

**Part 1            General**

**1.1                RELATED SECTIONS**

- .1      Division 0 – Bidding & Contract Requirements
- .2      General Requirements
- .3      All Electrical Drawings and Division 25, 26, 27, 28 Series Specification Sections.

**1.2                REFERENCES**

- .1      CSA-C22.1-15 - Canadian Electrical Code, Part I (23rd Edition), Safety Standard for Electrical Installations.
- .2      CSA-CAN3-C235-83 (R2010).
- .3      CSA (Canadian Standards Association).
- .4      UL (Underwriters Laboratories Inc.).
- .5      ASTM E-814, - Fire Tests of Penetration Fire Stops.
- .6      ANSI/ UL1479 - Fire Tests of Through Penetration Firestops

**1.3                REGULATORY REQUIREMENTS**

- .1      Conform to CSA-C22.1-15.
- .2      Comply with all CSA Electrical Bulletins in force at time of tender submission.
- .3      Comply with all provincial and local by-laws, ordinances, codes, rulings, and other requirements.
- .4      Comply with requirements of the electrical supply authority and the local inspection authority.
- .5      Products: Listed and classified by CSA, or ULc and as suitable for the purpose specified and indicated. Where there is no alternative to supplying equipment which is not CSA certified, obtain special approval from the appropriate Inspection Departments.

**1.4                DEFINITIONS**

- .1      The following are definitions of terms and expressions used in the specification:
  - .1      **Inspection Authority:** agent of any authority having jurisdiction over construction standards associated with any part of electrical work on site.
  - .2      **Supply Authority:** electrical power utility company responsible for delivery of electrical power to project.
  - .3      **Electrical Code:** Canadian Electrical Code or Local Code in effect at project location.
  - .4      **Indicated:** as shown on contract drawings or noted in Contract Documents.
  - .5      **Install:** To remove from site storage, move or transport to intended location, install in position, connect to utilities, repair site caused damage, and make ready for use.

- .6 **Supply:** To acquire or purchase, ship or transport to the site, unload, remove packaging to permit inspection for damage, re-package, replace damaged items, and safely store on-site.
- .7 **Provide:** Wherever the term "provide" is used in relationship to equipment, conduit and other materials specified for the work, it means "supply, install, connect and leave in working order all materials and necessary wiring, supports, access panels, etc., as necessary for equipment indicated." Wherever the terms "provide" is used in connection with services such as testing, load balancing, start-up, preparation of drawings for any part of the work, it means procure, prepare, supervise, take responsibility for, and pay for these services.
- .8 **Typical:** A representative characteristic that is standard for all installations whether individually noted or not throughout the documents. "Typical" applies to each individual or combined installation except where specifically noted or otherwise indicated that the application is non-typical.
- .9 **Exposed:** Any work not concealed in wall, shaft, or ceiling cavities or spaces. Work behind doors, in closets or cupboards or under counters is considered exposed.
- .10 **New:** Produced from new materials.
- .11 **Renewed:** Produced or rejuvenated from an existing material to like-new condition to serve a new or existing service.
- .12 **Defective:** A condition determined exclusively by the Contract Administrator.

## 1.5 PERMITS & FEES

- .1 Submit all quantities of drawings and specifications necessary for examination and approval to Electrical Permit Department and Electrical Supply Authority prior to commencement of work.
- .2 Obtain and pay for all permits necessary for the electrical installation.

## 1.6 INSPECTION

- .1 Furnish a Certificate of Acceptance from the Inspection Authorities on completion of work. Copies of Certificate shall be included in Maintenance Manuals.
- .2 Certificate of Inspection and Approval shall be submitted before final payment may be considered to be due.
- .3 During the course of the project construction, the Contract Administrator will carry out periodic site reviews and prepare a deficiency list for remedial action by the Electrical Subcontractor. When requested, the Electrical Subcontractor shall respond in writing to the Contract Administrator, stating corrective action and completion date for each item listed as deficient. This response shall be in the hands of the Contract Administrator within three working days of receipt of the Site Review Report.

## 1.7 SUBMITTALS FOR REVIEW

- .1 Section 01 33 00: Submission procedures.
- .2 Submit shop drawings and product data for review by the Contract Administrator. All drawings shall be in English and metric dimensions or in imperial where indicated. Manufacture of equipment shall not commence until shop drawings have been reviewed.

- .3 Shop drawings shall be submitted electronically in PDF format documents to [shopdrawings@eppsiepman.com](mailto:shopdrawings@eppsiepman.com).
- .4 Shop drawings shall be reviewed by the Electrical Subcontractor, general contractor, and where applicable the Utility prior to submittal to Contract Administrator, confirming that they meet all the design requirements.
- .5 Indicate details of construction, dimensions, capacities, weights and electrical performance characteristics of equipment or material.
- .6 Where applicable, include wiring, single line and schematic diagrams.
- .7 Include wiring drawings or diagrams showing inter-connection with work of other sections.
- .8 Provide scaled drawings showing layout of all electrical equipment and coordination of same with mechanical equipment in all electrical, electrical/mechanical and voice data rooms.
- .9 Submit samples in accordance with General Conditions. Samples shall be forwarded to the Contract Administrator's office and returned. Approved samples will be retained until after tender closing, then all samples will be returned except for the sample submitted by the Manufacturer who has been listed by the successful Contractor in the tender documents. This sample will be used for comparison with the actual production run of successful manufacturer.
- .10 Submit shop drawings of service entrance equipment to utilities.
- .11 Material submitted for review shall be marked up bear the Contractor's and where applicable the Utility's reviewed stamp.

## **1.8 CLOSEOUT SUBMITTALS**

- .1 Section 01 78 00: Closeout Submittals.
- .2 Maintenance Data:
  - .1 Provide operation and maintenance data for incorporation into Maintenance Manuals.
  - .2 Include details of design elements, construction features, component function and maintenance requirements, to permit effective start-up, operation, maintenance, repair, modification, extension and expansion of any portion or feature of installation.
  - .3 Include technical data, product data, supplemented by bulletins, component illustrations, exploded views, technical descriptions of items, and parts lists. Advertising or sales literature not acceptable.
  - .4 Include wiring and schematic diagrams and performance curves.
  - .5 Include names and addresses of local suppliers for items included in Maintenance Manuals.
  - .6 Include system certifications where applicable.
  - .7 Certificate of Acceptance from the Inspection Authorities.
  - .8 Include a list of maintenance materials provided in each related section. City shall sign-off confirming items have been received.
  - .9 Include all warranty information.

- .10 Submit Maintenance Manuals to the Contract Administrator for review. Manuals that are incomplete shall be returned to the Electrical Sub-Contractor for completion. Completed manuals shall be submitted, to the satisfaction of the Contract Administrator, before final payment may be considered to be due.
- .3 Maintenance Materials:
  - .1 Provide maintenance materials as specified. Include a list of the maintenance materials in each related section of the operation and maintenance data.
  - .2 Turn materials over to City in an orderly fashion upon completion of installation.
- .4 Record Documentation:
  - .1 Project record documents shall be submitted to the Contract Administrator in AutoCAD file format. Electrical Subcontractor shall be responsible for the production of the record documents. Electronic copies of the design AutoCAD files will be available to the Electrical Subcontractor for a nominal fee.
  - .2 Project record documents shall comprise a complete and accurate record of the actual electrical installation. Record drawings that are inaccurate or incomplete shall be returned to the contractor for correction and completion.
  - .3 Record drawings shall contain a stamp bearing the words "Record Drawing" or "As-Built Drawing", the Electrical Subcontractor's company name, date, and the contractor's signature.
  - .4 The Contract Administrators will recommend a suitable deficiency holdback until accurate and complete record drawings have been submitted in acceptable form.
  - .5 Indicate on record drawings, location of all buried services. This information is to be certified correct by Contract Administrator before backfilling commences.
  - .6 Record actual size and location of all cables including depth of cables where buried.
  - .7 Contractor to take all schedules/details from specification and put onto additional drawing sheets for Record Drawings.

## **1.9 EXAMINATION OF SITE CONSTRUCTION DRAWINGS**

- .1 Prior to submitting a tender, examine the site and local conditions which will affect the work. Refer to the Architectural, Mechanical and Structural drawings, schedules and specifications for construction details to be certain that the electrical work can be satisfactorily carried out as specified. Claims for extra payments resulting from conditions which could reasonably be foreseen during an examination of the documents and/or site, will not be recognized.
- .2 Ensure that all equipment designated as "Existing to Remain" or "Existing to be Relocated" is suitable for its intended re-use, including panelboards and circuits. Report any discrepancies to the Contract Administrator before tender close.
- .3 Refer to General Conditions for instructions regarding a prearranged site visit during the tender period.
- .4 Notify Contract Administrator of any discrepancies, omissions, etc., prior to the awarding of the contract, otherwise the Electrical Subcontractor shall perform the work as directed at no additional cost to the City.

**1.10 SHORT CIRCUIT/COORDINATION/ARC FLASH STUDY**

- .1 Provide a Short Circuit/Coordination/Arc Flash Study for service entrance equipment, main distribution switchboard breakers and first level of sub-distribution (including 120/208V transformers) to ensure proper short circuit capacity and proper selective coordination, and proper Arc Flash requirements. Study shall include:
  - .1 Arc Flash Approach Boundaries,
  - .2 Incident Energy Levels
  - .3 Personal Protective Equipment (PPE) requirements.
- .2 Submit a preliminary copy of the study complete with short circuit information and preliminary breaker coordination to the Contract Administrator with distribution shop drawings. Feeder lengths for the preliminary study shall be based on worst case estimates based on the intended installation by the Electrical Subcontractor.
- .3 Submit a final copy of the Short Circuit/Coordination/Arc Flash Study to the Contract Administrator upon completed installation of all feeders and distribution. Feeder lengths shall be based as-installed on site measurements.
- .4 Include a final copy of the Short Circuit/Coordination/Arc Flash Study in each Maintenance Manual.
- .5 Ensure circuit protective devices such as over current trips, relays, fuses, are installed and adjusted to values and settings as recommended in the Study.
- .6 Ensure equipment labels are provided indicating Arc Flash information for each piece of studied equipment.
- .7 Scope of Short Circuit Study shall include all infrastructure from the secondary side of the utility distribution transformer.

**Part 2 Products**

**2.1 MATERIALS AND EQUIPMENT**

- .1 Provide labour, materials, transportation, equipment and facilities, etc., required for the complete electrical installation as indicated or implied on the drawings and specifications.
- .2 Electrical equipment shall be new and of type and quality specified.
- .3 Request for approval of material, as equal shall be in accordance with B7.
- .4 All submissions shall include the following phrase “We have reviewed all contract documents, contract drawings and specifications relating to the equipment presented herein” and shall bear the name and signature of the manufacturer or their agent.

**2.2 VOLTAGE RATINGS**

- .1 Operating voltages: to CAN3-C235-83(R2010).
- .2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard. Equipment shall operate in extreme operating conditions established in above standard without damage to equipment.

### **2.3 FINISHES**

- .1 Finish outdoor electrical equipment such as parking lot panels, to match light standards.
- .2 Paint indoor switchgear and distribution enclosures light grey to EEMAC-2Y-1.
- .3 Paint outdoor electrical equipment enclosures with two (2) coats of U.V. resistant Urethane Enamel to minimum 1.5 mil dry coat thickness. Colour shall be "equipment green" to EEMAC 2Y-1.
- .4 Clean and touch up surfaces of shop-painted equipment, scratched or marred during shipment or installation, to match original paint.
- .5 Clean, prime and paint exposed hangers, racks, fastenings to prevent rusting.

### **2.4 LABELS AND WARNING SIGNS**

- .1 Manufacturer's nameplates and CSA labels shall be visible and legible after equipment is installed.
- .2 Provide warning signs on equipment, as required, to meet the requirements of the Inspection Authorities, including indication of multiple power sources.
- .3 Provide quantity as required of buried cable signs reading "Buried Cable" and "Buried High Voltage Cable". Signs shall be installed at building structure/equipment, at locations as directed on site and as per Canadian Electrical Code.

### **2.5 PROTECTION**

- .1 Guards
  - .1 Provide guards for all electrical equipment and devices in gymnasium and other areas subject to damage.
- .2 Sprinkler Proof Equipment
  - .1 All surface mounted electrical equipment located in sprinklered areas shall be sprinkler proof and shall be provided with suitable hoods and shields.
  - .2 Entrance of conduits into the top of surface mount electrical panels/cabinets/distributions and motor control centers shall utilize O-rings and watertight connectors.
- .3 Construction
  - .1 Protect exposed live equipment during construction for personnel safety.
  - .2 Shield and mark live part "LIVE ( ) VOLTS", with appropriate voltage.
  - .3 Arrange for installation of temporary doors for rooms containing electrical distribution equipment. Keep these doors locked except when under direct supervision.

### **2.6 SPARE PARTS**

- .1 Assemble spare parts as specified.
- .2 Include the following:
  - .1 Part number.
  - .2 Identification of equipment or system for which parts are applicable.

- .3 Installation instructions as applicable.
- .3 Provide a written list complete with City's signature assuring that spare parts have been received by the City.

## **2.7 ACCESS DOORS**

- .1 Access doors shall be minimum #12 gauge prime coat painted bonderized steel. Each shall be complete with a heavy flush frame and anchor, concealed hinges, positive locking screwdriver lock, and mounting and finishing provisions to suit the finish material for which they are supplied. Access doors in fire rated ceilings, walls, partitions, structures, etc. shall be ULc. listed and labeled and of a rating to maintain the fire separation integrity.
- .2 Where access doors are located in surfaces where special finishes are required, they shall be of a recessed door type capable of accepting the finish in which they are to be installed so as to maintain the final building surface appearance throughout.
- .3 Supply access doors in inaccessible construction shall give access to all concealed junction boxes, pullboxes, conductor joints and other similar electrical work which may need maintenance or repair.
- .4 Before commencing installation of electrical work, submit to the Architect for approval, a list of required access doors showing the exact sizes and locations of such access doors. Locate access doors in walls and partitions to the Architect's approval, and arrange electrical work to suit. Access doors shall be, wherever possible, of a standard size for all applications. Confirm exact dimensions with the Architect, prior to ordering.
- .5 Access doors will be installed by the Division responsible for the particular type of construction in which access doors are required. Supply the access doors to the Division installing same at the proper time to avoid construction delays.

## **Part 3 Execution**

### **3.1 COORDINATION WITH OTHER TRADES**

- .1 Refer to Mechanical, Structural, Architectural and Interior Design drawings and specifications for additional electrical work in connection with other Divisions. Where such work is included in other sections of the specifications, provide equipment, conduit, wiring, etc. (in accordance with the approved manufacturer's shop drawings), as required, for operation of the specified equipment.
- .2 Schedule execution of electrical work with associated work specified in other Divisions.
- .3 Coordinate electrical work with work of other trades to avoid conflicts with pipes, air ducts or other equipment. Provide additional supports, wiring, etc., to relocate electrical equipment, as required, where structural members, air ducts, piping or other equipment interferes with the electrical installation.
- .4 Prior to installation provide scaled drawings of all mechanical/electrical rooms and communication rooms showing layout of all equipment (mechanical and electrical) for Contract Administrator review.

### **3.2 QUALITY ASSURANCE**

- .1 Do complete installations in accordance with CSA C22.1-15.
- .2 While not identified and specified by number in this Division, comply with CSA Electrical bulletins in force at time of tender submission. Comply with the requirements of all Provincial and local laws, rules, ordinances and codes.
- .3 Electrical installations shall comply with all requirements of the electrical supply authority and the inspection authority.
- .4 Electrical installation shall be in accordance with the applicable versions of the Canadian Electrical Code, Provincial and other codes, rules and regulations. Supply material and labour required to meet the requirements of these codes, rules and regulations even though the work is not shown on the drawings or mentioned in the specifications. Where the electrical installation calls for better quality materials or construction than the minimum requirements of these codes, rules and regulations, the electrical installation shall be as shown on the drawings and as specified.

### **3.3 WORKMANSHIP**

- .1 Install equipment, conduit and cables in a workmanlike manner to present a neat appearance to the satisfaction of the Contract Administrator. Install conduit and cable runs parallel and perpendicular to building lines in chases, behind furring or above ceilings, where such concealment is possible. In areas where systems are to be exposed, install neatly and group in a tidy appearance.
- .2 Install equipment/junction boxes and apparatus requiring maintenance, adjustment or eventual replacement, with adequate clearances and accessibility for same.
- .3 Provide for all requirements shown on shop drawings or manufacturer's installation instructions.
- .4 Work deemed by the Contract Administrator to be unsatisfactory shall be replaced at no additional cost.

### **3.4 DELIVERY STORAGE AND HANDLING**

- .1 Deliver all materials to site in an orderly fashion.
- .2 Store all materials in a clean and dry place, secure from vandalism or theft. All materials shall be left in shipping containers until required for use.
- .3 Provide additional protection such as tarps, padding, wood skids, etc., as required to ensure protection of equipment and as directed by the Architect.

### **3.5 EXCAVATION AND BACKFILLING**

- .1 Excavate and backfill as required for underground electrical services as indicated. Provide protective materials around and over services and be present at all times during excavation and backfilling to supervise work. Backfilling shall restore the excavated area to the original condition and shall include sodding where required.
- .2 Work shall be in accordance with the current CSA Bulletin.
- .3 Include all costs for excavation and backfilling, for any underground electrical installation, unless otherwise indicated.

- .4 Work shall be arranged in such a manner that will not interfere with regular pedestrian or vehicular traffic patterns.
- .5 Provide trenching, cable installations and backfill promptly. Open trenches shall be barricaded in an appropriate manner.
- .6 Cables required to cross under roadways, paved areas, sidewalks, etc. shall be installed in PVC conduits pushed under such areas.
- .7 Six (6") of sand shall be provided surrounding installed cables and 2" x 4" treated plank installed 6" above the cables. Install cable marker tape in all trenches, minimum 12" above cables. The remainder of the trench shall be backfilled with granular base course. All backfill material shall be thoroughly tamped and compacted to at least 90% of maximum density at optimum moisture. The ground shall be left free from ruts and rough spots. In any asphalt areas, backfill shall be granular material only.
- .8 All sodded areas disturbed or damaged during trenching and backfilling shall be repaired with manured soil mix and resodded. Make all repairs to damaged asphalt and/or concrete surfaces to match existing.
- .9 Care shall be taken when excavating near existing services. Existing trees and shrubbery in work area shall be protected from damage.
- .10 Install buried cable signs as per CEC and Manitoba Electrical addendums.

### **3.6 CONDUIT SLEEVES AND HOLES**

- .1 Install conduit, and sleeves, prior to pouring of concrete. Sleeves through concrete shall be sized for free passage of conduit.
- .2 Holes through exterior walls and roof shall be flashed and made weatherproof.
- .3 Make necessary arrangements for cutting of chases, drilling of holes and other structural work required to install electrical conduits, cables, pullboxes and outlet boxes.
- .4 Install cables, conduits, and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.
- .5 Provide a minimum of two (2) separate conduit sleeves embedded in each concrete lighting fixture base. At least one (1) unused conduit shall be for possible future extension of wiring.
- .6 All conduits and cables shall be entered into the building above grade unless otherwise noted.
- .7 All coring in buildings with electrical in the slab shall be scanned at contractor's expense to prevent damage.

### **3.7 CUTTING AND PATCHING**

- .1 Pay the costs of all cutting and patching required for the installation of electrical work. Payment for cutting and patching shall be made through the General Contractor.
- .2 Cutting and patching required for the installation of electrical work shall be done by the particular trade whose work is involved. No cutting or patching shall be carried out by the tradesman employed on the electrical work.

- .3 Obtain the approval of the Architect before arranging for any cutting. Patching shall restore the affected area to the original condition; materials and methods used for patching shall be in accordance with the requirements of the corresponding Divisions of the specification.

### 3.8 DEVICE INSTALLATION

- .1 Device Location
- .1 Locate devices as indicated.
  - .2 Do not install devices back-to-back in wall.
  - .3 Drawings are schematic only and do not indicate all architectural or structural elements.
  - .4 Change location of devices at no extra cost or credit, providing distance does not exceed 10'-0" (3 m) and information is provided before installation.
  - .5 Locate light switches on latch side of doors.
  - .6 Vertically align devices of different systems when shown in close proximity to each other and occurring at different mounting heights.
  - .7 Coordinate mounting heights and location of all equipment with Architectural, Mechanical and Structural Drawings prior to installation of rough-in boxes.
- .2 Mounting Heights
- .1 Mounting height of equipment is from finished floor to centre line of equipment unless specified or indicated otherwise.
  - .2 If mounting height of equipment is not indicated, verify with Architect before proceeding with installation.
  - .3 Install electrical equipment at the following heights unless indicated or directed otherwise:

Device / Equipment	Mounting Height	
Devices above counters	150mm	6"****
Receptacles:		
- General	450mm	18"
- Mechanical/Shop Areas	1000mm	40"
- Clock	2150mm	84"
- Exterior	1000mm	39"
Switches, Dimmers, push buttons, Luxo bracket		
- General	1200mm	47"
- Accessible Suites	900mm	36"
Clocks	2150mm	84"
Automatic Door Operator Pushbuttons	900mm	36"
Occupancy Sensors	Per manufacturers recommendations	
Fire Alarm Visual, Audible, & Combination Devices	2350mm* or 150mm**	92"* or 6"***

Fire Alarm Manual Pullstations	1200mm	47"
Fire Fighter Handsets	1500mm	59"
Thermostats		
- General	1200mm	47"
- Accessible Suites	900mm	36"
Intercom Stations	1200mm	47"
Proximity/Card Readers	900mm	36"
Communication Outlets	400mm	16"
Hand Dryers	1200mm	47"
Branch Circuit Panelboards, Control Panels, Annunciators. Install panels taller than 1800mm (72") with bottom no more than 100mm (4") above floor.	2000mm*	78"*
Enclosed circuit breakers	1600mm***	60"***

\*Measured to top of device/equipment

\*\*Measured from Ceiling to top edge of device where mounting height would be lower than required specification.

\*\*\*Measured to operating handle of device.

\*\*\*\*Coordinate counter backsplash heights with architectural drawings prior to rough-in. Maintain minimum 1" clearance above backsplash height.

- .1 Coordinate all mounting heights with Architectural elevations.
- .2 Where installed in block or brick, mounting heights shall be as above or at bottom of nearest course.
- .4 Panelboards and other equipment which are to be surface mounted shall be installed on minimum 19mm (3/4") good one side, fir plywood mounting backboards. Treat backboards with wood preservative prior to installation and paint with primer and two (2) coats gray enamel before any equipment is mounted. Provide plywood mounted boards unless specified otherwise in other sections.
- .5 Panelboards mounted on exterior concrete/block walls shall have minimum 3/4" air gap behind enclosure (to minimize condensation).
- .6 All transformers, motor control centers and floor-mounted distribution panels shall be mounted on 100mm (4") concrete housekeeping pads. The Electrical Subcontractors shall be responsible for provision of these pads.

### 3.9 FIREPROOFING

- .1 Where cables or conduits pass through block or concrete walls and floors and any fire-rated assembly, seal openings with firestopping systems that have been tested for specific fire-resistance-rated construction conditions conforming to the construction assembly type, penetrating item type, annular space requirements, and fire-rating involved in each instance.

- .2 Provide products that upon curing, do not re-emulsify, dissolve, leach, breakdown or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture characteristic during and after construction.
- .3 Openings within walls and floors designed to accommodate cabling systems subjected to frequent cable changes shall be provided with re-enterable products.
- .4 Fire proofing of electrical cables, conduits, trays, etc, passing through fire barriers shall conform to local codes and inspection authorities.
- .5 Fire stop materials shall be asbestos free and have been tested in accordance with ASTM E-814, and ULC 1479.
- .6 Fire stop and smoke seals shall be done in accordance with Section 07 84 00.
- .7 Approved manufacturers:
  - .1 Nelson Firestop Products
  - .2 Specified Technologies
  - .3 Hilti Firestop

### **3.10 LOAD BALANCE**

- .1 Measure phase current to panelboards with normal loads operating at time of measurement. Adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
- .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
- .3 Submit, at completion of work, a report listing phase and neutral currents on panelboards, transformers and motor control centres, operating under normal load. State hour and date on which each load was measured, and voltage at time of test.
- .4 Include load balance test results in maintenance manuals.

### **3.11 TESTING**

- .1 Conduct and pay for tests including, but not limited to, the following systems:
  - .1 High voltage distribution equipment in accordance with relevant sections of specification.
  - .2 Power generation and distribution system.
  - .3 Circuits originating from branch distribution panels.
  - .4 Lighting and its control.
  - .5 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
  - .6 Heating cables and mats.
  - .7 Systems:
    - .1 Fire Alarm
    - .2 Public Address
    - .3 Communication cabling systems.
    - .4 Intrusion Detection

- .5 Access Control
- .6 CCTV
- .7 Nursecall
- .8 Grounding systems.
- .2 Insulation Resistance Testing
  - .1 Hi-pot all H.V. cable and equipment over 600 volts, to manufacturer's specifications.
  - .2 Megger circuits, feeders and equipment up to 350V with a 500V instrument.
  - .3 Megger 350-600V circuits, feeders and equipment with a 1000V instrument.
  - .4 Check resistance to ground before energizing.
- .3 Furnish Manufacturer's Certificate or letter confirming that entire installation, as it pertains to each system, has been installed to manufacturer's instructions. Submit letter in accordance with this section.
- .4 Carry out tests in presence of Contract Administrator where directed.
- .5 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .6 Submit test results in Maintenance Manuals.

**3.12 CARE, OPERATION AND START-UP**

- .1 Instruct the City's operating personnel in the operation, care and maintenance of equipment. Arrangement of such instructional sessions shall be done at a time convenient to the City.
- .2 Arrange and pay for services of Manufacturer's factory service Contract Administrator to supervise start-up of installation, check, adjust, balance and calibrate components.
- .3 Provide these services for such a period, and for as many visits as necessary to put equipment into operation, and ensure that operating personnel are conversant with all aspects of its care and operation.

**3.13 CLEANING**

- .1 Final cleaning shall be done in accordance with the specification.
- .2 Final cleaning shall include, but not be limited to, all lighting reflectors, lenses, and other lighting surfaces that have been exposed to dust and dirt throughout the course of construction.

**END OF SECTION**

**Part 1            General**

**1.1                SECTION INCLUDES**

- .1      Building wire and cable.
- .2      Non-metallic sheathed cable.
- .3      Direct burial cable.
- .4      Service entrance cable.
- .5      Armoured cable.
- .6      Metal clad cable.
- .7      Wiring connectors and connections.

**1.2                RELATED SECTIONS**

- .1      Section 26 05 53 - Electrical Identification.

**1.3                REFERENCES**

- .1      CSA-C22.1-15 - Canadian Electrical Code, Part I (23<sup>rd</sup> Edition), Safety Standard for Electrical Installations.
- .2      CSA C22.2 No. 0.3 - Test Methods for Electrical Wires and Cables.
- .3      CSA C22.2 No. 48-M90 (R2000) - Non-metallic Sheathed Cable.
- .4      CSA C22.2 No. 51 Armoured Cables.
- .5      CSA C22.2 No. 52-96 (R2000) - Underground Service-Entrance Cables.
- .6      CAN/CSA C22.2 No. 65-03 (CSA/UL/ANCE) – Wire Connectors.
- .7      CSA C22.2 No. 75-03 (CSA/UL/ANCE) - Thermoplastic-Insulated Wires and Cables.
- .8      CSA C22.2 No. 123 Aluminum Sheathed Cables.
- .9      CSA C22.2 No. 131 Type TECK 90 Cable.
- .10     CSA C22.2 No. 208-03 - Fire Alarm and Signal Cable.
- .11     NECA (National Electrical Subcontractors Association) - Standard of Installation.
- .12     NETA (International Electrical Testing Association) - ATS-2003 - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- .13     CSA (Canadian Standards Association).
- .14     UL (Underwriters Laboratories Inc.).

**1.4                ADMINISTRATIVE REQUIREMENTS**

- .1      Section 01 31 00: Project management and coordination procedures.
- .2      Coordination:
  - .1      Coordinate with other work having a direct bearing on work of this section.

- .2 Where wire and cable destination is indicated and routing is not shown, determine exact routing and lengths required.

**1.5 SUBMITTALS FOR REVIEW**

- .1 Section 01 33 00: Submission procedures.
- .2 Product Data: Provide for Fire Rated Cable.

**1.6 SUBMITTALS FOR INFORMATION**

- .1 Section 01 33 00: Submission procedures.
- .2 Design Data: Indicate voltage drop and ampacity calculations for aluminum conductors substituted for copper conductors.
- .3 Installation Data: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.

**1.7 CLOSEOUT SUBMITTALS**

- .1 Section 01 77 00: Closeout procedures.
- .2 Record Documentation: Record actual locations of components and circuits.

**1.8 QUALITY ASSURANCE**

- .1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum five (5) years documented experience.

**1.9 REGULATORY REQUIREMENTS**

- .1 Conform to CSA-C22.1.
- .2 Provide products listed and classified by CSA or ULC and as suitable for the purpose specified and indicated.

**1.10 PROJECT CONDITIONS**

- .1 Conductor sizes are based on copper unless indicated as aluminum or "AL".

**Part 2 Products**

**2.1 BUILDING WIRE**

- .1 Description: Single conductor insulated wire.
- .2 Conductor: Copper unless otherwise noted.
- .3 Insulation Voltage Rating: 600 volts.
- .4 Insulation: Thermoplastic material rated 90 degrees C.

**2.2 ARMOURED CABLE**

- .1 Description: Type ACWU90 and AC90.
- .2 Conductor: Copper unless otherwise noted.

- .3 Insulation Voltage Rating: 600 volts.
- .4 Insulation Temperature Rating: 90 degrees C.
- .5 Insulation Material: Thermoplastic.

### **2.3 METAL CLAD CABLE**

- .1 Description: Type TECK90.
- .2 Conductor: Copper unless otherwise noted.
- .3 Insulation Voltage Rating: 600 volts.
- .4 Insulation Temperature Rating: 90 degrees C.
- .5 Insulation Material: Cross-Linked Polyethylene RW90.
- .6 Armour Material: Aluminum.
- .7 Armour Design: Interlocked metal tape.
- .8 Jacket: PVC.
- .9 Rating: Hazardous Location, CSA FT4

### **2.4 CONNECTORS**

- .1 Pressure type connectors, fixture type splicing connectors, cable clamps and lugs, as required.

## **Part 3 Execution**

### **3.1 EXAMINATION**

- .1 Verify that field measurements are as indicated.
- .2 Verify that interior of building has been protected from weather.
- .3 Verify that mechanical work likely to damage wire and cable has been completed.
- .4 Verify that raceway installation is complete and supported.

### **3.2 PREPARATION**

- .1 Completely and thoroughly swab raceway before installing wire.

### **3.3 WIRING METHODS**

- .1 Concealed Dry Interior Locations: Use only armoured cable and building wire in raceway.
- .2 Exposed Dry Interior Locations: Use only building wire in raceway.
- .3 Above Accessible Ceilings: Use only armoured cable, metal clad cable, and building wire in raceway.
- .4 Wet or Damp Interior Locations: Use only metal clad cable, armoured cable with jacket, and building wire in raceway.

- .5 Exterior Locations: Use only building wire Type RWU90 insulation in raceway, metal clad cable, and armoured cable with jacket.
- .6 Underground Installations: Use only direct burial cable, armoured cable with jacket, and metal clad cable.

**3.4 INSTALLATION**

- .1 Route wire and cable as required to meet project conditions.
- .2 Install cable to the CSA-C22.1.
- .3 Use solid conductor for feeders and branch circuits 10 AWG and smaller.
- .4 Use stranded conductors for control circuits.
- .5 Use conductor not smaller than 12 AWG for power and lighting circuits.
- .6 Use conductor not smaller than 16 AWG for control circuits.
- .7 User conductors sized to accommodate a maximum 3% voltage drop for the length of the circuit as per the following table:

Maximum Conductor Length for 120V Branch Circuits		
Breaker Size[A]	Conductor	
	Size [AWG]	Max Length [m]
15A	#12	20
	#10	35
	#8	55
	#6	90
20A	#12	15
	#10	25
	#8	40
	#6	65
	#4	110
30A	#10	15
	#8	25
	#6	45
	#4	70

- .8 Pull all conductors into raceway at same time.
- .9 Use suitable wire pulling lubricant for building wire 4 AWG and larger.
- .10 Protect exposed cable from damage.

- .11 Support cables above accessible ceiling, using spring metal clips or metal cable ties to support cables from structure or ceiling suspension system. Do not rest cable on ceiling panels.
- .12 Single conductor cables shall be installed one cable diameter apart on suspended cable tray or channel supports and shall be clamped with aluminum cable clamps. Cables shall be terminated using non-magnetic connectors and shall be watertight for top entry. Cable armour shall be grounded via an aluminum plate at the supply end and isolated via an insulating plate, at the load end of the cable. A #3/0 AWG insulated (unless otherwise noted) copper ground wire shall be installed with each set of feeder cables. Cable bending radius shall be at least twelve times the overall cable diameter and bend shall not damage or distort the outer sheath.
- .13 Armoured cable shall be used for connections from conduit systems to recessed luminaires in accessible ceilings. Cable shall be of sufficient length to allow the lighting fixture to be relocated to any location within an 1800mm (6') radius. Cable shall be clamped before entering the lighting fixture and shall be clipped before entering the conduit system junction box. (Minimum requirements).
- .14 Armoured cable may be used for connections from conduit systems to wiring devices in steel stud partitions and for interconnection of wiring devices within steel stud partitions. Cables shall be clipped before entering junction or outlet boxes.
- .15 Use suitable cable fittings and connectors.
- .16 Neatly train and lace wiring inside boxes, equipment, and panelboards.
- .17 Clean conductor surfaces before installing lugs and connectors.
- .18 Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
- .19 Terminate aluminum conductors with tin-plated aluminum- bodied compression connectors only. Fill with anti- oxidant compound before installing conductor.
- .20 Use suitable reducing connectors or mechanical connector adaptors for connecting aluminum conductors to copper conductors.
- .21 Use split bolt connectors for copper conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.
- .22 Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
- .23 Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.
- .24 Trench and backfill for direct burial cable installation as specified in Section 32 23 18 and Section 32 23 23. Install warning tape along entire length of direct burial cable, within 75 mm(3 inches) of grade.
- .25 Identify wire and cable to Section 26 05 53. Identify each conductor with its circuit number or other designation indicated.

**END OF SECTION**

**Part 1            General**

**1.1                SECTION INCLUDES**

- .1            Grounding electrodes and conductors.
- .2            Equipment grounding conductors.
- .3            Bonding.

**1.2                RELATED SECTIONS**

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

**1.3                REFERENCES**

- .1            CSA-C22.1-15 - Canadian Electrical Code, Part I (23<sup>rd</sup> Edition), Safety Standard for Electrical Installations.
- .2            IEEE 81-2012 IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.

**1.4                SYSTEM DESCRIPTION**

- .1            Metal and underground water pipe.
- .2            Metal frame of the building.
- .3            Metal and underground gas piping system.
- .4            Rod electrode.

**1.5                PERFORMANCE REQUIREMENTS**

- .1            Maximum Grounding System Resistance: 5 ohms.

**1.6                SUBMITTALS FOR REVIEW**

- .1            Section 01 33 00: Submission procedures.
- .2            Product Data: Provide for grounding electrodes and connections.

**1.7                SUBMITTALS FOR INFORMATION**

- .1            Section 01 33 00: Submission procedures.
- .2            Test Reports: Indicate overall resistance to ground.

**1.8                CLOSEOUT SUBMITTALS**

- .1            Section 01 78 00: Closeout Submittals.
- .2            Record Documentation: Record actual locations of components and grounding electrodes.
- .3            Certificate of Compliance: Indicate approval of installation by authority having jurisdiction.

**1.9 QUALITY ASSURANCE**

- .1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three (3) years experience.

**1.10 REGULATORY REQUIREMENTS**

- .1 Products: Listed and classified by ULC and/or CSA as suitable for the purpose specified and indicated.

**Part 2 Products**

**2.1 ROD ELECTRODES**

- .1 Material: Copper-clad steel.
- .2 Diameter: 15.8 mm(5/8 inch) minimum.
- .3 Length and Quantity: As required to meet performance requirements.

**2.2 MECHANICAL CONNECTORS**

- .1 Material: Bronze.

**2.3 WIRE**

- .1 Material: Stranded copper.
- .2 Grounding Electrode Conductor: Size to meet CSA-C22.1 requirements.

**Part 3 Execution**

**3.1 EXAMINATION**

- .1 Verify that final backfill and compaction has been completed before driving rod electrodes.

**3.2 INSTALLATION**

- .1 Install rod electrodes as indicated. Install additional rod electrodes as required to achieve specified resistance to ground.
- .2 Provide bonding to meet Regulatory Requirements.
- .3 Exposed conductors shall be protected from mechanical injury.
- .4 Mechanical connections shall be used for bonding connections to equipment. Soldered joints shall not be permitted.
- .5 Buried connections of grounding and bonding conductors shall be made using exothermic welding process.
- .6 Provide bonding wire connected to both ends of flexible conduit. Neatly attach to exterior of flexible conduit.
- .7 Provide separate ground conductors for all exterior pole mounted luminaires.

- .8 Interface with site grounding system.
- .9 Interface with lightning protection system.
- .10 Bonding connections shall be made using a star configuration. Loop connections shall be avoided.
- .11 Single conductor cables with metallic armour shall be bonded at the supply end only. Provide non-metallic entry plates for load end terminations. Provide a separate bonding conductor.
- .12 Provide separate bonding conductor in all non-metallic raceways.

### **3.3 SYSTEM GROUNDING**

- .1 Install system and circuit grounding connection to neutral points of 600V and 208V systems.
- .2 Grounding conductors shall be routed in or adjacent to primary conduits or cables.
- .3 Provide grounding connection to utility pad mounted transformer in accordance with the requirements of the supply authority.

### **3.4 EQUIPMENT BONDING**

- .1 Install bonding connections to typical equipment included in, but not necessarily limited to:
  - .1 Service equipment
  - .2 Distribution Panels
  - .3 Transformers
  - .4 Motor Frames
  - .5 Starters
  - .6 Control Panels
  - .7 Building Steel Work
  - .8 Elevators
  - .9 Outdoor lighting

### **3.5 COMMUNICATION SYSTEMS**

- .1 Install communications grounding system for bonding of all telephone, data, fire alarm, paging as follows:
  - .1 Provide minimum #6 AWG ground (or larger as indicated on drawings) from all voice/data, server, and IT communications rooms to main building ground.
  - .2 Provide grounding for utility telephone and data demarcation locations in accordance with utility requirements.
  - .3 Sound, fire alarm, and other communication systems as indicated.

**END OF SECTION**

**Part 1            General**

**1.1                SECTION INCLUDES**

- .1        Conduit and equipment supports.
- .2        Anchors and fasteners.

**1.2                REFERENCES**

- .1        CSA-C22.1-15 - Canadian Electrical Code, Part I (23<sup>rd</sup> Edition), Safety Standard for Electrical Installations.
- .2        CECA - Canadian Electrical Subcontractors Association.
- .3        CSA (Canadian Standards Association).
- .4        ULC (Underwriters Laboratories Canada Inc.).

**1.3                SUBMITTALS FOR REVIEW**

- .1        Section 01 33 00: Submission procedures.
- .2        Product Data: Provide manufacturer's catalogue data for fastening systems.

**1.4                REGULATORY REQUIREMENTS**

- .1        Provide products listed and classified by CSA and as suitable for purpose specified and shown.

**Part 2            Products**

**2.1                PRODUCT REQUIREMENTS**

- .1        Materials and Finishes: Provide adequate corrosion resistance.
- .2        Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products.
- .3        Anchors and Fasteners:
  - .1        Concrete Structural Elements: Use expansion anchors.
  - .2        Steel Structural Elements: Use beam clamps and spring steel clips.
  - .3        Concrete Surfaces: Use expansion anchors.
  - .4        Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts and hollow wall fasteners.
  - .5        Solid Masonry Walls: Use expansion anchors.
  - .6        Sheet Metal: Use sheet metal screws.
  - .7        Wood Elements: Use wood screws.

**2.2 STEEL CHANNEL**

- .1 U-shape, galvanized steel, size 1.6" x 1.6" (40 x 40 mm), 0.1" (2.5 mm) thick, surface-mounted, suspended or set in poured concrete walls and ceilings as required.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install products to manufacturer's written instructions.
- .2 Provide anchors, fasteners, and supports to CSA-C22.1.
- .3 Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.
- .4 Do not use powder-actuated anchors.
- .5 Obtain permission from Contract Administrator before using powder-actuated anchors.
- .6 Do not drill or cut structural members.
- .7 Obtain permission from Contract Administrator before drilling or cutting structural members.
- .8 Do not use plastic cable ties.
- .9 Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
- .10 Install surface-mounted cabinets and panelboards with minimum of four anchors.
- .11 In wet and damp locations use steel channel supports to stand cabinets and panelboards 25 mm (1 inch) off wall.
- .12 Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

**END OF SECTION**

**Part 1            General**

**1.1                SECTION INCLUDES**

- .1      Metal conduit.
- .2      PVC coated metal conduit.
- .3      Flexible metal conduit.
- .4      Liquid tight flexible metal conduit.
- .5      Electrical metallic tubing.
- .6      Nonmetal conduit.
- .7      Electrical nonmetallic tubing.

**1.2                RELATED SECTIONS**

- .1      Section 07 84 00 - Firestopping.
- .2      Section 26 05 00 – Common Work Results for Electrical
- .3      Section 26 05 34 - Boxes.
- .4      Section 26 05 26 - Grounding And Bonding.
- .5      Section 26 05 29 - Electrical Supporting Devices.
- .6      Section 26 05 53 - Electrical Identification.

**1.3                REFERENCES**

- .1      CSA-C22.1-15 - Canadian Electrical Code, Part I (23<sup>rd</sup> Edition), Safety Standard for Electrical Installations.
- .2      CAN/CSA-C22.2 No. 18.1-04 (R2009) - Metallic Outlet Boxes.
- .3      CSA C22.2 No.45 - Rigid Metal Conduit.
- .4      CAN/CSA-C22.2 No. 45.1-07 - Electrical Rigid Metal Conduit - Steel.
- .5      CSA-C22.2 No. 56-04 - Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
- .6      CSA-C22.2 No. 83.1-07 - Electrical Metallic Tubing - Steel.
- .7      CSA-C22.2 No. 211.1-06 - Rigid Types EB1 and DB2/ES2 PVC Conduit.
- .8      CSA C22.2 No.211.2 - Rigid PVC (Unplasticized) Conduit.
- .9      CSA-C22.2 No. 2420-09 - Belowground reinforced thermosetting resin conduit (RTRC) and fittings.
- .10     CSA-C22.2 No. 227.1-06 - Electrical Nonmetallic Tubing.
- .11     CSA-C22.2 No. 227.2.1-04 - Liquid-Tight Flexible Nonmetallic Conduit.
- .12     CSA (Canadian Standards Association).
- .13     UL (Underwriters Laboratories Inc.).

#### **1.4 ADMINISTRATIVE REQUIREMENTS**

- .1 Section 01 31 00: Project management and coordination procedures.
- .2 Coordination:
  - .1 Coordinate with other work having a direct bearing on work of this section.

#### **1.5 CLOSEOUT SUBMITTALS**

- .1 Section 01 78 00: Closeout Submittals.
- .2 Record Documentation: Accurately record actual routing of conduits equal to or larger than 53mm(2").

#### **1.6 REGULATORY REQUIREMENTS**

- .1 Design conduit size to CSA-C22.1.
- .2 Provide products listed and classified by CSA or ULc as suitable for purpose specified and shown.

#### **1.7 DELIVERY, STORAGE, AND PROTECTION**

- .1 Section 01 61 00: Transport, handle, store, and protect products.
- .2 Accept conduit on site. Inspect for damage.
- .3 Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- .4 Protect PVC conduit from sunlight.

### **Part 2 Products**

#### **2.1 CONDUIT REQUIREMENTS**

- .1 Minimum Size: 21mm(3/4 inch) unless otherwise specified.
- .2 Underground Installations:
  - .1 More than 1525 mm(5 ft) from Foundation Wall: Use thick wall non-metallic conduit.
  - .2 Within 1525 mm(5 ft) from Foundation Wall: Use rigid steel conduit.
  - .3 In or Under Slab on Grade: Use thick wall non-metallic conduit.
  - .4 Minimum Size: 27 mm(1 inch).
  - .5 Provide a separate ground wire in all below-grade conduits.
  - .6 Provide an exterior trace wire for all conduits containing non-current carrying cabling.
  - .7 Use waterproof fittings.
- .3 Outdoor Locations, Above Grade: Use rigid steel conduit.
- .4 In Slab:
  - .1 Use electrical non-metallic tubing.

- .2 Maximum Size Conduit in Slab: 27mm(1 inch) and 16mm(1/2 inch) for conduits crossing each other.
- .5 Wet and Damp Locations: Use non-metallic conduit.
- .6 Dry Locations:
  - .1 Concealed: Use electrical metallic tubing.
  - .2 Exposed: Use electrical metallic tubing.
- .7 Hazardous Areas: Use rigid steel conduit or teck cable complete with conduit seal fittings and compound.
- .8 Raised Floor Systems: Liquid-tight flexible metal conduit or teck cable.

## **2.2 METAL CONDUIT**

- .1 Rigid Steel Conduit: C22.2 No. 45.1.
- .2 Fittings and Conduit Bodies: All steel fittings.

## **2.3 FLEXIBLE METAL CONDUIT**

- .1 Description: Interlocked steel construction.
- .2 Fittings: CSA C22.2 No. 56.
- .3 Provide a separate ground wire in all flexible metal conduit.

## **2.4 LIQUID TIGHT FLEXIBLE METAL CONDUIT**

- .1 Description: Interlocked steel construction with PVC jacket.
- .2 Fittings: CSA C22.2 No. 56.
- .3 Provide a separate ground wire in all liquid tight flexible metal conduit.

## **2.5 ELECTRICAL METALLIC TUBING (EMT)**

- .1 Description: CSA C22.2 N0. 83.1; galvanized tubing.
- .2 Fittings and Conduit Bodies: CSA C22.2 No. 83.1; steel, set screw type.
- .3 Refer to Section 26 05 53 for colour requirements.

## **2.6 NON-METALLIC CONDUIT**

- .1 Description: CSA C22.2 No. 211.2; PVC.
- .2 Fittings and Conduit Bodies: CSA C22.2 No. 211.2.
- .3 Provide a separate ground wire in all non-metallic conduit

## **2.7 ELECTRICAL NON-METALLIC TUBING**

- .1 Description: CSA 227.1.
- .2 Fittings and Conduit Bodies: CSA 227.1.
- .3 Provide a separate ground wire in all electrical non-metallic tubing.

## **2.8 FITTINGS**

- .1 Fittings shall be manufactured for use with conduit specified.
- .2 Insulated throat liners on connectors.
- .3 Steel raintight connector fittings complete with O-rings, for use on weatherproof or sprinklerproof enclosures. Steel raintight couplings shall be used for surface conduit installation exposed to moisture or sprinkler heads. Steel raintight connectors shall be used for all top entries to panels, contactors and motor control centres.
- .4 Expansion fittings
  - .1 Outdoor locations - Weatherproof expansion fittings with internal bonding assembly, suitable for 100mm(4") or 200mm(8") linear expansion.
  - .2 Wet and Damp Locations - Watertight expansion fittings with integral bonding jumper suitable for linear expansion, and 21mm(3/4") deflection in all directions, as required.
  - .3 Panel Entry - Weatherproof expansion fittings for linear expansion as required.
  - .4 PVC Conduit - O-ring type expansion fittings.
  - .5 Flexible watertight conduit between junction boxes with integral bonding jumper suitable for linear and lateral movement greater than 19mm(3/4").

## **Part 3 Execution**

### **3.1 EXAMINATION**

- .1 Verify that field measurements are as shown on Drawings.
- .2 Verify routing and termination locations of conduit prior to rough-in.
- .3 Conduit routing is shown on Drawings in approximate locations unless dimensioned. Route as required to complete wiring system.
- .4 Drawings do not contain all conduits. Provide all conduit as required for a complete system.
- .5 All conduit sizes indicated on drawings are minimum sizes unless otherwise noted. Where larger conduit sizes are required to meet Canadian Electrical Code requirements, contractor shall provide larger size at no additional cost. Increase conduit size at no extra costs where required to accommodate length of run and voltage drop requirements in accordance with Canadian Electrical Code requirements.

### **3.2 INSTALLATION**

- .1 Install conduit to CSA C22.1.
- .2 Install non-metallic conduit to manufacturer's written instructions.
- .3 Arrange supports to prevent misalignment during wiring installation.
- .4 Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
- .5 Group related conduits; support using conduit rack.
- .6 Construct rack using steel channel. Provide space on each for 25% additional conduits.

- .7 Fasten conduit supports to building structure and surfaces to Section 26 05 29.
- .8 Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.
- .9 Do not attach conduit to ceiling support wires.
- .10 Arrange conduit to maintain headroom and present neat appearance.
- .11 Provide flexible metal conduit for all connections to motors, recessed lighting, suspended lighting, transformers, and equipment subject to movement or vibration.
- .12 Conduit Routing:
  - .1 All conduit shall be concealed except in mechanical and electrical rooms or as otherwise noted.
  - .2 Where surface conduit is installed:
    - .1 Locate more than 2000mm(78 inches) from infrared or gas-fired heaters.
    - .2 Group conduits on suspended or surface rack support.
  - .3 Route conduit parallel and perpendicular to walls.
  - .4 Route conduit installed above accessible ceilings parallel and perpendicular to walls.
  - .5 Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket.
  - .6 Route conduit in and under slab from point-to-point.
  - .7 Do not route conduits through structural members unless otherwise indicated.
  - .8 Do not route conduit through terrazzo or concrete toppings unless otherwise indicated.
  - .9 Do not route conduit horizontally in masonry walls unless otherwise indicated.
- .13 Conduits in Poured Concrete:
  - .1 Submit marked up drawings of proposed conduit routing complete with conduit sizes to Structural and Electrical Contract Administrators for approval prior to installation.
  - .2 Coordinate installation of conduit to suite reinforcing steel.
  - .3 Locate in centre third of slab.
  - .4 Provide minimum separation of 150mm(6") between parallel conduit runs.
  - .5 Do not install conduit in drop panels, beams, or columns unless approved by the Structural Contract Administrator.
  - .6 Where conduits are grouped, or do not follow perpendicular to parallel to building lines, provide photos in electronic format (minimum resolution 1920x1080) of conduit installation prior to concrete pour.
  - .7 Record drawings shall indicated location of all conduit embedded in concrete, or run below slab complete with dimensions to building lines.
  - .8 For slab-on-grade, conduit larger than 27mm(1") shall be routed below slab and encased in minimum 75mm(3") of concrete.
- .14 All conduit below grade shall be sloped to provide drainage away from the building.
- .15 Maintain adequate clearance between conduit and piping.

- .16 Maintain 300mm(12 inch) clearance between conduit and surfaces with temperatures exceeding 40 degrees C(104 degrees F).
- .17 Cut conduit square using saw or pipe cutter; de-burr cut ends.
- .18 Bring conduit to shoulder of fittings; fasten securely.
- .19 Where threaded connections are used, threads shall be of sufficient length to ensure a tight connection.
- .20 Where conduit becomes blocked, remove and replaced blocked sections.
- .21 Join non-metallic conduit using cement as recommended by manufacturer.
  - .1 Wipe non-metallic conduit dry and clean before joining.
  - .2 Apply full even coat of cement to entire area inserted in fitting.
  - .3 Allow joint to cure for 20 minutes, minimum.
- .22 Use conduit hubs to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.
- .23 Install no more than equivalent of three 90-degree bends between boxes.
  - .1 Use conduit bodies to make sharp changes in direction, as around beams.
  - .2 Use hydraulic one-shot bender to fabricate and factory elbows for bends in metal conduit larger than 53mm(2 inch) size.
  - .3 All metallic conduit shall be bent cold. Replace sections where conduit is kinked or flattened by more than 10% of its original diameter.
- .24 Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.
- .25 Ensure conduit systems are dry prior to installation of wiring.
- .26 Provide suitable fittings to accommodate expansion and deflection where conduit crosses seismic and control expansion joints, and where conduit transitions from below to above grade.
- .27 Provide polypropylene pull string in each empty conduit except sleeves and nipples.
- .28 Use suitable caps to protect installed conduit against entrance of dirt and moisture.
- .29 Ground and bond conduit to Section 26 05 26.
- .30 Identify conduit to Section 26 05 53.

**END OF SECTION**

**Part 1            General**

**1.1                SECTION INCLUDES**

- .1      Wall and ceiling outlet boxes.
- .2      Floor boxes.
- .3      Pull and junction boxes.

**1.2                RELATED SECTIONS**

- .1      Section 07 84 00 - Firestopping.
- .2      Section 26 27 26 - Wiring Devices.

**1.3                REFERENCES**

- .1      CAN/CSA-C22.2 No. 18.1-04 (R2009) - Metallic Outlet Boxes.
- .2      CSA-C22.1-15 - Canadian Electrical Code, Part I (23<sup>rd</sup> Edition), Safety Standard for Electrical Installations.
- .3      CAN/CSA-C22.2 No. 18.1-04 (R2009) - Metallic Outlet Boxes.
- .4      CSA-C22.2 No. 40-1989 (R2004) - Cutout, Junction and Pull Boxes.
- .5      CAN/CSA-C22.2 No. 85-M89 (R2010) - Rigid PVC Boxes and Fittings.
- .6      CSA (Canadian Standards Association).
- .7      UL (Underwriters Laboratories Inc.).

**1.4                ADMINISTRATIVE REQUIREMENTS**

- .1      Section 01 31 00: Project management and coordination procedures.
- .2      Coordination:
  - .1      Coordinate with other work having a direct bearing on work of this section.
  - .2      Coordinate installation of outlet box for equipment connected under Section 26 05 80.

**1.5                CLOSEOUT SUBMITTALS**

- .1      Section 01 78 00: Closeout Submittals.
- .2      Record Documentation: Record actual locations and mounting heights of outlet, pull, and junction boxes on project record documents.

**1.6                REGULATORY REQUIREMENTS**

- .1      Provide products listed and classified by CSA or ULc as suitable for purpose specified and shown.

**Part 2 Products**

**2.1 OUTLET BOXES**

- .1 Sheet Metal Outlet Boxes: CSA-C22.2 No. 18, galvanized steel.
  - .1 Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 13 mm(1/2 inch) male fixture studs where required.
  - .2 Concrete Ceiling Boxes: Concrete type.
- .2 Non-metallic Outlet Boxes: CSA-C22.2 No. 18.
- .3 Cast Boxes: CSA-C22.2 No. 18, Type FD, cast ferric alloy. Provide gasketed cover by box manufacturer. Provide threaded hubs.
- .4 In-wall Boxes: 18 gauge white powder coated steel complete with trim ring, will accept standard single gang outlet boxes, wiring devices and cover plates, complete with screw-on steel cover with cable exit.
- .5 Wall Plates for Finished Areas: As specified in Section 26 27 26.

**2.2 PULL AND JUNCTION BOXES**

- .1 Sheet Metal Boxes: CSA-C22.2 No. 18, galvanized steel.
- .2 Surface Mounted Cast Metal Box: CSA-C22.2 No. 18, Type [4] [6] and; flat-flanged, surface mounted junction box:
  - .1 Material: Galvanized cast iron.
  - .2 Cover: Provide with ground flange, neoprene gasket, and stainless steel cover screws.
- .3 In-Ground Cast Metal Box: CSA-C22.2 No. 18, Type 6, flanged, recessed cover box for flush mounting:
  - .1 Material: Galvanized cast iron.
  - .2 Cover: Non-skid cover with neoprene gasket and stainless steel cover screws.
  - .3 Cover Legend: "ELECTRIC".
- .4 Fibreglass Hand Holes: Die moulded glass fibre hand holes:
  - .1 Cable Entrance: Pre-cut 150 x 150 mm (6 x 6 inch) cable entrance at centre bottom of each side, or as required.
  - .2 Cover: Glass fibre weatherproof cover with non-skid finish.

**Part 3 Execution**

**3.1 EXAMINATION**

- .1 Verify locations of floor boxes and outlets throughout prior to rough-in.

**3.2 INSTALLATION**

- .1 Install boxes to CSA-C22.1.

- .2 Install in locations as shown on drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.
- .3 Set wall mounted boxes at elevations to accommodate mounting heights specified in section for outlet device and as indicated. Coordinate locations with architectural drawings.
- .4 Electrical boxes are shown on drawings in approximate locations unless dimensioned. Adjust box location up to 3 m(10 ft) if required to accommodate intended purpose.
- .5 Orient boxes to accommodate wiring devices oriented as specified in Section 26 27 26.
- .6 Maintain headroom and present neat mechanical appearance.
- .7 Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- .8 Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 150 mm(6 inches) from ceiling access panel or from removable recessed luminaire.
- .9 Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- .10 Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.
- .11 Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.
- .12 Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.
- .13 Use flush mounting outlet box in finished areas.
- .14 Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
- .15 Do not install flush mounting box back-to-back in walls; provide minimum 150 mm(6 inches) separation. Provide minimum 600 mm(24 inches) separation in acoustic rated walls.
- .16 Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- .17 Use stamped steel bridges to fasten flush mounting outlet box between studs.
- .18 Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- .19 Use in-wall boxes for wall mounted television and smart board power and communications applications.
- .20 Do not install in-wall box back-to-back in walls; provide minimum 150 mm(6 inches) separation. Provide minimum 600 mm(24 inches) separation in acoustic rated walls.
- .21 Secure in-wall box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- .22 Use stamped steel bridges to fasten in-wall outlet box between studs.
- .23 Install in-wall mounting box without damaging wall insulation or reducing its effectiveness.
- .24 Use adjustable steel channel fasteners for hung ceiling outlet box.

- .25 Do not fasten boxes to ceiling support wires.
- .26 Support boxes independently of conduit.
- .27 Use gang box where more than one device is mounted together. Do not use sectional box.
- .28 Use gang box with plaster ring for single device outlets.
- .29 Use cast outlet box in exterior locations [exposed to the weather] and wet locations.
- .30 Set floor boxes level.
- .31 Large Pull Boxes: Use hinged enclosure in interior dry locations, surface-mounted cast metal box in other locations.

**3.3 ADJUSTING**

- .1 Adjust floor box flush with finish flooring material.
- .2 Adjust flush-mounting outlets to make front flush with finished wall material.
- .3 Install knockout closures in unused box openings.

**3.4 CLEANING**

- .1 Clean interior of boxes to remove dust, debris, and other material.
- .2 Clean exposed surfaces and restore finish.

**END OF SECTION**

**Part 1            General**

**1.1                SECTION INCLUDES**

- .1            Cable trays and accessories.

**1.2                RELATED SECTIONS**

- .1            Section 07 84 00 - Firestopping.
- .2            Section 26 05 26 - Grounding And Bonding.
- .3            Section 26 05 29 - Electrical Supporting Devices.

**1.3                REFERENCES**

- .1            ASTM A123/A123M-09 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- .2            ASTM A653/A653M-10 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- .3            CSA-C22.1-15 - Canadian Electrical Code, Part I (23<sup>rd</sup> Edition), Safety Standard for Electrical Installations.
- .4            CSA-C22.2 No. 126.1-09 - Metal Cable Tray Systems.
- .5            CAN/CSA-C22.2 No. 126.2-02 (R2007) - Nonmetallic Cable Tray Systems.
- .6            CSA (Canadian Standards Association).
- .7            UL (Underwriters Laboratories Inc.).

**1.4                ADMINISTRATIVE REQUIREMENTS**

- .1            Section 01 31 00: Project management and coordination procedures.
- .2            Pre-installation Meetings: Convene one (1) week before starting work of this section.

**1.5                SUBMITTALS FOR REVIEW**

- .1            Section 01 33 00: Submission procedures.
- .2            Product Data: Provide data for fittings and accessories.
- .3            Shop Drawings: Indicate tray type, dimensions, support points, and finishes.

**1.6                SUBMITTALS FOR INFORMATION**

- .1            Section 01 33 00: Submission procedures.
- .2            Manufacturer's Instructions:
  - .1            Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements.
  - .2            Include instructions for storage, handling, protection, examination, preparation, and installation of product.

**1.7 CLOSEOUT SUBMITTALS**

- .1 Section 01 78 00: Closeout Submittals.
- .2 Record Documentation: Record actual routing of cable tray and locations of supports.

**1.8 QUALITY ASSURANCE**

- .1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum five (5) years documented experience.

**1.9 REGULATORY REQUIREMENTS**

- .1 Products: Listed and classified by CSA and as suitable for the purpose specified and indicated.

**Part 2 Products**

**2.1 BASKET TRAY**

- .1 Manufacturers:
  - .1 Cablofil: CF Series
  - .2 Substitutions: Refer to Section 01 25 00.
- .2 Description: CSA-22.2 No. 126.1, Nema 12C continuous rigid welded steel wire mesh cable management system.
- .3 Material: Carbon Steel Wire complete with Electroplated Zinc Plating
- .4 Inside Width: 305 mm(12 inches)
- .5 Inside Depth: 102 mm(4 inches)
- .6 Manufacturer's standard couplings, clamps, hangers, stabilizers, end caps, brackets, wall brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, floor supports, rung caps, cable drop outs, and grounding straps.
- .7 Covers and Bottom Inserts: Solid.

**2.2 WARNING SIGNS**

- .1 Engraved Nameplates: 13 mm(1/2 inch) black letters on yellow laminated plastic nameplate, engraved with the following wording:
  - .1 WARNING! DO NOT USE CABLE TRAY AS WALKWAY, LADDER, OR SUPPORT. USE ONLY AS STRUCTURAL SUPPORTS FOR CABLES AND TUBING!

**Part 3 Execution**

**3.1 EXAMINATION**

- .1 Section 01 70 00: Verify existing conditions before starting work.

- .2 Verify that field measurements are as indicated on Shop Drawings and as instructed by manufacturer.

### **3.2 INSTALLATION**

- .1 Install metallic cable tray to CSA-C22.1 SB-02 and C22.2 No. 126.1.
- .2 Install fibreglass cable tray to CSA-C22.1 SB-02 and C22.2 No. 126.2.
- .3 Support trays to Section 26 05 29.
- .4 Utilize 13mm(1/2 inch) threaded rod complete with double lock nuts below tray and single lock nuts above tray for center hung cable tray.
- .5 Provide supports as per manufacturer's recommendations, or at a minimum, at each connection point, at the end of each run, and at other points to maintain spacing between supports.
- .6 Use expansion connectors where required.
- .7 Provide firestopping to Section 07 84 00 to sustain ratings when passing cable tray through fire-rated elements.
  - .1 Provide continuity between tray components.
  - .2 Use anti-oxidant compound to prepare aluminum contact surfaces before assembly.
  - .3 Provide 2 AWG bare copper equipment grounding conductor through entire length of tray; bond to each component.
  - .4 Connections to tray may be made using mechanical or exothermic connectors.
- .8 Install warning signs at 15,000 mm(50 ft) centres along cable tray, located to be visible.

**END OF SECTION**

**Part 1            General**

**1.1                SECTION INCLUDES**

- .1      Nameplates and labels.
- .2      Wire markers.
- .3      Conduit markers.
- .4      Underground warning tape.

**1.2                RELATED SECTIONS**

- .1      Section 09 91 00 - Painting.

**1.3                REFERENCES**

- .1      CSA (Canadian Standards Association).
- .2      ULC (Underwriters Laboratories of Canada).

**1.4                SUBMITTALS FOR REVIEW**

- .1      Section 01 33 00: Submission procedures.
- .2      Product Data: Provide catalogue data for nameplates, labels, and markers.
- .3      Installation Data: Provide list of all equipment requiring nameplates complete with associated nameplate configuration for review.

**1.5                REGULATORY REQUIREMENTS**

- .1      Provide products listed and classified by CSA or ULC and as suitable for purpose specified and shown.

**1.6                LANGUAGE**

- .1      All identification shall be in English.

**Part 2            Products**

**2.1                NAMEPLATES AND LABELS**

- .1      Nameplates: Engraved three-layer laminated plastic, white letters on blue background for normal power and systems, white letters on red background for life safety power and systems, and white letters on orange background for standby power and systems.
  - .1      Locations:
    - .1      Electrical distribution, motor control centres, disconnect switches, panelboards and control equipment enclosures.
    - .1      Nameplate shall include:
      - .1      Distribution Name
      - .2      Distribution Voltage, Phase, Wires, Amperage

- .3 Room Location
- .4 Fed From:
  - .1 Panel Name
  - .2 Supplying Breaker Size/Poles
  - .3 Room Location
- .2 Mechanical equipment disconnect switches:
  - .1 Nameplate shall include:
    - .1 Mechanical Equipment Mark
    - .2 Panel Name & Circuit number
- .3 Communication/Systems Racks & Cabinets
  - .1 Nameplate shall include:
    - .1 System Name
    - .2 Room Number
    - .3 Rack/Cabinet Number (if applicable)
    - .4 Fed From:
      - .1 Room Number.
      - .2 Rack/Cabinet Number (if applicable)
      - .3 Patch Panel and/or Rack Position (if applicable)
- .4 Fire Alarm System Equipment
  - .1 Nameplate shall include:
    - .1 Room Number
    - .2 Equipment Name
    - .3 Fed From:
      - .1 Room Number.
      - .2 Panel Name and Circuit Number
- .5 Fire Alarm Equipment Branch Circuit Breakers
  - .1 Nameplate shall indicate "FIRE ALARM PANEL" or approved wording.
- .6 Pole mounted luminaires.
  - .1 Nameplate shall include:
    - .1 Manufacturer & Model # of Pole
    - .2 Manufacturer & Model # of Luminaire
    - .3 Voltage
    - .4 Ballast Model #
    - .5 Lamp Wattage & Model #
    - .6 Fed From Panel & Circuit Number
- .7 Parking receptacles.
  - .1 Nameplate shall include:
    - .1 Circuit number
- .2 Letter Size:

- .1 Use 6 mm(1/4 inch) letters for identifying equipment mark designations and system types.
  - .2 Use 3 mm(1/8 inch) letters for identifying supporting information.
  - .3 Use 6 mm(1/4 inch) letters for identifying grouped equipment and loads.
  - .3 Nameplates on exterior equipment shall be UV & weather resistant.
  - .4 Wording on nameplates shall be approved prior to manufacture. Submit schedule of nameplates and wording.
- .2 Labels: Plastic self-adhesive non-smear labels with 3 mm(1/8 inch) black letters on white background.
- .1 Locations:
    - .1 Wiring devices, including lighting control devices and receptacles.
      - .1 Label shall include:
        - .1 Indicate associated panel and circuit number.
        - .2 E.g. "A-32" (A is for Panel-A, and 32 is the circuit number)
        - .3 Lighting controls to include brief description of lighting being controlled.
        - .4 E.g. "Pendants"
      - .2 Voice/Data Outlets
        - .1 Label shall include:
          - .1 Indicate associated rack or cabinet name
          - .2 Indicate associated patch panel and drop number
          - .3 E.g. "IDC-A-13" (IDC is for rack name, patch panel A, drop number 13)
        - .3 Voice/Data Patch Panels
          - .1 Label shall include:
            - .1 Indicate associated rack or cabinet name
            - .2 Indicate patch panel name.
            - .3 E.g. "IDC-A" (IDC is for rack name, patch panel A)

## 2.2 WIRE MARKERS

- .1 Description: Tape type wire markers.
- .2 Locations:
  - .1 Each conductor at panelboard gutters, pull boxes, outlet and junction boxes and each load connection.
    - .1 Legend:
      - .1 Power and Lighting Circuits: Branch circuit or feeder number indicated on drawings.
      - .2 Control Circuits: Control wire number indicated on Shop Drawings.
    - .2 Voice/Data drops including both ends of cable.
      - .1 Label shall include:

- .1 Indicate associated rack or cabinet name
- .2 Indicate associated patch panel and drop number
- .3 E.g. "IDC-A-13" (IDC is for rack name, patch panel A, drop number 13)

## **2.3 CONDUIT MARKERS**

- .1 Manufacturers:
  - .1 Brady; Product: BMP71 Indoor/Outdoor Vinyl Labels.
  - .2 Substitutions: Refer to Section 01 25 00.
- .2 Description: Vinyl label.
- .3 Location: Provide markers for each conduit longer than 4.7 m(10 ft).
- .4 Spacing: 6 m(20 ft) on centre.
- .5 Colour:
  - .1 Normal Power System: Blue
  - .2 Life-Safety Power System: Red
  - .3 Fire Alarm System: Red.
  - .4 Communication System: Yellow
  - .5 Security Systems: Black
  - .6 Controls System: White
- .6 Legend:
  - .1 120/208 Volt System: 120/208V.
  - .2 Fire Alarm System: FIRE ALARM.
  - .3 Communication System:
    - .1 VOICE
    - .2 DATA
    - .3 VOICE/DATA
  - .4 Public Address System: PA
  - .5 Access Control System: ACCESS CONTROL
  - .6 Intrusion System: INTRUSION
  - .7 Controls System: CONTROLS

## **2.4 UNDERGROUND WARNING TAPE**

- .1 Manufacturers: Brady
  - .1 Product: Detectable Identoline.

## **Part 3 Execution**

### **3.1 PREPARATION**

- .1 Degrease and clean surfaces to receive nameplates and labels.

**3.2 APPLICATION**

- .1 Install nameplate and label parallel to equipment lines.
- .2 Secure nameplate to equipment front using rivets or screws.
- .3 Identify conduit using field painting to Section [09 91 00].
- .4 Paint coloured band on each conduit longer than 2 m(6 ft).
- .5 Paint bands 6 m(20 ft) on centre.
- .6 Colour:
  - .1 208 Volt System: Blue
  - .2 Fire Alarm System: Red.
  - .3 Communication System: Yellow
  - .4 Security Systems: Black
  - .5 Controls System: White
- .7 Identify underground conduits using underground warning tape. Install one tape per trench at 75 mm(3 inches) below finished grade.
- .8 Provide identification on all junction box covers indicating associated system, panel and circuit numbering using permanent marker.

**END OF SECTION**

**Part 1            General**

**1.1                SECTION INCLUDES**

- .1            Electrical connections to equipment specified under other sections.

**1.2                RELATED SECTIONS**

- .1            Section 01 11 00 - Summary of Work.
- .2            Section 22 47 00 - Plumbing Equipment.
- .3            Section 26 05 33 - Conduit.
- .4            Section 26 05 19 - Building Wire And Cable.
- .5            Section 26 05 34 - Boxes.

**1.3                REFERENCES**

- .1            CSA-C22.1-15 - Canadian Electrical Code, Part I (23<sup>rd</sup> Edition), Safety Standard for Electrical Installations.
- .2            CSA-C22.2 No. 127-09 - Equipment and Lead Wires.
- .3            NEMA WD 6-2002 (R2008) - Wiring Devices - Dimensional Requirements.
- .4            NEMA WD 1-1999 (R2010) - General Colour Requirements for Wiring Devices.
- .5            CSA (Canadian Standards Association).
- .6            UL (Underwriters Laboratories Inc.).

**1.4                ADMINISTRATIVE REQUIREMENTS**

- .1            Section 01 31 00: Project management and coordination procedures.
- .2            Coordination:
  - .1            Coordinate with other work having a direct bearing on work of this section.
  - .2            Obtain and review shop drawings, product data, and manufacturer's instructions for equipment provided under other sections.
  - .3            Determine connection locations and requirements.
- .3            Sequencing:
  - .1            Sequence rough-in of electrical connections to coordinate with installation schedule for equipment.
  - .2            Sequence electrical connections to coordinate with start-up schedule for equipment.

**1.5                SUBMITTALS FOR REVIEW**

- .1            Section 01 33 00: Submission procedures.
- .2            Product Data: Provide wiring device manufacturer's catalogue information showing dimensions, configurations, and construction.

**1.6 SUBMITTALS FOR INFORMATION**

- .1 Section 01 33 00: Submission procedures.
- .2 Installation Data: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

**1.7 REGULATORY REQUIREMENTS**

- .1 Products: Listed and classified by CSA and as suitable for the purpose specified and indicated.

**Part 2 Products**

**Part 3 Execution**

**3.1 EXAMINATION**

- .1 Verify that equipment is ready for electrical connection, wiring, and energization.

**3.2 ELECTRICAL CONNECTIONS**

- .1 Make electrical connections to equipment manufacturer's written instructions.
- .2 Make conduit connections to equipment using flexible conduit. Use liquid-tight flexible conduit with watertight connectors in damp or wet locations.
- .3 Make wiring connections using wire and cable with insulation suitable for temperatures encountered in heat producing equipment.
- .4 Provide receptacle outlet where connection with attachment plug is indicated or as required. Provide cord and cap where field-supplied attachment plug is indicated or as required.
- .5 Provide suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- .6 Install disconnect switches, controllers, control stations, and control devices as indicated or as required.
- .7 Modify equipment control wiring with terminal block jumpers as indicated or as required.
- .8 Provide interconnecting conduit and wiring between devices and equipment where indicated or as required.

**END OF SECTION**

**Part 1            General**

**1.1                SECTION INCLUDES**

- .1      Fusible switch assemblies.
- .2      Non-fusible switch assemblies.

**1.2                RELATED SECTIONS**

**1.3                REFERENCES**

- .1      CSA-C22.1-15 - Canadian Electrical Code, Part I (23<sup>rd</sup> Edition), Safety Standard for Electrical Installations.
- .2      CSA-C22.2 No. 4-04 (2009) - Enclosed and Dead-Front Switches.
- .3      CSA-C22.2 No. 248.1-11 - Low-voltage fuses - Part 1: General requirements.
- .4      NETA ATS 2007 - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- .5      CSA (Canadian Standards Association).
- .6      ULC (Underwriters Laboratories Canada Inc.).

**1.4                SUBMITTALS FOR REVIEW**

- .1      Section 01 33 00: Submission procedures.
- .2      Product Data: Provide switch ratings and enclosure dimensions.

**1.5                CLOSEOUT SUBMITTALS**

- .1      Section 01 78 00: Closeout Submittals.
- .2      Record Documentation: Record actual locations of enclosed switches in project record documents.

**1.6                QUALITY ASSURANCE**

- .1      Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum five (5) years documented experience.

**1.7                REGULATORY REQUIREMENTS**

- .1      Products: Listed and classified by CSA and as suitable for the purpose specified and indicated.

**Part 2 Products**

**2.1 FUSIBLE SWITCH ASSEMBLIES**

- .1 Fusible Switches: CSA-C22.2 No. 4, Type as indicated with externally operable handle interlocked to prevent opening front cover with switch in ON position, enclosed load interrupter knife switch. Handle lockable in OFF position.
- .2 Fuse clips: Designed to accommodate fuses as indicated.

**2.2 NON-FUSIBLE SWITCH ASSEMBLIES**

- .1 Non-Fusible Switches: CSA-C22.2 No. 4, Type as indicated with externally operable handle interlocked to prevent opening front cover with switch in ON position, enclosed load interrupter knife switch. Handle lockable in OFF position.

**2.3 ENCLOSURES**

- .1 Enclosures: CSA-C22.2 No. 4.
  - .1 Interior Dry Locations: Type 1.
  - .2 Exterior Locations: Type 3R.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install to CSA-C22.1.
- .2 Install fuses in fusible disconnect switches.
- .3 Apply adhesive tag on inside door of each fused switch indicating CSA fuse class and size installed.

**3.2 FIELD QUALITY CONTROL**

- .1 Section 01 45 00: Field inspection and testing.
- .2 Perform inspections and tests listed in NETA ATS, Section 7.5.

**END OF SECTION**

**Part 1            General**

**1.1                SECTION INCLUDES**

- .1      Distribution panelboards.
- .2      Branch circuit panelboards.
- .3      Load centres.

**1.2                RELATED SECTIONS**

- .1      Section 26 05 26 - Grounding and Bonding.
- .2      Section 26 05 53 - Electrical Identification.

**1.3                REFERENCES**

- .1      CSA-C22.1-15 - Canadian Electrical Code, Part I (23<sup>rd</sup> Edition), Safety Standard for Electrical Installations.
- .2      CSA-C22.2 No. 29-11 - Panelboards and Enclosed Panelboards.
- .3      NEMA ICS 2-2000 (R2005) - Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.
- .4      NEMA KS 1-2001 (R2006) - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
- .5      NETA ATS 2007 - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- .6      CSA (Canadian Standards Association).
- .7      UL (Underwriters Laboratories Inc.).

**1.4                SUBMITTALS FOR REVIEW**

- .1      Section 01 33 00: Submission procedures.
- .2      Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.

**1.5                SUBMITTALS FOR INFORMATION**

- .1      Section 01 33 00: Submission procedures.
- .2      Installation Data: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

**1.6                CLOSEOUT SUBMITTALS**

- .1      Section 01 78 00: Closeout Submittals.
- .2      Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

- .3 Record Documentation: Record actual locations of panelboards and record actual circuiting arrangements in project record documents.

## **1.7 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Extra Stock Materials: Provide two (2) of each panelboard key.

## **1.8 QUALITY ASSURANCE**

- .1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum five (5) years documented experience.

## **1.9 REGULATORY REQUIREMENTS**

- .1 Products: Listed and classified by CSA and as suitable for the purpose specified and indicated.

## **Part 2 Products**

### **2.1 DISTRIBUTION PANELBOARDS**

- .1 Manufacturers:
  - .1 Eaton
  - .2 Schneider
  - .3 Siemens
  - .4 GE
  - .5 Substitutions: Refer to Section 01 25 00.
- .2 Description: CSA-C22.2 No.29, circuit breaker type.
- .3 Panelboard Bus: Copper and ratings as indicated. Provide copper ground bus in each panelboard.
- .4 Minimum integrated short circuit rating: 35,000 amperes rms symmetrical for 250 volt panelboards or as indicated.
- .5 Moulded Case Circuit Breakers: CSA-C22.2 No. 5, circuit breakers with integral thermal and instantaneous magnetic trip in each pole. Provide circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.
- .6 Circuit Breaker Accessories: Trip units and auxiliary switches as indicated.
- .7 Enclosure: CSA-C22.2 No. 5, Type 1 Sprinklerproof and Type 4 for exterior use or as indicated.
- .8 Cabinet Front: Surface type, fastened with hinge and latch and concealed trim clamps, hinged door with flush lock, metal directory frame and finished in manufacturer's standard gray enamel.

### **2.2 BRANCH CIRCUIT PANELBOARDS**

- .1 Manufacturers:
  - .1 Eaton

- .2 Schneider
- .3 Siemens
- .4 Substitutions: Refer to Section 01 25 00.
- .2 Description: CSA-C22.2 No.29, circuit breaker type, lighting and appliance branch circuit panelboard.
- .3 Panelboard Bus: Copper and ratings as indicated. Provide copper ground bus in each panelboard.
- .4 Minimum Integrated Short Circuit Rating: 35,000 amperes rms symmetrical for 250 volt panelboards or as indicated.
- .5 Moulded Case Circuit Breakers: CSA-C22.2 No. 5, bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles, listed as Type SWD for lighting circuits, Type HACR for air conditioning equipment circuits, Class A ground fault interrupter circuit breakers where scheduled. Do not use tandem circuit breakers unless indicated.
- .6 Current Limiting Moulded Case Circuit Breakers: CSA-C22.2 No. 5, circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size Class RK-5 fuse.
- .7 Enclosure: CSA-C22.2 No. 5, Type 1 Sprinklerproof or Type 4 for exterior use or as indicated.
- .8 Cabinet Box: 153 mm(6 inches) deep, 508 mm(20 inches) wide.
- .9 Cabinet Front: Surface and Flush cabinet front with concealed trim clamps, concealed hinge, metal directory frame, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.

### **2.3 LOAD CENTRES**

- .1 Not acceptable.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install panelboards to CSA-C22.1 and to manufacturer's written instructions.
- .2 Install panelboards plumb. Install recessed panelboards flush with wall finishes.
- .3 Height: Refer to section 26 05 00.
- .4 Provide filler plates for unused spaces in panelboards.
- .5 Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads.
- .6 Provide engraved plastic nameplates under the provisions of Section 26 05 53.

- .7 Provide spare conduits out of each recessed panelboard to an accessible location below floor and above ceiling where applicable. Minimum spare conduits: three (3) empty 35mm (1-1/4") up and two (2) 35mm (1-1/4") down. Identify each as spare.
- .8 Ground and bond panelboard enclosure according to Section 26 05 26.

### **3.2 FIELD QUALITY CONTROL**

- .1 Section 01 45 00: Field inspection.
- .2 Perform inspections and tests listed in NETA ATS Section 7.4 for switches, Section 7.5 for circuit breakers.

### **3.3 ADJUSTING**

- .1 Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 20% of each other.
- .2 Maintain proper phasing for multi-wire branch circuits.

**END OF SECTION**

**Part 1            General**

**1.1                SECTION INCLUDES**

- .1      Wall switches.
- .2      Wall dimmers.
- .3      Receptacles.
- .4      Device plates and decorative box covers.
- .5      Floor box service fittings.
- .6      Poke-through service fittings.
- .7      Access floor box.

**1.2                RELATED SECTIONS**

- .1      Section 26 05 34 - Boxes.

**1.3                REFERENCES**

- .1      CSA-C22.1-15 - Canadian Electrical Code, Part I (23<sup>rd</sup> Edition), Safety Standard for Electrical Installations.
- .2      CSAC22.2 No.42 - General Use Receptacles, Attachment Plugs and Similar Devices.
- .3      CSAC22.2 No.42.1 - Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).
- .4      CSAC22.2 No.55 - Special Use Switches.
- .5      CSAC22.2 No.111 - General-Use Snap Switches (Bi-national standard, with UL 20, twelfth edition).
- .6      CSA-C22.2 No. 184-M1988 (R2009) - Solid State Lighting Controls.
- .7      CSA-C22.2 No. 184-M1988 (R2009) - Solid-State Lighting Controls.
- .8      CSA (Canadian Standards Association).
- .9      UL (Underwriters Laboratories Inc.).

**1.4                SUBMITTALS FOR REVIEW**

- .1      Section 01 33 00: Submission procedures.
- .2      Product Data: Provide manufacturer's catalogue information showing dimensions, colours, and configurations.

**1.5                SUBMITTALS FOR INFORMATION**

- .1      Section 01 33 00: Submission procedures.
- .2      Installation Data: Submit manufacturer's installation instructions.

**1.6 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Extra Stock Materials:
  - .1 Provide two (2) of each style, size, and finish wall plate.

**1.7 QUALITY ASSURANCE**

- .1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum five (5) years documented experience.

**1.8 REGULATORY REQUIREMENTS**

- .1 Provide products listed and classified by CSA and as suitable for the purpose specified and indicated.

**Part 2 Products**

**2.1 WALL SWITCHES**

- .1 Manufacturers:
  - .1 Leviton
  - .2 Hubbell
  - .3 Cooper
  - .4 Legrand
  - .5 Substitutions: Refer to Section 01 25 00.
- .1 General-use snap switch:
  - .1 Grade: Commercial Specification Grade CSA-C22.2 No. 111
  - .2 Style: Standard toggle
  - .3 Device Body: white nylon toggle.
  - .4 Ratings: Match branch circuit and load characteristics. Amperage rating shall be marked on body of switch.
- .2 Body and Handle: White nylon toggle handle.
- .3 Locator Pilot Light: Separate pilot strap, red light.

**2.2 RECEPTACLES**

- .1 Manufacturers:
  - .1 Leviton
  - .2 Hubbell
  - .3 Cooper
  - .4 Legrand
  - .5 Substitutions: Refer to Section 01 25 00.
- .2 General-duty duplex convenience receptacle:
  - .1 Grade: Commercial Specification Grade, Nema WD-6 Compliant, CSA-C22.2 No.42.

- .2 Style: Standard
- .3 Device Body: Smooth white nylon face and base.
- .4 CSA Configuration: Type as specified and indicated.
- .5 Tamper resistant throughout or as indicated otherwise.
- .3 GFCI Receptacle: Duplex receptacle with integral ground fault circuit interrupter to meet regulatory requirements complete with steady-on “Green-Power-On” and steady-on “Red-Power-Tripped Off” LED indicator lights.
- .4 Exterior Use Receptacle: Extra Heavy Duty Industrial grade duplex receptacle with integral ground fault circuit interrupter to meet regulatory requirements complete with steady-on “Green-Power-On” and steady-on “Red-Power-Tripped Off” LED indicator lights complete with UV and corrosion resistant device body complete with CSA 5-20R configuration only.
- .5 Suitable for No. 10 AWG for back and side wiring.
- .6 Break-off links for use as split receptacles.
- .7 Double wipe contacts and riveted grounding contacts.
- .8 Receptacles shall be of one manufacturer throughout the project.

### **2.3 WALL PLATES**

- .1 Standard Stainless Steel Cover Plate: 430 type stainless steel cover plate complete with protective plastic film. Combination or multi-gang covers as required or indicated.
- .2 Metallic While-in-Use covers: Nema 3R rated, die-cast aluminum construction with powder coated “chip resistant” paint corrosion protection and plug/cord management, suitable for horizontal mounting on device box only, and padlock provision.

## **Part 3 Execution**

### **3.1 EXAMINATION**

- .1 Verify that outlet boxes are installed at proper height.
- .2 Verify that wall openings are neatly cut and will be completely covered by wall plates.
- .3 Verify that floor boxes are adjusted properly.
- .4 Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- .5 Verify that openings in access floor are in proper locations.

### **3.2 PREPARATION**

- .1 Provide extension rings to bring outlet boxes flush with finished surface.
- .2 Clean debris from outlet boxes.

### **3.3 INSTALLATION**

- .1 Install to CSA-C22.1 and to manufacturer's written instructions.

- .2 Install devices plumb and level.
- .3 Install switches with OFF position down.
- .4 Install wall dimmers to achieve full rating specified and indicated after de-rating for ganging as instructed by manufacturer.
- .5 Do not share neutral conductor on load side of dimmers.
- .6 Install receptacles with grounding pole on bottom.
- .7 Install non-tamper resistant receptacles with mechanical spaces only.
- .8 Use exterior use receptacles for exterior applications unless noted otherwise.
- .9 Connect wiring device grounding terminal to branch circuit equipment grounding conductor and outlet box.
- .10 Connect wiring device grounding terminal to branch circuit equipment grounding conductor and outlet box with bonding jumper.
- .11 Install decorative plates on switch, receptacle, and blank outlets in finished areas.
- .12 Connect wiring devices by wrapping conductor around screw terminal.
- .13 Use jumbo size plates for outlets installed in masonry walls.
- .14 Stainless steel protective coverings shall be maintained until project completion and turn-over to City.
- .15 Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.
- .16 Install metallic While-In-Use covers on exterior receptacles.
- .17 Use weatherproof covers for dust-tight applications only, or as indicated.
- .18 Install protective rings on active flush cover service fittings.

### **3.4 FIELD QUALITY CONTROL**

- .1 Inspect each wiring device for defects.
- .2 Operate each wall switch with circuit energized and verify proper operation.
- .3 Verify that each receptacle device is energized.
- .4 Test each receptacle device for proper polarity.
- .5 Test each GFCI receptacle device for proper operation.

### **3.5 ADJUSTING**

- .1 Adjust devices and wall plates to be flush and level.

### **3.6 CLEANING**

- .1 Section 01 74 11: Cleaning.
- .2 Clean exposed surfaces to remove splatters and restore finish.

**END OF SECTION**

**Part 1            General**

**1.1                SECTION INCLUDES**

- .1      Manual motor controllers.
- .2      Magnetic motor controllers.
- .3      Combination magnetic motor controllers.

**1.2                RELATED SECTIONS**

- .1      Section 26 05 29 - Electrical Supporting Devices.
- .2      Section 26 05 53 - Electrical Identification: Engraved nameplates.

**1.3                REFERENCES**

- .1      CSA-C22.1-15 - Canadian Electrical Code, Part I (23<sup>rd</sup> Edition), Safety Standard for Electrical Installations.
- .2      CSA-C22.2 No. 14 10 - Industrial Control Equipment.
- .3      CSA-C22.2 No. 248.1-11 - Low-voltage fuses - Part 1: General requirements.
- .4      CSA-C22.2 No. 5-09 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures.
- .5      CAN/CSA-C22.2 No. 94-M91 (R2006) - Special Purpose Enclosures.
- .6      CSA-C22.2 No. 4-04 (2009) - Enclosed and Dead-Front Switches.
- .7      CSA (Canadian Standards Association).
- .8      UL (Underwriters Laboratories Inc.).

**1.4                SUBMITTALS FOR REVIEW**

- .1      Section 01 33 00: Submission procedures.
- .2      Product Data: Provide catalogue sheets showing voltage, controller size, ratings and size of switching and over-current protective devices, short circuit ratings, dimensions, and enclosure details.

**1.5                SUBMITTALS FOR INFORMATION**

- .1      Section 01 33 00: Submission procedures.
- .2      Test Reports: Indicate field test and inspection procedures and test results.
- .3      Installation Data: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

**1.6                MAINTENANCE MATERIAL SUBMITTALS**

- .1      Extra Stock Materials: Provide three (3) of each size and type fuse installed.

**1.7 QUALITY ASSURANCE**

- .1 Perform Work to CSA-C22.1.
- .2 Maintain one (1) copy of each document on site.
- .3 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum ten (10) years documented experience.

**1.8 REGULATORY REQUIREMENTS**

- .1 Provide products listed and classified by CSA as suitable for purpose specified and indicated.

**Part 2 Products**

**2.1 MANUAL CONTROLLERS**

- .1 Manual Motor Controller: CSA-C22.2 No. 14, AC general-purpose Class A, manually operated, full-voltage controller with overload element, red pilot light and auxiliary contact and push button operator.
- .2 Fractional Horsepower Manual Controller: CSA-C22.2 No. 14, AC general-purpose Class A, manually operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit, red and green pilot light, and toggle operator.
- .3 Motor Starting Switch: CSA-C22.2 No. 14, AC general-purpose Class A, manually operated, full-voltage controller for fractional horsepower induction motors, without thermal overload unit, with red pilot light and toggle operator.
- .4 Enclosure: CAN/CSA-C22.2 No. 94; Type 1B.

**2.2 AUTOMATIC CONTROLLERS**

- .1 Magnetic Motor Controller: CSA-C22.2 No. 14, AC general-purpose Class A, magnetic controller for induction motors rated in horsepower.
- .2 Reversing Controllers: Include electrical interlock and integral time delay transition between FORWARD and REVERSE rotation.
- .3 Two Speed Controllers: Include integral time delay transition between FAST and SLOW speeds.
- .4 Coil operating voltage: 600 and 120 volts, 60 Hertz.
- .5 Overload Relay: CSA-C22.2 No. 14; bimetal.
- .6 Enclosure: NEMA ICS 6, Type 1.

**2.3 PRODUCT OPTIONS AND FEATURES**

- .1 Auxiliary Contacts: CSA-C22.2 No. 14, two (2) each field convertible contacts in addition to seal-in contact.
- .2 Cover Mounted Pilot Devices: CSA-C22.2 No. 14, heavy duty type.
- .3 Pilot Device Contacts: CSA-C22.2 No. 14, Form Z, rated A150.
- .4 Pushbuttons: Recessed type.

- .5 Indicating Lights: LED type.
- .6 Selector Switches: Rotary type.
- .7 Relays: CSA-C22.2 No. 14.
- .8 Control Power Transformers: 120 volt secondary, sized for 20% spare capacity, in each motor starter. Provide fused secondary, and bond unfused leg of secondary to enclosure.

#### **2.4 DISCONNECTS**

- .1 Combination Controllers: Combine motor controllers with switch (fusible or non-fusible), motor circuit protector, and disconnect in common enclosure.
- .2 Motor Circuit Protector: CAN/CSA-C22.2 No. 5, circuit breakers with integral instantaneous magnetic trip in each pole.
- .3 Fusible Switch Assemblies: CAN/CSA-C22.2 No. 4, enclosed knife switch with externally operable handle. Fuse clips: Designed to accommodate Class J and R fuses.

#### **2.5 FUSES**

- .1 Interrupting Rating: 200,000 rms amperes.

### **Part 3 Execution**

#### **3.1 INSTALLATION**

- .1 Install enclosed controllers where indicated, to manufacturer's written instructions.
- .2 Install enclosed controllers plumb. Provide supports to Section 26 05 29.
- .3 Height: 1.6 m (5 ft) to operating handle.
- .4 Install fuses in fusible switches.
- .5 Select and install overload heater elements in motor controllers to match installed motor characteristics.
- .6 Provide engraved plastic nameplates under the provisions of Section 26 05 53.
- .7 Provide label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

**END OF SECTION**

**Part 1            General**

**1.1                SECTION INCLUDES**

- .1 Interior luminaires and accessories.
- .2 Emergency lighting units.
- .3 Emergency remote fixtures
- .4 Exit signs.
- .5 Ballasts.
- .6 Fluorescent dimming ballasts and controls.
- .7 Fluorescent lamp emergency power supply.
- .8 Lamps.
- .9 Luminaire accessories.

**1.2                RELATED SECTIONS**

- .1 Section 23 82 00 - Terminal Heat Transfer Units: Air distribution accessories for air handling luminaires.

**1.3                REFERENCES**

- .1 ANSI/NEMA C78.379-2006 - American National Standard for Electric Lamps - Classification of the Beam Patterns of Reflector Lamps.
- .2 CSA-C22.1-15 - Canadian Electrical Code, Part I (23<sup>rd</sup> Edition), Safety Standard for Electrical Installations.
- .3 CSA-C22.2 No. 9.0-96 (R2006) - General Requirements for Luminaires.
- .4 CSA-C22.2 No. 250.0-08 - Luminaires.
- .5 CSA-C22.2 No. 141-10 - Emergency lighting equipment.
- .6 CAN/CSA-E920-98 (R2007) - Ballasts for Tubular Fluorescent Lamps - General and Safety Requirements.
- .7 CAN/CSA-E928-98 (R2007) - Auxiliaries for Lamps - A.C. Supplied Electronic Ballasts for Tubular Fluorescent Lamps - General and Safety Requirements.
- .8 CAN/CSA-E61347-2-3-03 (R2008) - Lamp Controlgear - Part 2-3: Particular Requirements for A.C. Supplied Electronic Ballasts for Fluorescent Lamps.
- .9 NEMA WD 6-2002 (R2008) - Wiring Devices - Dimensional Requirements.
- .10 CSA (Canadian Standards Association).
- .11 UL (Underwriters Laboratories Inc.).

**1.4                SUBMITTALS FOR REVIEW**

- .1 Section 01 33 00: Submission procedures.

- .2 Shop Drawings: Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
- .3 Product Data: Provide dimensions, ratings, and performance data.

## **1.5 SUBMITTALS FOR INFORMATION**

- .1 Section 01 33 00: Submission procedures.
- .2 Installation Data: Submit data indicating application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

## **1.6 CLOSEOUT SUBMITTALS**

- .1 Section 01 78 00: Closeout Submittals.
- .2 Operation and Maintenance Data: Submit manufacturer's operation and maintenance instructions for each product.

## **1.7 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Extra Stock Materials:
  - .1 Provide two (2) of each plastic lens type.
  - .2 Provide four (4) emergency remote fixture replacement lamp type.
  - .3 Provide two (2) exit sign replacement lamp type.

## **1.8 QUALITY ASSURANCE**

- .1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum five (5) years documented experience.
- .2 Conform to requirements of CSA C22.1, and to the Manitoba Hydro Power Smart Commercial Lighting Program.
- .3 Products: Listed and classified by CSA, and as suitable for the purpose specified and indicated.

## **Part 2 Products**

### **2.1 LUMINAIRES**

- .1 Manufacturers:
  - .1 Refer to Luminaire Schedule on drawings.
  - .2 Substitutions: Refer to Section 01 25 00.

### **2.2 EMERGENCY LIGHTING UNITS**

- .1 Manufacturers:
  - .1 Refer to Luminaire Schedule on drawings.
  - .2 Substitutions: Refer to Section 01 25 00.

### **2.3 EMERGENCY REMOTE FIXTURES**

- .1 Manufacturers:
  - .1 Refer to Luminaire Schedule on drawings.
  - .2 Substitutions: Refer to Section 01 25 00.

### **2.4 EXIT SIGNS**

- .1 Manufacturers:
  - .1 Refer to Luminaire Schedule on drawings.
  - .2 Substitutions: Refer to Section 01 25 00.

### **2.5 LED LUMINAIRES AND DRIVERS**

- .1 All Luminaires
  - .1 Comply with IES LM-79-08 Approved Method for measuring lumen maintenance of LED light sources.
  - .2 Comply with IES LM-80-08 Approved Method for electrical and photometric measurement of SSL product.
  - .3 LED's shall be Restriction of Hazardous Substances Directive (RoHS) compliant.
  - .4 LED arrays shall be sealed, high performance, long life type; minimum 70% rated output at 50,000 hours.
  - .5 LED luminaires shall deliver a minimum of 60 lumens per watt.
    - .1 LED's shall be "Bin No. 1" quality.
  - .6 Drivers shall be solid state and accept 120 through 277 VAC at 60 Hz input.
  - .7 The LED light source shall be fully dimmable with use of compatible dimmers switch designated for low voltage loads.
  - .8 LED color temperatures: CRI 85, 2700K as noted +/- 145K.
  - .9 LED color temperatures: CRI 85, 4000K as noted +/- 275K.
  - .10 LED color temperatures: CRI 85, 5000K as noted +/-283K.
  - .11 Luminaires shall have internal thermal protection.
  - .12 Luminaires shall not draw power in the off state. Luminaires with integral occupancy, motion, photo-controls, or individually addressable luminaires with external control and intelligence are exempt from this requirement. The power draw for such luminaires shall not exceed 0.5 watts when in the off state.
  - .13 Color spatial uniformity shall be within .004 of CIE 1976 diagram.
  - .14 Color maintenance over rated life shall be within .007 of CIE 1976.
  - .15 Indoor luminaires shall have a minimum CRI of 85.
  - .16 Luminaire manufacturers shall adhere to device manufacturer guidelines, certification programs, and test procedures for thermal management
  - .17 LED package(s)/module(s)/array(s) used in qualified luminaires shall deliver a minimum 70% of initial lumens, when installed in-situ, for a minimum of 50,000 hours.

- .18 Luminaires shall be fully accessible from below ceiling plane for changing drivers, power supplies and arrays.
- .2 Power Supplies and Drivers
  - .1 MB Hydro Powersmart approved.
  - .2 Power Factor: 0.90 or higher
  - .3 Maximum driver case temperature not to exceed driver manufacturer recommended in-situ operation.
  - .4 Output operating frequency: 60Hz.
  - .5 Interference: EMI and RFI compliant with FCC 47 CFR Part 15.
  - .6 Total Harmonic Distortion Rating: 20% Maximum.
  - .7 Meet electrical and thermal conditions as described in LM-80 Section 5.0.
  - .8 Primary Current: Confirm primary current with Drawings.
  - .9 Secondary Current: Confirm secondary current specified by individual luminaire manufacturers.
  - .10 Compatibility: Certified by manufacturer for use with individually specified luminaire and individually specified control components.
  - .11 Solid-state control components to be integral or external per each specified luminaire. Remote control gear to be enclosed in Class 1, Class 2, or NEMA 3R enclosures as required.
- .3 Controller and Control System
  - .1 System electronics driver / controller to use coordinated communication protocols: DMX512, 0-10V, DALI, or proprietary as required.
  - .2 The Contractor shall ensure that external control equipment is compatible with LED control requirements
  - .3 Provide connector types and wiring as appropriate for un-interrupted communication between devices, considering distance maximums, field obstructions, and accessibility. Ensure that connection points are optically isolated for system noise reduction.
  - .4 Compatibility: Certified by manufacturer for use with individually specified luminaire and individually specified power supplies and/or drivers

## **2.6 ACCESSORIES**

- .1 Description: Standard down light reflector shall be semi-specular unless noted otherwise.
- .2 Joiner Fittings: As specified for linear lighting systems, or as required for end to end continuous row mounting as indicated on drawings. Fittings to match style and finish of luminaire specified.
- .3 End Caps: As specified for linear lighting systems, or as required for end of row or stand-alone luminaire installations as indicated on drawings. End caps to match style and finish of luminaire specified.
- .4 Wireguard: As specified for luminaire, or as indicated on the drawings.
  - .1 Gauge: Minimum 10 gauge unless noted otherwise.

## **2.7 SOURCE QUALITY CONTROL**

- .1 Section 01 43 00: Manufacturer quality control.
- .2 Certify fluorescent ballast design and construction by Certified Ballast Manufacturers, Inc.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Support luminaires larger than 600 x 1200 mm(24 x 48 inch) size independent of ceiling framing.
- .2 Locate recessed ceiling luminaires as indicated on reflected ceiling plan.
- .3 Install surface mounted luminaires, emergency lighting, and exit signs plumb and adjust to align with building lines and with each other. Secure to prevent movement.
- .4 Exposed Grid Ceilings: Fasten surface mounted luminaires to ceiling grid members using bolts, screws, or suitable clips.
- .5 Install recessed luminaires to permit removal from below.
- .6 Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.
- .7 Install clips to secure recessed grid-supported luminaires in place.
- .8 Install wall mounted luminaires, emergency lighting units, and exit signs at height as indicated.
- .9 Install end to end, or continuous rows of luminaires with appropriate joiner fittings to match the luminaire manufacturer and finish.
- .10 Install linear lighting with appropriate end caps where practicable.
- .11 Install accessories provided with each luminaire.
- .12 Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
- .13 Bond products and metal accessories to branch circuit equipment grounding conductor.
- .14 Install specified lamps in each luminaire, emergency lighting unit and exit sign.

### **3.2 INTERFACE WITH OTHER PRODUCTS**

- .1 Interface with air handling accessories provided and installed under Section 23 37 00.

### **3.3 FIELD QUALITY CONTROL**

- .1 Operate each luminaire after installation and connection. Inspect for proper connection and operation.

### **3.4 ADJUSTING**

- .1 Aim and adjust luminaires as directed.
- .2 Position exit sign directional arrows as indicated.

**3.5 CLEANING**

- .1 Section 01 74 11: Cleaning.
- .2 Clean electrical parts to remove conductive and deleterious materials.
- .3 Remove dirt and debris from enclosures.
- .4 Clean photometric control surfaces as recommended by manufacturer.
- .5 Clean finishes and touch up damage.

**3.6 CLOSEOUT ACTIVITIES**

- .1 Demonstration: Demonstrate luminaire operation for minimum of one (1) hours.

**3.7 PROTECTION OF FINISHED WORK**

- .1 Re-lamp luminaires that have failed lamps at Substantial Completion.

**END OF SECTION**

**Part 1            General**

**1.1                SECTION INCLUDES**

- .1        Luminaires and accessories.

**1.2                RELATED SECTIONS**

- .1        Section 03 30 00 - Cast-in-place Concrete: Foundations for poles.

**1.3                REFERENCES**

- .1        CAN/CSA-A14-07 - Concrete Poles.
- .2        CAN/CSA-C239-02 (R2007) - Performance Standard for Dusk-to-Dawn Luminaires.
- .3        CAN/CSA-E60598-2-3B-98 (R2007) - Amendment 2:2002 to CAN/CSA-E60598-2-3-98, Luminaires - Part 2-3: Particular Requirements - Luminaires for Road and Street Lighting.
- .4        CAN/CSA-E61347-2-3-03 (R2008) - Lamp Controlgear - Part 2-3: Particular Requirements for A.C. Supplied Electronic Ballasts for Fluorescent Lamps.
- .5        CAN/CSA-E922-98 (R2007) - Ballasts for Discharge Lamps (Excluding Tubular Fluorescent Lamps) - General Safety Requirements.
- .6        CSA-C22.2 No. 9.0-96 (R2006) - General Requirements for Luminaires.
- .7        CSA-C22.2 No. 206-M1987 (R2008) - Lighting Poles.
- .8        CAN/CSA-C239-02 (R2007) - Performance Standard for Dusk-to-Dawn Luminaires.
- .9        CSA-C22.2 No. 206-M1987 (R2008) - Lighting Poles.
- .10       NEMA C78.379-2006 - Standard for Electric Lamps - Classification of the Beam Patterns of Reflector Lamps.
- .11       IES RP8 Recommended Practice for Roadway Lighting.
- .12       IES RP20 Lighting for Parking Facilities.
- .13       CSA (Canadian Standards Association).
- .14       ULC (Underwriters Laboratories Canada Inc.).

**1.4                ADMINISTRATIVE REQUIREMENTS**

- .1        Section 01 31 00: Project management and coordination procedures.
- .2        Coordination:
  - .1        Coordinate with other work having a direct bearing on work of this section.
  - .2        Provide bolt templates and pole mounting accessories to installer of pole foundations.

**1.5                SUBMITTALS FOR REVIEW**

- .1        Section 01 33 00: Submission procedures.

- .2 Product Data: Provide dimensions, ratings, and performance data.
- .3 Shop Drawings: Indicate dimensions and components for each luminaire which is not a standard Product of the manufacturer.

## **1.6 SUBMITTALS FOR INFORMATION**

- .1 Section 01 33 00: Submission procedures.
- .2 Test Reports: Indicate measured illumination levels.
- .3 Installation Data: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

## **1.7 CLOSEOUT SUBMITTALS**

- .1 Section 01 78 00: Closeout Submittals.
- .2 Maintenance Data: Submit maintenance data for each luminaire.

## **1.8 QUALITY ASSURANCE**

- .1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum five (5) years documented experience.

## **1.9 REGULATORY REQUIREMENTS**

- .1 Products: Listed and classified by CSA and as suitable for the purpose specified and indicated.

## **1.10 DELIVERY, STORAGE, AND PROTECTION**

- .1 Section 01 61 00: Transport, handle, store, and protect products.
- .2 Store and handle lighting poles to CAN/CSA-A14 and CSA-C22.2 No. 206.

## **Part 2 Products**

### **2.1 LUMINAIRES AND ACCESSORIES**

- .1 Refer to Luminaire Schedule on drawings.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Provide concrete bases for lighting poles at locations indicated, to Section 03 30 00.
- .1 Install poles plumb. Provide shims and double nuts to adjust plumb. Grout around each base.
- .2 Bond metal poles, metal accessories and luminaires to branch circuit equipment grounding conductor.

**3.2 FIELD QUALITY CONTROL**

- .1 Section 01 45 00: Field inspection and testing.
- .2 Operate each luminaire after installation and connection. Inspect for improper connections and operation.

**3.3 ADJUSTING**

- .1 Aim and adjust luminaires to provide illumination levels and distribution as directed and indicated on Drawings.

**3.4 CLEANING**

- .1 Section 01 74 11: Cleaning.
- .2 Clean electrical parts to remove conductive and deleterious materials.
- .3 Remove dirt and debris from enclosure.
- .4 Clean photometric control surfaces as recommended by manufacturer.
- .5 Clean finishes and touch up damage.

**3.5 PROTECTION OF FINISHED WORK**

- .1 Re-lamp luminaires where lamps have failed at Substantial Completion.

**END OF SECTION**