer will be ISO-9001 registered.
    - .2 Manufacturer to provide products consistent with UL 515, CSA 22.2 No 130-13 and IEEE 515.1 requirements.
  - .7 Certifications: The system (heating cable, connection kits, and controller) shall be CSA Certified for freeze protection of aboveground water lines.

#### **1.4 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for unit heaters for incorporation into manual.
- .3 Indicate on the drawings the cables configuration.

#### **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 off ground indoors in dry location with temperature range 0°C to 60°C in clean, dry, well ventilated area and in accordance with manufacturer's recommendations.
  - .2 Store and protect heating electrical cables from nicks, scratches, and blemishes.
  - .3 Protect the heating cable from water damage by protecting all cables ends from water ingress.
  - .4 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

### **Part 2 Products**

#### **2.1 MATERIALS**

- .1 All equipment listed below shall be from the same manufacturer.

#### **2.2 HEATING CABLES (canalisation mounted)**

- .1 Heating cables shall be self-regulating type heating cables and designed for the following voltage/wattage: 208-277 VAC – 16.4 watts/m @ 10°C.
- .2 The heating cables shall have a polyolefin outer insulating jacket with the following information clearly printed on the cable – cable model #, agency listings, meter marks & batch ID.

- .3 The heating cable shall have a modified polyolefin inner jacket and a tinned-copper braid to provide a ground path and enhance the cables ruggedness.
- .4 The heating cable shall consist of a continuous core of conductive polymer that is radiation cross-linked, extruded between two (2) 16 AWG nickel-plated copper bus wires.
- .5 The heating cable shall be CSA Certified.
- .6 Constant wattage cables are not acceptable.

## **2.3 HEATING CABLES (inside conduit- under slab)**

- .1 Alloy 825 Sheathed Mineral Insulated Heating Cable.
- .2 Heating cable shall be MI heating cable.
- .3 The heating cable shall consist of dual conductors surrounded by magnesium oxide insulation.
- .4 The configuration is the design D.
- .5 The heating cable shall be factory terminated with a minimum 2133.6 mm cold lead (unheated) length and an NPT gland connector to allow connection to a junction box.
- .6 The heating cable shall have a pulling eye for ease of installation in conduit.
- .7 Use only UL Listed or CSA Certified 27 mm or larger diameter rigid galvanized steel or stainless steel or rigid aluminum electrical conduit (provided and installed by division 22).
- .8 The heating cable shall be supplied with a reversed gland to make a liquid-tight/air-tight connection to the conduit.
- .9 The power supply end of the conduit should be terminated with suitably sized female NPT thread to allow connection of the reversed gland supplied on the heating cable.
- .10 Only one run of heating cable shall be installed per conduit. The heating section length is 7010.4 mm and with a power of 157 W.
- .11 For non-metallic junction boxes are used, a grounding kit is required.
- .12 The heating cable shall operate on line voltages of 208 without the use of transformers.
- .13 The heating cable shall be part of a c-CSA-us Certified or FM Approved system.
- .14 The MI heating cable tag shall have the following markings:
  - .1 Complete heating cable model number
  - .2 Agency listings
  - .3 Serial Number

## **2.4 HEATING CABLES CONNECTION KITS**

- .1 Contractor shall provide power connections, splices/tees and end seal kits to properly connect & terminate the heating cable circuit along the specified length of above ground water piping.

- .2 All splices, tees and crosses shall be installed on the pipe insulation with service loops installed to allow for future service of the piping.
- .3 Connection kits shall be rated NEMA 4X to prevent water ingress and corrosion. All components shall be UV stabilized.
- .4 Connection kits shall be CSA Certified.
- .5 Connection point: metal or PVC box are not permitted. Only heating cable accessory shall be provided by the same manufacturer.

## 2.5 ATTACHMENT OF HEATING CABLE

- .1 Attachment method of heating cable to the piping shall comply with the manufacturer installation guide.
- .2 General purpose, high temperature, roll of glass filament tape for installation 5°C and below. Contractor to fix the heating cable to the pipe every 300 mm by wrapping the tape around the pipe & over the heating cable.
- .3 Metal cable ties are not permitted.

## 2.6 IDENTIFICATION OF HEATING CABLE SYSTEM

- .1 Contractor shall provide & install labels “ **Heat Cable Traced** ” labels on exterior of pipe insulation every 3 meters on opposite sides of the pipe for the entire length of heat traced piping.
- .2 In addition, all splices, tees, crosses and power connections shall be labeled on the exterior of the pipe insulation indicating that presence of a connection kit.

## 2.7 CONTROL

- .1 Contractor shall provide one (1) controller for each heat tracing circuit as indicated on heat tracing schedule.
- .2 The unit shall be digital electronic controllers.
- .3 See table below for complete list of required controller capabilities:

Supply Voltage	100 VAC to 277 +/- 10% 50-60 Hz Common supply for controller and heat tracing circuit
Enclosure	
Protection	NEMA 4X
Material	Fiberglass reinforced polyester plastic
Entries	1 x 19 mm conduit for power 1 x 27 mm conduit for heating cable 1 x 16 mm conduit for RTD sensor
Relative humidity	0% to 90%, noncondensing
Ambient installation and usage temperature	-40°C – 60°C
Control	
Relay Type:	Double pole, mechanical
Control range:	0°C to 93°C
Deadband:	Adjustable 2°C to 6°C
Input Power	



Voltage:	277 Vac nominal, 50/60 Hz maximum
Current:	30 A maximum
Monitoring and Alarm Output (included digital display)	
Temperature	Low alarm range: $-6^{\circ}\text{C}$ to set point minus deadband, or OFF High alarm range: Set point plus (Deadband $+3^{\circ}\text{C}$ ) to $110^{\circ}\text{C}$ , or OFF
RTD failure	Shorted or open temperature sensor
Alarm relay	Form C: 2 A at 277 Vac, 2 A at 48 Vdc
Temperature Sensor (included)	
Input type	Thermistor 10K ohm @25C Type J
Ground-Fault	
Ground-fault protection	30 mA fixed
Ground fault trip reset	Reset button, manual
Ground-fault test	Manual ground-fault circuitry test; automatic hourly circuitry test

Programming and Setting	
Method	Programmable at controller – Push buttons on front panel
Units	$^{\circ}\text{F}$ or $^{\circ}\text{C}$
Digital display	Four numeric display digits for parameter and error/alarm indication
LEDs	Indicate actual, set point from display and alarm state
Memory	Nonvolatile, restored after power loss
Stored parameters	Parameters can be programmed without power supply (external battery) and parameters are stored in nonvolatile memory.
Alarm conditions	Low/high temperature and thermistor failure (open or shorted) Ground-fault trip, ground-fault circuit failure and loss of power.
Connection Terminals	
Power supply input	Screw rising cage clamp, 18 – 6 AWG
Heating cable output	Screw rising cage clamp, 18 – 6 AWG
Ground	Screw rising cage clamp, 18 – 6 AWG
Thermistor	Screw rising cage clamp, 22 – 14 AWG
Alarm	Screw rising cage clamp, 22 – 14 AWG
Remote display panel	Screw rising cage clamp, 22 – 14 AWG

**2.8****TEMPERATURE SENSORS**

- .1 Contractor shall provide one (1) thermistor, 100  $\Omega$  @  $25^{\circ}\text{C}$  Type J, platinum 3 wire for ambient temperature sensing for each unit heat tracing controller.
- .2 Control shall use proportional ambient sensing for enhanced energy saving.

**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 radiant heating electrical cables 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 PREPARATION**

- .1 Protection of In-Place Conditions
  - .1 All heating cable ends shall be protected from moisture ingress until cable is terminated.
  - .2 Acceptable methods are installing shall comply with manufacturer installation guide.

**3.3 INSTALLATION**

- .1 Install heating cables as indicated and in accordance with manufacturer's instructions.
- .2 Install electric heating cable according to the drawings and the manufacturer's instructions. The installer shall be responsible for providing a complete functional system, installed in accordance with applicable national and local requirements.
- .3 Interface with Other Work:
  - .1 Connection of all electrical wiring shall be according to Section 26 05 21 – Wires and Cables (0-1000 V).
  - .2 Grounding of controller.
  - .3 Coordination on site with the plumbing piping insulation contractor for a properly operating heat trace system.
- .4 Avoid sharp 90 degrees bends at ends of run.

**3.4 FIELD QUALITY CONTROL**

- .1 Field Tests and inspections:
  - .1 The following test shall be performed after the heat cable has been installed but before the insulation and after insulating the piping. The results of both sets of test shall be recorded as detailed in the manufacturer Installation and Maintenance Manual and included in submittals to Departmental Representative:
    - .1 Continuity Test
    - .2 Insulation Resistance – 2500VDC
    - .3 Capacitance Check – Circuit Length Verification
    - .4 Power Check
    - .5 Ground-fault Test
  - .2 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
  - .3 Use 500 V megger to test continuity before and after installation to manufactures requirement technical information. Maintain 100,000 ohms for polyethylene insulated cables. Test after application of base plaster coat over cable. Reductions in insulation values are unacceptable.
- .2 Non-Conforming Work:
  - .1 Any heat tracing circuit which fails the any of the above test must be corrected prior to commissioning or startup of the system.

### **3.5 SYSTEM STARTUP**

- .1 Provide a factory-certified technician or manufacturer's representative for startup & commissioning of the heat tracing system and controller.
- .2 Coordinate all controller settings with plumbing contractor prior to programming the controller.
- .3 Provide commissioning report in submittals package to Departmental Representative.

### **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 recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**