

Part I General

I.1 RELATED REQUIREMENTS

- .1 This Section covers items common to Sections of Division 26, 27 and 28. These sections supplement requirements of Division I.

I.2 REFERENCES

- .1 Definitions:
 - .1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SPI 122.
- .2 Reference Standards:
 - .1 CSA Group
 - .1 CSA C22.1-12, Canadian Electrical Code, Part I (22nd Edition), Safety Standard for Electrical Installations.
 - .2 CSA C22.2.
 - .3 CAN/CSA-C22.3 No.1-10, Overhead Systems.
 - .4 CAN3-C235-83(R2010), Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
 - .2 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)
 - .1 IEEE SPI 122-2000, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.

I.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for review and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Submit for review fire alarm riser diagram, plan and zoning of building at fire alarm control panel and annunciator.
- .4 Submit for review Fire Verification Report.
- .5 Submit for review single line electrical diagrams and locate as indicated.
- .6 Shop drawings:
 - .1 Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure co-ordinated installation.
 - .2 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.

- .3 Indicate on drawings clearances for operation, maintenance, and replacement of operating equipment devices.
- .4 Submit required number of copies of required size drawings to authority having jurisdiction.
- .5 If changes are required, notify Departmental Representative of these changes before they are made.
- .7 Certificates:
 - .1 Provide CSA certified equipment.
 - .2 Where CSA certified equipment is not available, submit such equipment to authority having jurisdiction or inspection authorities for special approval before delivery to site.
 - .3 Submit test results of installed electrical systems and instrumentation.
 - .4 Permits and fees: in accordance with General Conditions of contract.
 - .5 Submit, upon completion of Work, load balance report as described in PART 3 - LOAD BALANCE.
 - .6 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Departmental Representative.
- .8 Manufacturer's Field Reports: submit to Departmental Representative manufacturer's written report, within 3 days of review, verifying compliance of Work and electrical system testing, as described in PART 3 - FIELD QUALITY CONTROL.
- .9 Sustainable Design Submittals:
 - .1 Building Energy and Water Consumption: submit Measurement and Verification Plan following IPMVP for monitoring end-uses as follows:
 - .1 Lighting systems and controls.
 - .2 Constant and variable motor loads.
 - .3 Cooling load.
 - .4 Building-related process energy systems and equipment.

I.4 CLOSEOUT SUBMITTALS

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

- .5 Other items of instruction as recommended by manufacturer of each system or item of equipment.
- .3 Print or engrave operating instructions and frame under glass or in approved laminated plastic.
- .4 Post instructions where directed.
- .5 For operating instructions exposed to weather, provide weather-resistant materials or weatherproof enclosures.
- .6 Ensure operating instructions will not fade when exposed to sunlight and are secured to prevent easy removal or peeling.

I.5 DELIVERY, STORAGE AND HANDLING

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

Part 2 Products

2.1 DESIGN REQUIREMENTS

- .1 Operating voltages: to CAN3-C235.
- .2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.
 - .1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.
- .3 Language operating requirements: provide identification nameplates and labels for control items in English.

2.2 MATERIALS AND EQUIPMENT

- .1 Provide material and equipment in accordance with Section 01 61 00 - Common Product Requirement.
- .2 Material and equipment to be CSA certified. Where CSA certified material or equipment is not available, obtain special approval from authority having jurisdiction or inspection authorities before delivery to site and submit such approval as described in PART I - ACTION AND INFORMATIONAL SUBMITTALS.
- .3 Factory assemble control panels and component assemblies.

- .4 Electrical equipment shall be new and of the type and quality specified.
- .5 Electrical equipment shall be CSA approved and shall carry the CSA label or CSA testing laboratory listing. Where there is no alternative to supplying equipment which is not CSA certified, obtain special approval from appropriate Inspection Department.
- .6 Provide labour, materials, transportation, equipment and facilities, etc. required for the complete electrical installation as indicated or implied on the drawings and specifications.

2.3 VOLTAGE RATING

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

2.4 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

- .1 Verify installation and co-ordination responsibilities related to motors, equipment and controls, as indicated.
- .2 Control wiring and conduit: Control Devices except for conduit, wiring and connections below 50 V which are related to control systems are specified in mechanical sections or as shown on mechanical drawings.
- .3 Supplier and installer responsibility is generally indicated on the electrical drawings.
- .4 Refer also to mechanical drawings and specifications for all related electrical work and include in tender price.
- .5 Control wiring and conduit with exception to equipment supplied by Divisions 25 is the responsibility of Division 26. All conduit, wiring and connections which are related to control systems specified in Division 25 is the responsibility of the controls contractor.

2.5 WIRING TERMINATIONS

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

2.6 EQUIPMENT IDENTIFICATION

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

NAMEPLATE SIZES			
Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters

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

- .2 Wording on nameplates labels to be approved by Departmental Representative and Consultant prior to manufacture.
- .3 Allow for minimum of twenty-five (25) letters per nameplate.
- .4 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .5 Identify equipment with Size 3 labels engraved "ASSET INVENTORY NO. " as directed by Departmental Representative and Consultant.
- .6 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .7 Terminal cabinets and pull boxes: indicate system and voltage.
- .8 Transformers: indicate capacity, primary and secondary voltages.

2.7 OPERATION AND MAINTENANCE DATA

- .1 Provide operation and maintenance data for incorporation into operation and maintenance manuals. Operation and maintenance manuals shall be submitted to Owner.
- .2 Include detail of design elements, construction features, components 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, supplement by bulletins, component illustration, exploded views, technical description of items, and parts lists. Advertising or sales literature not acceptable.
- .4 Include wiring and schematic diagrams and performance curves.
- .5 Include name and addresses of local supplier for items included in maintenance manuals.
- .6 Maintenance manuals to be submitted to Consultant for review. Manuals that are incomplete shall be returned to electrical subcontractor for completion. Completed manual must be submitted, to the satisfaction of the Consultant, before final payment may be considered to be due.

2.8 SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

- .1 Submit shop drawings, product data and samples for review by Consultant. Manufacture of equipment must not commence until shop drawings have been reviewed.
- .2 Indicate detail construction, dimension, capacities, weights and electrical performance characteristics of equipment or material.
- .3 Include wiring, single line and schematic diagrams, wherever applicable.
- .4 Include wiring drawings or diagrams showing interconnection with work of other sections.

- .5 Shop drawing submissions shall include a photocopy of all applicable specification sections showing a complete compliance/non-compliance listing.
- .6 Each drawing submission to bear following signed stamp, and include name of project, equipment supplier and clause number equipment is specified under.

CONTRACTORS CERTIFICATION

This drawing has been reviewed by
(firm name)

All dimensions have been checked and found compatible with the contract drawings and all capacities, quantities, sizes and other data contained in the contract documents have been listed by the supplier on this drawing and have been checked by the undersigned and found correct.

Date

Per

- .7 Clearly show division of responsibility. No item, equipment or description of work shall be indicated to be supplied or work to be done 'By Others' or 'By Purchaser'. Any item, equipment or description of work shown on shop drawings shall form part of the contract, unless specifically noted to the contrary.
- .8 Provide field dimensions required by electrical supplier and sub-subcontractors. In cases where fabrication is required prior to field dimensions being available, check all related drawings and obtain clarification from Consultant if necessary.
- .9 Check all shop drawings carefully and make all necessary changes, prior to submission to the Consultant for review. If re-submission is required, the Contractor shall ensure that the supplier's drawings have been changed to comply before returning them to Consultant for another review. If the drawings still do not comply, and require additional review by the Consultant, the Consultant shall be reimbursed by the Contractor for the time required for such additional reviews.
- .10 Review of the shop drawings by the Consultant shall not relieve the Contractor from responsibility for errors and omissions therein.
- .11 Shop drawings reflecting additional design or change in design shall be reviewed by the Consultant and Owner.
- .12 Provide shop drawings for all electrical components, including but not limited to wiring devices, receptacles, lamps, starters, luminaires, etc.
- .13 Main distribution and utility metering shop drawings must be approved by local utility prior to submission to Consultant.
- .14 Quality Control:
 - .1 Provide CSA or equivalent certified equipment and material.

- .2 Where CSA or equivalent certified equipment and material is not available, submit such equipment and material to authority having jurisdiction for special approval before delivery to site.
- .3 Submit test results of installed electrical systems and instrumentation.
- .4 Permits and fees: in accordance with General Conditions of contract.
- .5 Submit, upon completion of Work, load balance report.
- .6 Submit certificate of acceptance from authority having jurisdiction upon completion of Work.
- .7 Other requirements as listed in specification.

2.9 QUALITY ASSURANCE

- .1 Quality Assurance: in accordance with Front End specifications.
- .2 Qualifications: electrical Work to be carried out by qualified, licensed electricians or apprentices in accordance with authorities having jurisdiction and as per the conditions of Provincial or Territorial Act respecting manpower vocational training and qualification.

2.10 WIRING IDENTIFICATION

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

2.11 CONDUIT AND CABLE IDENTIFICATION

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

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

2.12 FINISHES

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.

2.13 SURFACE MOUNTED RACEWAYS

General:

- .1 System: Provide surface raceway systems for branch circuit and data network voice, video and other low-voltage wiring. Surface raceway system shall consist of raceway bases, covers, pre-divided raceway bases, dual covers, appropriate fittings and device mounting plates necessary for a complete installation.
- .2 Configuration: Raceways shall be two-piece design with base and snap-on cover, side by side on a common base. Base shall be dividable with a fixed barrier for up to 4 compartments. Provide raceways from a company that can provide custom sizes if required. Raceway covers shall be available in tamper-resistant form with screws on access plates and covers of fittings, but not on standard cover lengths. [Raceways shall be multi-piece design with metal base and snap-on metal covers. Base shall have 2 wiring channels, separated by 1 integral divider, large enough to accept standard power and communication devices without restricting capacity of the adjacent channel. The raceway base shall accept 2 covers that allow separation of services. The cover shall slightly curve and form the raceway sidewall. Provide the base with scored lines to facilitate sectioning of the raceway in 102mm increments and include mounting holes, and tunnel knockouts in the divider wall that will facilitate the crossing over of services.
- .1 Fittings: Fittings shall include flat, internal and external elbows, couplings for joining raceway sections, wire clips, blank end fittings, and device mounting brackets and plates as applicable. Where required, provide tamper-resistant form, dividable with barriers and matching the size of the accompanying raceway base. Provide full capacity corner elbows and tee fittings to maintain a controlled 51 mm cable bend radius, meeting the specification for Fiber Optic and UTP cabling and exceeding the TIA/EIA-569-A requirements for communications pathways.
- .2 Device Brackets and Plates: Provide in sizes to match raceway width and with mounting holes located to ensure proper mounting of devices in up to 4 compartments. Device plates shall be available in any length from 152mm to 1524mm, with cutouts to accommodate various combinations of power and communications devices in up to 4 compartments. Provide 152mm and 305mm long device plates with a flange to overlap the joint of adjacent cover as applicable.
- .3 Communications Devices and Accessories: Raceway shall accommodate a complete line of connectivity outlets and modular inserts for UTP (including Category 5, 5e, 6) STP (150 ohm) fiber optic, coaxial, and other cabling types with matching faceplates and bezels to facilitate mounting. Where indicated, provide connectivity outlets and modular inserts.
- .4 Classification: Raceway and system components shall be UL and CUL listed.

Surface raceways shall be suitable for use in dry interior locations only, as covered in Article 386 (Surface Metal Raceways) of the Canadian Electrical Code.

Surface metal raceways and fittings shall be listed by Underwriters Laboratories.

Systems shall comply with UL Standard UL5 for Surface Metal Raceways.
- .5 Surface Mounted Metal Raceways: Dual-Channel Steel Raceway.

- .6 Fittings: Fittings shall include flat, internal and external elbows, tees, entrance fittings, wire clips, cover clips, couplings, support clips, and end caps. Covers for fittings shall overlap adjoining raceway covers a minimum of 10mm. Fittings shall be color matched to the raceway. Supply fittings with a base where applicable to eliminate mitering. Provide fittings with adjustable couplings that integrate with the raceway base. Provide a take-off fitting supporting dual services to adapt to existing flush wall boxes and other series of metallic raceways. Fittings shall have provisions to accept tamper resistant fasteners to fully secure the raceway.
- .7 Fiber Optic/UTP/STP Fittings: Corner elbows, tees, and entrance end fittings as required to maintain a controlled 51mm nominal cable bend radius that meets the specifications for Fiber Optic and UTP/STP cabling and exceeds TIA 569 requirements for communications pathways.
- .8 Obstacle Avoidance and Offset Fittings: Provide fittings as required to bypass large and small obstacles and small offsets in supporting wall. Small obstacle avoidance fitting capable of being converted into a take off fitting to transition to other metallic raceways.

2.14 POKE-THRU DEVICES

- .1 Poke-Thru Devices:
 - .1 Poke-thru device provides an interface between power and communications cabling in an above grade concrete or steel deck floor and the workstation or activation location where power and or data communication device outlets are required.
 - .2 Classification and Use: Poke-thru device shall have been examined and tested by Underwriters Laboratories Inc. to comply with UL263, UL514A and/or UL514C, as applicable and tested to Canadian Standard C22.2 and bear the cULus mark. The poke-thru shall conform to the standards set in the National Electrical Code, Section 300-21.
 - .1 Poke-thru device shall be for use in 2-hour rated, unprotected reinforced concrete floors and 2 hour rated floors employing unprotected steel floor units and concrete toppings or concrete floors with suspended ceilings. Fire resistive designs with suspended ceilings shall have provisions for accessibility in the ceiling below the poke-thru device fittings.
 - .2 Poke-thru device shall have been evaluated by UL to meet the applicable U.S. and Canadian safety standards for scrub water exclusion when used on tile, terrazzo, wood, and carpet covered floors.
 - .3 Poke-thru device shall be suitable for use in air handling spaces in accordance with Section 300-22C of the Canadian Electrical Code.
 - .4 Shall accommodate:
 - .1 1-Duplex receptacle
 - .2 1-4 port data outlet

Part 3 Execution

3.1 EXAMINATION

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

3.2 INSTALLATION

- .1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.

3.3 NAMEPLATES AND LABELS

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

3.4 LOCATION OF OUTLETS

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

3.5 MOUNTING HEIGHTS

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .3 Install electrical equipment at following heights unless indicated otherwise.
 - .1 Local switches: 1200 mm.
 - .2 Wall receptacles:
 - .1 General: 450 mm.
 - .2 Above top of continuous baseboard heater: 200 mm.

- .3 Above top of counters or counter splash backs: 175 mm.
- .4 In mechanical rooms: 1400 mm.
- .3 Panelboards: as required by Code or as indicated.
- .4 Telephone and interphone outlets: 450 mm.
- .5 Fire alarm stations: 1200 mm.
- .6 Fire alarm bells: 2100 mm.
- .7 Television outlets: 450 mm or as specified by Architectural.
- .8 Clocks: 2100 mm.
- .9 Door bell pushbuttons: 1200 mm.
- .10 As per Architectural Specifications.

3.6 CO-ORDINATION OF PROTECTIVE DEVICES

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

3.7 FIELD QUALITY CONTROL

- .1 Load Balance:
 - .1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
 - .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
 - .3 Provide upon completion of work, load balance report as directed in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS, phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.
- .2 Conduct following tests in accordance with Section 01 45 00 - Quality Control.
 - .1 Power distribution system including phasing, voltage, grounding and load balancing.
 - .2 Circuits originating from branch distribution panels.
 - .3 Lighting and its control.
 - .4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
 - .5 Systems: fire alarm and communications.
 - .6 Insulation resistance testing:
 - .1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
 - .2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
 - .3 Check resistance to ground before energizing.

- .3 Carry out tests in presence of Departmental Representative.
- .4 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .5 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART I - ACTION AND INFORMATIONAL SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

3.8 SYSTEM STARTUP

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

3.9 CLEANING

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

END OF SECTION

Part I General

I.1 RELATED REQUIREMENTS

- .1 This Section covers items common to Sections of Division 26, 27 and 28. These sections supplement requirements of Division I.

I.2 REFERENCES

- .1 CSA International
 - .1 CAN/CSA-C22.2 No.18-98(R2003), Outlet Boxes, Conduit Boxes and Fittings.
 - .2 CAN/CSA-C22.2 No.65-03(R2008), Wire Connectors (Tri-National Standard with UL 486A-486B and NMX-J-543-ANCE-03).
- .2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)
 - .1 EEMAC IY-2-[1961], Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).
- .3 National Electrical Manufacturers Association (NEMA)

I.3 ACTION AND INFORMATIONAL SUBMITTALS

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

I.4 CLOSEOUT SUBMITTALS

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

I.5 DELIVERY, STORAGE AND HANDLING

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

Part 2 Products

2.1 MATERIALS

- .1 Pressure type wire connectors to: CAN/CSA-C22.2 No.65, with current carrying parts of copper conductors as required.
- .2 Fixture type splicing connectors to: CAN/CSA-C22.2 No.65, with current carrying parts of copper conductors 10 AWG or less.
- .3 Bushing stud connectors: to NEMA to consist of:
 - .1 Connector body and stud clamp for conductors.
 - .2 Clamp for stranded copper conductors
 - .3 Stud clamp bolts.
 - .4 Bolts for copper conductors
 - .5 Bolts for aluminum conductors
 - .6 Sized for conductors as indicated.
- .4 Clamps or connectors for armoured cable TECK cable as required to: CAN/CSA-C22.2 No.18.

Part 3 Execution

3.1 EXAMINATION

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

3.2 INSTALLATION

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

3.3 CLEANING

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

END OF SECTION

Part 1 General

I.1 RELATED REQUIREMENTS

- .1 This Section covers items common to Sections of Division 26, 27 and 28. These sections supplement requirements of Division 1.

I.2 REFERENCES

- .1 CSA Group
 - .1 CSA C22.1-15, Canadian Electrical Code, Part I (23rd Edition), Safety Standard for Electrical Installations.
 - .2 CSA C22.2.
 - .3 CAN/CSA-C22.3 No.1-10, Overhead Systems.
 - .4 CAN3-C235-83(R2010), Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
- .2 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)
 - .1 IEEE SPI 122-[2000], The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.

I.3 PRODUCT DATA

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

I.4 DELIVERY, STORAGE AND HANDLING

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

Part 2 Products

2.1 BUILDING WIRES

- .1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.
- .2 Copper conductors: size as indicated, with 1000 V insulation of cross-linked thermosetting polyethylene material rated RW90 XLPE Jacketted.
- .3 Copper conductors: size as indicated, with thermoplastic insulation type TWH rated at 600 V.
- .4 Neutral supported cable: 1, 2, 3 phase insulated conductors of Copper and one neutral conductor of Copper reinforced, size as indicated. Type: Insulation: Type NSF-2 flame retardant rated 600 V.

2.2 **TECK 90 CABLE**

- .1 Cable: in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Conductors:
 - .1 Grounding conductor: copper.
 - .2 Circuit conductors: copper, size as indicated.
- .3 Insulation:
 - .1 Ethylene propylene rubber EP.
 - .2 Cross-linked polyethylene XLPE.
 - .3 Rating: 1000 V.
- .4 Inner jacket: polyvinyl chloride material.
- .5 Armour: interlocking galvanized steel.
- .6 Overall covering: thermoplastic polyvinyl chloride, compliant to applicable Building Code classification for this project.
- .7 Fastenings:
 - .1 One hole steel straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.
 - .2 Channel type supports for two or more cables spaced as per CEC.
 - .3 Threaded rods: 6 mm diameter to support suspended channels.
- .8 Connectors:
 - .1 Watertight approved for TECK cable.

2.3 **ARMOURED CABLES**

- .1 Conductors: insulated, copper size as indicated.
- .2 Type: AC90.
- .3 Armour: interlocking type fabricated from aluminum strip.
- .4 Type: ACWU90 flame retardant jacket over thermoplastic armour and compliant to applicable Building Code classification for this project.
- .5 Connectors: anti short connectors.
- .6 Utilize for final lighting luminaires connections only.

2.4 **ALUMINUM SHEATHED CABLE**

- .1 Conductors: copper size as indicated.
- .2 Insulation: cross linked polyethylene type RA90 rated 600V.
- .3 Sheath: aluminum applied to form continuous sheath.
- .4 Outer jacket: thermoplastic applied over sheath and to be compliant to applicable Building Code classification for this project.

- .5 Fastenings for aluminum sheathed cable:
 - .1 One hole steel straps to secure surface cables 25 mm and smaller. Two hole steel straps for cables larger than 25 mm. Use aluminum strap only with single conductor cable.
 - .2 Channel type supports for two or more cables.
 - .3 Threaded rods: 6 mm diameter to support suspended channels.

2.5 CONTROL CABLES

- .1 Type: LVT: 2 soft annealed copper conductors, sized as indicated:
 - .1 Insulation: thermoplastic.
 - .2 Sheath: thermoplastic jacket.
- .2 Type: low energy 300 V control cable: solid or stranded (as required) annealed copper conductors sized as indicated LVT: 2 soft annealed copper conductors
- .3 Type: 600 V stranded annealed copper conductors, sizes as indicated:
 - .1 Insulation: TWH butyl rubber insulation type RW90 (x-link)
 - .2 Shielding: non-magnetic tape conductors.

2.6 VARIABLE FREQUENCY DRIVE CABLE

- .1 Cable:
 - .1 Variable frequency drive cable to CAN/CSA C22.2 No. 131.
- .2 Conductors:
 - .1 Copper power and ground.
- .3 Ground conductors:
 - .1 Three bare ground conductors spaced evenly around circumference of cable (sectored ground).
- .4 Insulation:
 - .1 Cross linked polyethylene, 1000V.
- .5 Armour:
 - .1 Continuous aluminum sheath formed into corrugates seamless sheath.
- .6 Outer jacket:
 - .1 PVC, UV resistant.
- .7 Fire rating: FT4, HL and AGI4.
- .8 Connectors:
 - .1 As for RA90.

Part 3 Execution

3.1 FIELD QUALITY CONTROL

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

3.2 GENERAL CABLE INSTALLATION

- .1 Lay cable in cable trays in accordance with Section 26 05 36 - Cable Trays for Electrical Systems.
- .2 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - (0-1000 V).
- .3 Cable Colour Coding: to Section 26 05 00 - Common Work Results for Electrical.
- .4 Conductor length for parallel feeders to be identical.
- .5 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.
- .6 Wiring in walls: typically drop or loop vertically from above to better facilitate future renovations. Generally wiring from below and horizontal wiring in walls to be avoided unless indicated.
- .7 Branch circuit wiring for surge suppression receptacles and permanently wired computer and electronic equipment to be 2-wire circuits only, i.e. common neutrals not permitted.
- .8 Provide numbered wire collars for control wiring. Numbers to correspond to control shop drawing legend. Obtain wiring diagram for control wiring.

3.3 INSTALLATION OF BUILDING WIRES

- .1 Install wiring as follows:
 - .1 In conduit systems in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
 - .2 In surface and lighting fixture raceways in accordance with Section 26 09 43.

3.4 INSTALLATION OF TECK90 CABLE (0 -1000 V)

- .1 Group cables wherever possible on channels.
- .2 Install cable concealed, securely supported by straps and hangers.

3.5 INSTALLATION OF ARMoured CABLES

- .1 Group cables wherever possible on channels.

- .2 Type AC90 armoured cable will not be permitted with the exception of the final connection from the junction box to light fixture when the distance from the junction box to the light fixture is not more than 1.8m, for final connection from junction box to motors and equipment, within millwork and for vertical drop within walls and partitions to receptacles. Looping of BX from fixture to fixture or from receptacle to receptacle will not be accepted.

3.6 INSTALLATION OF ALUMINUM SHEATHED CABLE

- .1 Group cables wherever possible on channels.

3.7 INSTALLATION OF CONTROL CABLES

- .1 Install control cables in conduit.
- .2 Ground control cable shield.

3.8 INSTALLATION OF NON-METALLIC SHEATHED CABLE

- .1 Install cables.
- .2 Install straps and box connectors to cables as required.

END OF SECTION

Part I General

I.1 RELATED REQUIREMENTS

- .1 Refer to all sections of the specifications for related work.

I.2 REFERENCES

- .1 CSA Group
 - .1 CSA C22.1-15, Canadian Electrical Code, Part I (23rd Edition), Safety Standard for Electrical Installations.
 - .2 CSA C22.2 No.41-13, Grounding and Bonding Equipment (Tri-National Standard, with NMX-J-590ANCE and UL 467).
 - .3 CSA C22.2 No.65-13, Wire connectors (Tri-National Standard, with UL 486A-486B NMX-J-543-ANCE).

I.3 ACTION AND INFORMATIONAL SUBMITTALS

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

I.4 CLOSEOUT SUBMITTALS

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

I.5 DELIVERY, STORAGE AND HANDLING

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

Part 2 Products

2.1 CONNECTORS AND TERMINATIONS

- .1 Copper long barrel compression connectors to CSA C22.2 No.65 as required sized for conductors.
- .2 Contact aid for aluminum cables where applicable.
- .3 2, 3, 4 way joint boxes type in accordance with Section 26 05 33 - Raceway and Boxes for Electrical Systems.
- .4 2, 3, 4 way junction boxes with respective pothead for conductor cables

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for connectors and terminations installation in accordance with manufacturer's written instructions.

3.2 INSTALLATION

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

3.3 CLEANING

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

END OF SECTION

Part I General

I.1 RELATED REQUIREMENTS

- .1 Refer to all sections of the specification for related work.

I.2 REFERENCES

- .1 American National Standards Institute /Institute of Electrical and Electronics Engineers (ANSI/IEEE)
 - .1 ANSI/IEEE 837-02, IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding.
- .2 CSA International

I.3 ACTION AND INFORMATIONAL SUBMITTALS

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

I.4 CLOSEOUT SUBMITTALS

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

I.5 DELIVERY, STORAGE AND HANDLING

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

Part 2 Products

2.1 EQUIPMENT

- .1 Clamps for grounding of conductor: size to electrically conductive underground water pipe.
- .2 Grounding conductors: bare stranded copper, soft annealed. Verify grounding impedance.
- .3 Insulated grounding conductors: green, copper conductors.
- .4 Ground bus: copper, complete with insulated supports, fastenings, connectors.
- .5 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
 - .1 Grounding and bonding bushings.
 - .2 Protective type clamps.
 - .3 Bolted type conductor connectors.
 - .4 Thermit welded type conductor connectors.
 - .5 Bonding jumpers, straps.
 - .6 Pressure wire connectors.

Part 3 Execution

3.1 EXAMINATION

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

3.2 INSTALLATION GENERAL

- .1 Install complete permanent, continuous grounding system including, conductors, connectors, accessories. Where EMT is used, run ground wire in conduit.
- .2 Install connectors in accordance with manufacturer's instructions.
- .3 Protect exposed grounding conductors from mechanical injury.
- .4 Make buried connections, and connections to conductive water main, electrodes, using copper welding by thermit process.
- .5 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .6 Soldered joints not permitted.

- .7 Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.
- .8 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.
- .9 Avoid loop connections.
- .10 Bond single conductor, metallic armoured cables to cabinet at supply end.
- .11 Ground secondary service pedestals.

3.3 SYSTEM AND CIRCUIT GROUNDING

- .1 Install system and circuit grounding connections to secondary 120/600 V system.

3.4 EQUIPMENT GROUNDING

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

3.5 GROUNDING BUS

- .1 Ground items of electrical equipment in electrical room and IT equipment in communication equipment room to ground bus with individual bare stranded copper connections size 2/0AWG.

3.6 COMMUNICATION SYSTEMS

- .1 Install grounding connections for sound, fire alarm, security systems, intercommunication systems as follows:
 - .1 Sound, fire alarm, security systems, intercommunication systems as indicated.
 - .2 Make connections to pipes on building side of main valves and tanks. Connect jumpers across boilers to supply and return hot water heating pipes.

3.7 FIELD QUALITY CONTROL

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

3.8 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

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

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Refer to all sections of the specification for related work.

Part 2 Products

2.1 SUPPORT CHANNELS

- .1 U shape, size 41 x 41 mm, 2.5 mm thick, surface mounted suspended or set in poured concrete walls and ceilings.

Part 3 Execution

3.1 INSTALLATION

- .1 Secure equipment to solid masonry, tile and plaster surfaces with lead anchors.
- .2 Secure equipment to poured concrete with expandable inserts.
- .3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
- .4 Secure surface mounted equipment with twist clip fasteners to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment specified before installation.
- .5 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .6 Fasten exposed conduit or cables to building construction or support system using straps.
 - .1 One-hole steel straps to secure surface conduits and cables 50 mm and smaller.
 - .2 Two-hole steel straps for conduits and cables larger than 50 mm.
 - .3 Beam clamps to secure conduit to exposed steel work.
- .7 Suspended support systems.
 - .1 Support individual cable or conduit runs with 6 mm dia threaded rods and spring clips.
 - .2 Support 2 or more cables or conduits on channels supported by 6 mm dia threaded rod hangers where direct fastening to building construction is impractical.
- .8 For surface mounting of two or more conduits use channels.
- .9 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.

- .10 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .11 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .12 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Departmental Representative
- .13 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Refer to all sections of the specification for related work.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.1-15, Canadian Electrical Code, Part 1, 23rd Edition.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

Part 2 Products

2.1 JUNCTION AND PULL BOXES

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

2.2 CABINETS

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

Part 3 Execution

3.1 JUNCTION, PULL BOXES AND CABINETS INSTALLATION

- .1 Install pull boxes in inconspicuous but accessible locations.
- .2 Mount cabinets with top not higher than 2 m above finished floor except where indicated otherwise.
- .3 Install terminal block as indicated in Type T cabinets.

- .4 Only main junction and pull boxes are indicated. Install additional pull boxes as required by CSA C22.1.

3.2 IDENTIFICATION

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

3.3

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Refer to all sections of the specification for related work.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.1-15, Canadian Electrical Code, Part I, 23rd Edition.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.

Part 2 Products

2.1 OUTLET AND CONDUIT BOXES GENERAL

- .1 Size boxes in accordance with CSA C22.1.
- .2 102 mm square or larger outlet boxes as required.
- .3 Gang boxes where wiring devices are grouped.
- .4 Blank cover plates for boxes without wiring devices.
- .5 347 V outlet boxes for 347 V switching devices.
- .6 Combination boxes with barriers where outlets for more than one system are grouped.

2.2 GALVANIZED STEEL OUTLET BOXES

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

2.3 FLOOR BOXES

- .1 Concrete tight electro-galvanized sheet steel floor boxes with adjustable finishing rings to suit floor finish with brushed aluminum faceplate. Device mounting plate to accommodate short or long ear duplex receptacles. Minimum depth: 73 mm for receptacles and communication outlets.
- .2 Adjustable, watertight, concrete tight, cast floor boxes with openings drilled and tapped for 27 mm conduit. Minimum size: 73 mm deep.

2.4 CONDUIT BOXES

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

2.5 OUTLET BOXES FOR NON-METALLIC SHEATHED CABLE

- .1 Electro-galvanized, sectional, screw ganging steel boxes, minimum size 76 x 50 x 63 mm with two double clamps to take non-metallic sheathed cables.

2.6 FITTINGS - GENERAL

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

Part 3 Execution

3.1 INSTALLATION

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

END OF SECTION

Part I General

I.1 RELATED REQUIREMENTS

- .1 Refer to all related sections 26, 27, 28.

I.2 REFERENCES

- .1 CSA International
 - .1 CSA C22.2 No.40-M1989(R2009), Cutout, Junction and Pull Boxes.

I.3 ACTION AND INFORMATIONAL SUBMITTALS

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

I.4 CLOSEOUT SUBMITTALS

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

I.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect raceway and boxes from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

Part 3 Execution

3.1 EXAMINATION

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

3.2 INSTALLATION

- .1 Install splice boxes at cable joint, on floor of trench. Tighten armour clamps and fill with compound.
 - .1 Ground splice boxes as required.
- .2 Install junction boxes on trench floor around cable splice to CSA C22.2 No.40. Connect cable terminals to box contacts.
 - .1 Ground junction boxes as required.
 - .2 Fasten lid securely and check for air leaks before trench is backfilled.
- .3 Install power level boxes as follows:
 - .1 Cast iron type: on trench floor, connect cable terminals to box contacts, fasten lid and fill with compound before trench is backfilled.
 - .2 Steel type: mount on wall of [maintenance holes; connect cables to box terminals; install disconnect links, fasten lid securely check for air leaks.
 - .3 Ground power level boxes as required.

3.3 CLEANING

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

END OF SECTION

Part 1 General

I.1 RELATED REQUIREMENTS

- .1 Refer to all sections of the specification for related work.

I.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA C22.2 No. 18, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware, A National Standard of Canada.
 - .2 CSA C22.2 No. 45, Rigid Metal Conduit.
 - .3 CSA C22.2 No. 56, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
 - .4 CSA C22.2 No. 83, Electrical Metallic Tubing.
 - .5 CSA C22.2 No. 211.2-M1984(R2003), Rigid PVC (Unplasticized) Conduit.
 - .6 CAN/CSA C22.2 No. 227.3-05, Nonmetallic Mechanical Protection Tubing (NMPT), A National Standard of Canada (February 2006).

I.3 ACTION AND INFORMATIONAL SUBMITTALS

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

Part 2 Products

2.1 CONDUITS

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

- .6 FRE conduit
- .7 Flexible metal conduit: to CSA C22.2 No. 56, liquid-tight flexible metal steel.
- .8 Flexible pvc conduit: to CAN/CSA-C22.2 No. 227.3

2.2 CONDUIT FASTENINGS

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

2.3 CONDUIT FITTINGS

- .1 Fittings: to CAN/CSA C22.2 No. 18, manufactured for use with conduit specified.
Coating: same as conduit.
- .2 Ensure factory "ells" where 90 degrees bends for 25 mm and larger conduits.
- .3 Watertight connectors and couplings for EMT.
 - .1 Set-screws are not acceptable.

2.4 EXPANSION FITTINGS FOR RIGID CONDUIT

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

2.5 FISH CORD

- .1 Polypropylene.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 Conceal conduits except in mechanical and electrical service rooms.

- .3 Surface mount conduits in existing walls.
- .4 Use rigid galvanized steel threaded conduit except where specified otherwise.
- .5 Use epoxy coated conduit in corrosive areas.
- .6 Use electrical metallic tubing (EMT) except in cast concrete above 2.4 m not subject to mechanical injury.
- .7 Use rigid pvc conduit in corrosive areas.
- .8 Use flexible metal conduit for connection to motors in dry areas, connection to recessed incandescent fixtures without prewired outlet box, connection to surface or recessed fluorescent fixtures or work in movable metal partitions.
- .9 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations.
- .10 Minimum conduit size for lighting and power circuits: 21 mm.
- .11 Install EMT conduit from computer room branch circuit panel to outlet boxes.
- .12 Bend conduit cold:
 - .1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .13 Mechanically bend steel conduit over 19 mm diameter.
- .14 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .15 Install fish cord in empty conduits.
- .16 Remove and replace blocked conduit sections.
 - .1 Do not use liquids to clean out conduits.
- .17 Dry conduits out before installing wire.

3.3 SURFACE CONDUITS

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

3.4 CONCEALED CONDUITS

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

3.5 CLEANING

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

END OF SECTION

PART I General

I.1 RELATED WORK

- .1 Refer to all Sections of the specification for related work.
- .2 Mechanical Divisions.

I.2 REQUIREMENTS

Motor Size	Voltage System
3/4 HP (0.562 kW) and larger	208V/1Ø, 208V/3Ø and 600 V, 3Ø
1/2 HP (0.373 kW) and smaller	120 V, 1Ø

- .1 Provide a complete system of power wiring to motors and controls.
- .2 Unless specifically noted otherwise, wire and leave in operation all electrically operated equipment supplied under this Contract. Examine the drawings and shop drawings of all Divisions for the extent of electrically operated equipment supplied by other Divisions.
- .3 Where control wiring diagrams are shown illustrate typical control circuits applicable to the equipment. Control circuits may vary with different manufacturers of equipment. Verify all control circuits with the suppliers of the equipment and make any corrections that may be required.
- .4 Unless specifically noted otherwise, supply all pushbuttons, relays, starters, etc. necessary for the operation of equipment. Check all starters, relay coils and thermal elements to ensure that they provide the necessary protection for motors.
- .5 Do not operate motors and controls until approval is obtained from the trade providing equipment.
- .6 Examine drawings and shop drawings of other Divisions to obtain exact location of motors and equipment shown on other Division drawings and specifications. Where necessary, obtain conduit locations from other trades' drawings & shop drawings. The complete list of motors may not be shown on the electrical drawings. Verify and confirm motor sizes and electrical protection before installation.
- .7 Assist in placing in operation all mechanical equipment having electrical connections.
- .8 Provide three phase starters with primary and secondary fused 120 volt control transformers and overload relays.

- .9 In general, wiring for freezestats, firestats, EP switches P.E. switches, dampers, temperature controllers, flow switches, solenoid valves, etc., for heating, ventilating and air conditioning equipment will be by Mechanical Contractor, from control panels supplied and installed by Mechanical Contractor. Provide terminations in starters for control wiring, so that starter control circuits may be extended by Mechanical Contractor. Where 120 volt power is required for mechanical equipment, i.e.: for roll type filters, refrigerated aftercoolers, control cabinets, etc., wiring to the equipment terminals is the work of the Electrical Contractor. Electrical Contractor to wire all 120V AHU internal lighting and receptacles, condensers and rooftops weatherproof outdoor receptacles.

PART 2 Products

2.1 3Ø MOTOR DISCONNECT SWITCHES

- .1 Industrial Type "A" having quick-make, quick-break visible blade mechanism, cover interlocks and padlocking switch in the closed or open position. Use EEMAC-4 enclosures outdoors, EEMAC-1 indoors and drip proof shield watertight for areas exposed to sprinklers. Switches to be kW rated, Square "D" Type A heavy duty.

2.2 120V 1Ø DISCONNECT SWITCHES

- .1 Manual starter without overload relay.

2.3 208V 1Ø MOTOR DISCONNECT SWITCHES

- .1 Manual starter without overload relay.

PART 3 Execution

3.1 GENERAL

- .1 For all motors, provide disconnect switches adjacent to the motors.
- .2 Wall mount disconnects adjacent to equipment or floor mount at motor locations. Wall mounted disconnects to be 1400 mm above floor.

3.2 CONTROL CABINETS & CONTROLS

- .1 Verify the location of all control cabinets, and provide power wiring to each cabinet from the nearest electrical panel where not specifically shown from a particular panel.
- .2 Power wiring for mechanical equipment is the responsibility of the Electrical Contractor. Provide circuits and wiring to suit the controls contractor requirements. All control power wiring requirements may not be specifically shown on the drawings.

- .3 All control wiring shall be run in conduit. Coordinate with controls subcontractor.

3.3 FLOW SWITCHES

- .1 Verify the location of all sprinkler flow switches, valve monitor switches, jockey pumps, etc. with Mechanical. Devices may not be specifically shown on the electrical drawings.

3.4 AIR VOLUME (CAV, VAV) CONTROLLERS

- .1 Verify the location of all CAVs or VAVs, etc. with Mechanical Contractor and wire and connect these devices. Devices may not be specifically shown on the electrical drawings.
 - .1 Provide 120 volt power and control wiring to each CAV or VAV unit.

3.5 COMMISSIONING

- .1 Do not start motors until the supplier of the equipment has verified that the electrical connection has been made in accordance with the nameplate information.
- .2 Extreme caution must be taken in connection of motors with nameplates having multiple connection diagrams i.e.: WYE-DELTA Start, MULTISPEED.
- .3 Be responsible for replacement of motors or other equipment damaged by starting-up prior to being checked by equipment supplier.

END OF SECTION

PART I General

I.1 CODES

- .1 Comply with latest edition of CSA Z320
- .2 Refer to Commissioning Sections for Commissioning Plan and samples

I.2 INCLUDED SYSTEMS AND EQUIPMENT

- .1 The following is a partial list of equipment and system test requirements included in this section:
 - .1 Distribution systems including phasing, voltage, grounding, load balancing hipot and/or megger testing.
 - .2 Circuits originating from central distribution and branch distribution panels.
 - .3 Grounding systems.
 - .4 Lighting systems and controls, and interior and exterior light level readings.
 - .5 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
 - .6 Emergency Lighting and power systems.
 - .7 Power feeders and systems downstream of new switchgear.
 - .8 Receptacles.
 - .9 Connections and circuits to Owner supplied equipment.
 - .10 Telecommunications systems as outlined in Section 27 05 00.
 - .11 Coordinate testing requirements with Commissioning requirements.
 - .12 Connections to mechanical equipment.

I.3 DESCRIPTION

- .1 This section specifies the functional testing and commissioning requirements for electrical systems and equipment as performed by the electrical contractor. The test requirements for each piece of equipment or system shall contain the following:
 - .1 A list of the integral components being tested.
 - .2 Pre-functional checklists associated with the components.
 - .3 Functions and modes to be tested.
 - .4 Required conditions of the test for each mode.
 - .5 Special procedures.
 - .6 Required methods of testing.
 - .7 Required monitoring.
 - .8 Acceptance criteria.
- .2 Include the cost of testing in the contract price.

- .3 In each purchase order or subcontract written, include requirements for submittal data, O&M data and training.
- .4 Provide a copy of the O&M manual submittals of tested equipment, through normal channels, to the Consultant for review and approval.
- .5 Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure technicians are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests and adjustments.
- .6 Prepare O&M manuals according to the Contract Documents. Include clarifying and updating the original sequences of operation to as-built conditions.
- .7 Provide training of the Owner's operating personnel.
- .8 Immediately prior to building occupancy, test the entire electrical system by performing a loss and return of utility power test.

1.4 TEST EQUIPMENT

- .1 Electrical Contractor shall provide all test equipment necessary to fulfill the testing requirements of this Division.

PART 2 Products

- .1 Not used

PART 3 Execution

3.1 GENERAL

- .1 Furnish manufacturer's certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions.
- .2 Carry out tests in presence of the Departmental Representative.
- .3 Give advance notice of proposed time of tests so that the Departmental Representative can be represented at the tests.
- .4 Submit test results for review by the Departmental Representative. Complete deficiencies within construction schedule.
- .5 Include copy of test results in maintenance manuals.

- .6 Testing methods and test results: in accordance with CSA, CEC and regulations of the supply authority, other authorities having jurisdiction and manufactures recommendations.
- .7 Conduct dielectric tests, megger tests, insulation resistance tests and ground continuity tests as required by the nature of the various systems and equipment.

3.2 EQUIPMENT TESTING

- .1 With the systems completely connected and lamped, conduct the following tests on the power system:
 - .1 Control and Switching: test all circuits for the correct operation of devices, switches and controls.
 - .2 Polarity Tests: test all circuits for correct operation of devices, switches and controls.
 - .3 Voltage Tests: make a voltage test at the last outlet of each circuit. Maximum drop in potential permitted will be 3% on 120V, and 208V branch circuits. 3% on 208V feeder circuits, and 3% on 600V feeder circuits. Correct any deficiency in this respect.
 - .4 Phase Balance: measure the load on each phase at each switchboard, distribution panelboard and lighting and power panelboards. Report results in writing to the Departmental Representative. Re-arrange phase connections as necessary to balance the load on each phase as instructed by the Departmental Representative with the re-arrangement being restricted to the exchanging of connections at the distribution points mentioned in this paragraph. After marking any such changes, make available to the Departmental Representative, drawings or marked prints showing the modified connections.
 - .5 Supply Voltage: measure the line voltage of each phase at the load terminals of the main breakers and report the results in writing to the Departmental Representative. Perform this test with the majority of electrical equipment in use.
 - .6 Motor Loading: measure the line current of each phase of each motor with the motor operating under load and report the results in writing to the Departmental Representative. Upon indications of any imbalance or overload, thoroughly examine the electrical connections and rectify any defective parts or wiring. If electrical connections are correct, overloads due to defects in the driven machines shall be reported in writing to the Departmental Representative. Verify motor full load amps and overload relays are properly sized and adjusted accordingly.
 - .7 General Operations: energize and put into operation each and every electrical circuit and item. Make repairs, alterations, replacements, tests and adjustments necessary for a complete and satisfactory operating electrical system.
- .2 When tests are performed, the Departmental Representative may require that equipment be opened and removed from their housings to examine interior of equipment, terminations and connections. Provide all required labour and tools.

- .3 Coordinate the testing of motors with the trades providing the equipment driven by the motors so that they are carried out at the time the driven equipment is put on test. In addition to the motor loading tests, provide labour and instruments to take and record all motor load readings required to supplement the tests on the driven equipment through various load sequences, as required by the trades involved.
- .4 General Component Starting and Testing:
 - .1 Prior to energizing:
 - .1 Confirm components nameplate data with characteristics of power supply.
 - .2 Verify supply voltage and phase rotation.
 - .3 Ensure all testing as specified has been completed and deficiencies have been corrected.
 - .4 Close and open all devices to ensure proper mechanical operation.
 - .5 Megger all feeders and record results on approved verification forms.
 - .5 Load balancing:
 - .1 At time of acceptance carry out the following work at peak load hours:
 - .1 Measure load balance on all feeders at distribution centres, motor control centres and panelboards with normal loads (lighting included). If load unbalance exceeds 15%, reconnect circuits to obtain the best possible balance of current between phases. Revise panelboard directories and wiring identification accordingly.
 - .2 Measure phase voltages at distribution centres, motor control centres and panelboards with normal loads (lighting included). Adjust transformer taps, where required, to within 2% of rated voltage of components.
- .6 Insulation Resistance Testing:
 - .1 After installing cable and terminating reform insulation resistance test with megger on each phase conductor.
 - .2 Megger all circuits, feeders and components up to 350 V with a 500 V instrument.
 - .3 Megger all 350-600 V circuits, feeders and components with a 1000 V instrument.
 - .4 Check insulation resistance to ground before energizing.
 - .5 Megger cables for one minute, graph results at 10 second intervals. Submit graphs to Consultant and include graphs in O & M manuals.
 - .6 Minimum insulation resistance to earth or between phases: 100.
 - .7 Instrument to have minimum of 100 Megaohm resolution in the 0 to 500 Megaohm range.
 - .8 Check insulation resistance after each termination to ensure that cable system is ready for acceptance testing.

- .7 Ground Resistance Testing:
 - .1 Measure ground resistance with earth test megger to verify compliance with CSA C22.2 No. 0.4 and Canadian Electrical Code.

- .8 Coordination of Protective Devices:
 - .1 Ensure circuit protective devices such as overcurrent trip relays, fuses are installed to values and settings determined by the Coordination Study.

- .9 Arc Flash Protection:
 - .1 Ensure circuit protective devices such as overcurrent trip relays, fuses are installed to values and settings determined by the Arc Flash Study.

- .10 L.V. Power Distribution:
 - .1 Completely isolate from all sources of power, the switchgear enclosure to be tested and inspected.
 - .2 Remove necessary access panels, doors and cover plates.
 - .3 Cleaning:
 - .1 Check for accumulations of dirt especially on insulating surfaces and clean all interiors of compartments thoroughly using a vacuum or blower.
 - .2 Use only clean, lint free cloth.
 - .3 Remove all filings caused by burnishing of contact.
 - .4 Visual and Mechanical Inspection:
 - .1 Check physical, electrical and mechanical condition.
 - .2 Compare equipment nameplate data with latest contractual documents/requirements.
 - .3 Check for proper anchorage, required clearances, physical damage and proper alignment.
 - .4 Check physical appearance of all doors, panels, and sections for paint, dents, scratches, fit and missing hardware. Lubricate in accordance with manufacturer's instructions.
 - .5 Inspect all insulators and insulating surfaces for evidence of physical damage, cracks, chips and tracking or contaminated surfaces.
 - .6 Check condition of all bussing for moisture or other contamination, proper torque using calibrated torque wrench, and clearance to ground. Seal all bolted connections with red lacquer.
 - .7 Check all mechanical devices for proper operation. Exercise all active components.
 - .8 Check and verify that circuit breakers comply with latest contractual documents/requirements:
 - .5 Check condition of all contacts.
 - .6 Check and report all discovered unsafe conditions.

- .7 Check cable and wiring condition, appearance, termination. Perform electrical tests as required.
- .8 Inspect for proper grounding of components.
- .9 Molded case circuit breakers 150 amp frame and larger:
 - .1 Visual and Mechanical Inspection:
 - .1 Check physical, electrical and mechanical condition. Inspect for cracks or other defects.
 - .2 Compare equipment nameplate data with latest contractual documents/requirements. Check for proper mounting. Ensure correct protection elements.
 - .3 Operate circuit breaker to ensure smooth operation.
 - .4 Check tightness of connections using calibrated torque wrench
 - .2 Electrical Tests:
 - .1 Megger test.
 - .2 Mechanical function test
 - .3 Set all units with adjustable magnetic trip units.
 - .3 Where solid state protection is provided with large breakers, test units as follows:
 - .1 Inspect and test in accordance with manufacturer's most recent installation and maintenance brochure.
 - .2 Perform tests using manufacturer's relay test unit as applicable, with corresponding test instruction
 - .3 Proof test each relay in its control circuit by simulated trip tests to ensure total and proper operation of breaker and relay trip circuit by injection of the relay circuit to test the trip operation.
 - .4 Check C/T and P/T ratios and compare to coordination data.
 - .5 Record all observations, data and test results.
- .10 Molded case circuit breakers to 150 amp:
 - .1 Visual and mechanical inspection as for the larger moulded case breakers.
 - .2 Mechanical function test.
 - .3 Set all units with adjustable magnetic trip units.
 - .4 Record all observations, data and test results.
- .11 Protective Relaying:
 - .1 Set and test protective relays to the settings provided in the coordination study. The manufacturer's instructions for the specific relay must always be used for information concerning connections, adjustments, repairs, timing and data.
 - .2 Record all observations, data and test results.
- .11 Dry Type Transformers up to 600V primary:

- .1 Inspect for physical damage, broken insulation, tightness of connections using calibrated torque wrench, defective wiring and general condition.
 - .2 Thoroughly clean unit prior to making any tests.
 - .3 Complete verification form for each transformer
 - .4 Perform insulation resistance test from winding to winding and each winding to ground. Calculate dielectric absorption ratio and polarization index.
 - .5 Perform core to ground test as for the high voltage transformer.
 - .6 Test operation of temperature and operation of all associated alarm contacts, where applicable.
 - .7 Test and calibrate ground fault relays and function test to trip associated breakers, where applicable.
 - .8 Verify taps and connect to the desired tap.
 - .9 Energize primary winding with system voltage and measure secondary voltage with secondary load disconnected.
 - .10 Record all observations, data and test results.
- .12 Disconnect Switches - Fused/Unfused:
- .1 Visual and mechanical inspection:
 - .1 Check physical, electrical and mechanical condition. Inspect for cracks or other defects.
 - .2 Compare equipment nameplate data with latest contractual documents/requirements. Operate switch to ensure smooth operation.
 - .3 Check tightness of connections using calibrated torque wrench.
 - .4 Check blade alignment.
 - .5 Check each fuse holder for adequate mechanical support of each fuse.
 - .6 Check all electrical and mechanical interlocks.
 - .7 Check proper phase barrier materials and installation.
 - .8 Inspect all indicating devices for proper operation.
 - .9 Clean entire switch using approved methods and materials.
 - .10 Lubricate to manufacturer's recommendations.
 - .11 Exercise all active components.
 - .2 Electrical Tests:
 - .1 Perform a contact resistance test across each switch blade and fuse holder.
- .13 Distribution, Power and Lighting Panelboards:
- .1 Conduct load balancing as defined in this section.
 - .2 Carry out visual inspection
 - .3 Torque all bus connections using calibrated torque wrench
 - .4 Record all observations, data and test results
- .14 Wiring and Cables:

- .1 Test all conductors, including those at distribution centres and panelboards for insulation resistance to ground (megger test).
 - .2 Test service grounding conductors for ground resistance.
 - .3 Provide list of test results on approved verification form showing location at which each test was made, circuit tested and results of each test.
 - .4 Remove and replace entire length of cable if cable fails to meet any of the test criteria.
- .15 Grounding:
- .1 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Engineer and local authority having jurisdiction over installation.
 - .2 Perform tests before energizing electrical distribution.
 - .3 Provide test report documenting successful test results.
- .16 Motor Starters:
- .1 Operate switches, contactors to verify correct functioning.
 - .2 Perform starting and stopping sequences of contactors and relays.
 - .3 Check that sequence controls, interlocking with other separate related starters, components and control devices operate as per component verification form.
 - .4 Record all observations, data and test results
- .17 Motors:
- .1 Prior to starting motors:
 - .1 Confirm motor nameplate data with motor starter heater overloads, setting of MCP's and sizing of fuses.
 - .2 Verify rotation.
 - .3 Ensure disconnects are installed.
 - .4 Confirm labeling of motors, disconnects and starters.
- .18 Receptacles:
- .1 Verify all receptacles have been wired correctly using an outlet circuit tester. Provide written test results.
- .19 Lighting Systems:
- .1 Lighting components:
 - .1 Function test all light switches, luminaires, dimmers and lighting control components.
 - .2 Record all time settings.
 - .3 Verify that correct lamps, drivers and ballasts have been used.
 - .2 Emergency Lighting:
 - .1 Check operation of all emergency lights.

- .2 Check for proper operation of all emergency battery lights and lighting units.
- .3 Record all observations, data and test results.
- .3 Lighting Controls:
 - .1 For lighting control systems, examine all components individually for physical condition and compliance with the latest contractual documents. Also check each component for correct operation. Record all observations, data and test results.
 - .2 Dimming – Fluorescent:
 - .1 Complete lighting system start up tests.
 - .2 Demonstrate that dimming systems are installed as indicated.
 - .3 Demonstrate that dimming systems operate as designed and that there are no problems in starting lamps, nor in keeping them lit at any setting of dimming intensity control.
- .20 Fire Alarm System Testing and Adjusting:
 - .1 Ensure Manufacturer conducts an inspection of the fire alarm and smoke detection system and equipment including those components necessary to the direct operation of the system such as manual stations, heat detectors, smoke detectors and controls whether or not manufactured by the manufacturer. The inspection tests to conform to CAN/ULC-S537-04 Verification of Fire Alarm Systems and also comprise an examination of such equipment for the following:
 - .1 Type of equipment installed is as described by these electrical specifications.
 - .2 Wiring connections to all equipment components show that the installer undertook to have observed ULC and CSA requirements.
 - .3 Equipment of the manufacturer has been installed in accordance with the manufacturer's recommendations and that all signaling devices of whatever manufacturer have been operated or tested to verify their operation.
 - .4 Supervisory wiring of those items of equipment connected to a supervised circuit is operating and governmental regulations, if any, concerning such supervisory wiring have been met to the satisfaction of inspection authorities.
 - .2 The Manufacturer shall supply to the Electrical Contractor reasonable amounts of technical assistance with respect to any changes necessary. During the period of inspection by the manufacturer, the Electrical Contractor shall make available to the manufacturer, electricians as designated by the manufacturer.
 - .3 To assist the Electrical Contractor in preparing his bid, the manufacturer shall indicate the number of hours necessary to complete the inspection described, prior to closing of tenders.
 - .4 On completion of the inspection and when all of the above conditions have been complied with, the manufacturer shall issue to the Consultant the following, in accordance with CAN/ULC-S537-04:

- .1 A copy of the inspecting technician's report showing the location of each device and certifying the test results of each device.
- .2 A certificate of verification confirming that the inspection has been completed and showing the conditions upon which such inspection and certification have been rendered.
- .3 Proof of liability insurance for the inspection.
- .5 All costs involved in the inspection described herein, both for the manufacturer's and the Electrical Contractor's work shall be included in the Electrical Contractor's total tender price.
- .6 Verification procedures, testing requirements, documentation required, etc. shall be in accordance with the requirement of ULC Standard CAN/ULC-S537-04.
- .7 Project Substantial Completion Schedule: Schedule witness testing in a timely manner. The successful completion of witness testing with a sealed report is necessary before considering the project substantially completed. Notify Consultant minimum 60 days before project completion that the witness testing has been arranged.
- .8 Re-testing:
 - .1 Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the specifications and complies with applicable standards.
- .9 Report of tests and inspections:
 - .1 Provide a written record of inspections, test, and detailed test results in the form of a test log.
- .10 Final Test, Certificate of Completion, and Certificate of Occupancy:
 - .1 Test the system as required by the Authority Having Jurisdiction in order to obtain a certificate of occupancy.

3.3 EQUIPMENT COMMISSIONING

- .1 Division 26 shall coordinate all required responsible in the commissioning process directed by the CA.
- .2 Commissioning requires the participation of Division 26 to ensure all equipment and systems are operating in a manner consistent with the contract documents. Division 26 shall be familiar with all requirements and coordination and shall execute all commissioning responsibilities assigned to them in the Contract Documents.
- .3 Include the cost of commissioning in the contract price.
- .4 Attend all necessary meetings schedule by the CA to facilitate the commissioning process.
- .5 Provide all cut sheets and shop drawing submittals to the CA of commissioned equipment.

- .6 Provide all additional requested documentation, prior to normal O&M manual submittals, to the CA for development of start-up and functional testing procedures.
- .7 Provide a copy of the O&M manual submittals of commissioned equipment. Through normal channels, to the CA for review and approval.
- .8 Provide assistance to the CA in preparation of the specific functional performance test procedures. Sub contractors shall review test procedures to ensure feasibility, safety and equipment protection.
- .9 Develop a full start-up and initial checkout plan of equipment and systems. Execute and document the electrical related portions for all commissioned equipment. Provide a copy to the CA.
- .10 Provide skilled technicians to execute starting of equipment and to execute functional performance tests.
- .11 Perform functional performance testing under the direction of the CA for all commissioned equipment.
- .12 Correct all deficiencies.
- .13 Provide training of the Owner's operating personnel as specified.
- .14 Required commissioned equipment and systems are outlined below:
 - .1 Occupancy sensors:
 - .1 Parties responsible:
 - .1 Electrical Contractor: Provide all testing.
 - .2 CA: Coordinate and document testing.
 - .2 Procedure:
 - .1 Space should be normally furnished and wall, floor and ceiling finishes complete.
 - .3 Required monitoring:
 - .1 None.
 - .4 Acceptable criteria:
 - .1 Activation of all required luminaires by associated occupancy sensor.
 - .2 Adjusted sensitivity to accommodate the required space.
 - .5 Sample strategy:
 - .1 All occupancy sensors installed.
 - .2 Electric heaters:
 - .1 Parties responsible:
 - .1 Electrical Contractor: Provide all testing.
 - .2 CA: Coordinate and document testing.

- .2 Procedure:
 - .1 Space should be normally furnished and wall, floor and ceiling finishes complete.
- .3 Required monitoring:
 - .1 None.
- .4 Acceptable criteria:
 - .1 Test cut out protection when air movement is obstructed.
 - .2 Test fan delay switch to ensure dissipation of heat after shutdown.
 - .3 Test unit cut off when fan motor overload protection has operated.
 - .4 Ensure that heaters and controls operate correctly.
- .5 Sample strategy:
 - .1 All electric heaters and associated controls installed.
- .3 Connections to mechanical equipment:
 - .1 Parties responsible:
 - .1 Electrical Contractor: Confirmation of electrical connection.
 - .2 CA: Coordinate and document testing.
 - .3 Mechanical Contractor: Operation of equipment/systems.
 - .2 Procedure:
 - .1 Space should be normally furnished and wall, floor and ceiling finishes complete.
 - .3 Required monitoring:
 - .1 None.
 - .4 Acceptable criteria:
 - .1 Verification of proper electrical connections to mechanical equipment/systems.
 - .5 Sample strategy:
 - .1 All mechanical equipment requiring commissioning. Coordinate with CA and Mechanical Contractor.

3.4 TRAINING OF PERSONNEL

- .1 The General Contractor shall be responsible for the overall training schedule and shall ensure that all training activities specified herein are completed.
- .2 Electrical Contractor: The electrical contractor shall have the following training responsibilities:
 - .1 Provide designated personnel with comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of tested electrical equipment or system.

- .2 Training shall be hands on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
- .3 During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
- .4 The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment are required. More than one party may be required to execute the training.
- .5 Training shall include:
 - .1 Use the printed installation, operation and maintenance instruction material included in the O&M manuals.
 - .2 Include a review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.
 - .3 Discuss relevant health and safety issues and concerns.
 - .4 Discuss warranties and guarantees.
 - .5 Cover common troubleshooting problems and solutions.
 - .6 Explain information included in the O&M manuals and the location of all plans and manuals in the facility.
 - .7 Discuss any peculiarities of equipment installation or operation.
- .6 Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and maintenance of all pieces of equipment.
- .7 The electrical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls.
- .8 Training shall occur after functional testing is complete, unless approved otherwise by Consultant.
- .9 Duration of Training. The electrical contractor shall provide training on each system for suitable period of time, to ensure a reasonable understanding of its operation by the trainee.

END OF SECTION

Part I General

I.1 RELATED REQUIREMENTS

- .1 This Section covers items common to Sections of Division 26, 27 and 28. These sections supplement requirements of Division I.
- .2

I.2 REFERENCES

- .1 CSA International
 - .1 CSA C22.1-15, Canadian Electrical Code, Part I (23rd Edition), Safety Standard for Electrical Installations.

I.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for network lighting controls and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Indicate on drawings:
 - .1 Complete assembly.
 - .2 Contact surfaces.
 - .3 Construction features.
 - .4 Wiring diagrams.

I.4 CLOSEOUT SUBMITTALS

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

I.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

- .2 Store and protect network lighting controls from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section
- .5 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan.

Part 2 Products

2.1 OVERVIEW

- .1 Provide a complete stand-alone, decentralized, low voltage, digital lighting control system for classrooms, offices or defined spaces as shown on the plans and specified herein.
- .2 Lighting control system shall utilize 2-wire, non-polarized, topology free data line networking technology to provide power and data to occupancy/vacancy sensors, daylight sensors, and wall station switches.
- .3 The network shall be free topology and therefore not require a serial loop to achieve maximum network distance.
- .4 The system shall be offered in factory configured and programmed kit that includes occupancy/vacancy sensors, daylight sensors, and wall station switches.
- .5 The controller shall be installed directly onto the knockouts of a 4x4 metal junction box.

2.2 ROOM CONTROLLER

- .1 Where indicated on the drawings provide a pre-configured, digitally addressable, plenum-rated room controller.
- .2 The Room Controller shall be capable of:
 - .1 Autonomously controlling a space.
 - .2 Networking to a central control system.
 - .3 Networking to a central BACnet based management system.
- .3 The Room Controller shall consist of:
 - .1 A universal voltage type (120Vac/277Vac/347Vac) power supply.
 - .2 Four 20A rated relays complete with manual override. Circuit Load rating dependent on usage. One circuit dedicated for 20A receptacle control.
 - .3 Four 0-10V control channels, capable of 100mA current sinking
 - .4 A port to connect downstream switches, occupancy sensors and daylight sensors. All downstream devices shall be connected via two #18AWG, non-polarized, non-shielded, non-twisted conductors.
 - .5 A port to connect to an upstream Lighting Control Unit.

- .6 A port to connect upstream to BACnet IP building management system. The Controller shall communicate using native BACnet command objects appropriate for the application.
- .7 An indicating LED to aid in locating the controller in a darkened ceiling space.
- .8 Circuit testing buttons

- .9 Output 24Vac 120mA
- .4 Relay Ratings
 - .1 20A Suitable for General Purpose Loads @ 120/277/247VAC
 - .2 20A Suitable for Standard Ballasts and Tungsten Loads @ 120/277VAC
 - .3 15A Suitable for Standard Ballasts Only @ 347VAC
 - .4 16A Suitable for Electronic Ballasts @ 120/277VAC
 - .5 0.5HP @120/277Vac
 - .6 US & Canada Plenum Rated
- .5 The Room Controller relays shall be connected such that 120Vac plug load(s) and 277Vac/347Vac lighting loads can be switched by a single Controller with no additional add-ons or remote modules
- .6 The Room Controller shall mount to electrical junction box via threaded ½” chase nipple. No other mounting hardware shall be required.

2.3 UL924 RELAY EXPANSION PACK

2.4 RELAY PANELS

- .1 Where indicated on the drawings provide a 2-relay expansion pack consisting of two independently controllable, 20A relays capable of emergency lighting circuit control.
- .2 Expansion pack relays shall force EM lights on when the Room Controller loses power.
- .3 The expansion pack shall connect to the Room Controller. No wires or tools shall be required to add an expansion pack to a Room Controller. The Room Controller will include a means for remote mounting if required.
- .4 Circuit testing buttons

2.5 WALL SWITCH

- .1 Switches shall connect to the lighting control network via a common low voltage, 2-wire, non-polarized data line.
- .2 Switches shall be factory configured and programmed to control one or more outputs in the lighting control system.
- .3 Switches shall be factory configured and included in the Room Controller kit.
- .4 Switches can be programmed for preset control to set a specific lighting scene.

- .5 Switches, with LED indicators to indicate both ON and OFF output/group status, shall be available with 2 or 4 single button switches per gang. Switch to fit standard Decora opening.
- .6 Switches and switch hardware shall mount to standard wall boxes.
- .7 Each switch shall provide a location for a label to identify function. The label shall be under a clear plastic cover and shall be field replaceable should the operation of the switch change. Permanently etched switches are not acceptable.

2.6 DIMMER SWITCHES

- .1 Dimmer switches shall connect to the lighting control network via a common low voltage 2-wire, non-polarized data line.
- .2 Switches shall be capable of raising or lowering light levels of individual or groups of lighting fixtures.
- .3 Switches shall include integral LED indication for light levels as well as a button switch for ON/OFF control.

2.7 CEILING OCCUPANCY SENSORS

- .1 Sensors shall be recessed ceiling occupancy/vacancy sensors.
- .2 Sensing technology shall be Passive Infrared (PIR).
- .3 Sensor shall derive its power and data from the lighting control network via a common low voltage 2-wire, non-polarized data line.
- .4 Ceiling sensors shall be low profile recessed ceiling sensors that mount into the ceiling.
- .5 Ceiling sensor shall not be surface mounted.
- .6 Ceiling sensors shall have an adjustable tilt head to direct sensing to, or away from, particular areas or to allow for installation on sloped ceilings.
- .7 Sensors shall provide an adjustable time out period from 3 seconds up to 40 minutes.
- .8 A Manual Override Switch is to be provided on the sensor to allow the load to be manually switched ON and OFF for the purpose of testing during installation.
- .9 Ceiling sensor shall have an Auxiliary Relay for signaling other systems ON/OFF based on room occupancy status

2.8 PHOTO SENSOR AND DAYLIGHT CONTROL

- .1 Sensor shall be capable of sensing from 0 to 65,000 lux of direct light.
- .2 Sensor shall be capable of closed loop control for Natural Daylight Harvesting.
- .3 Sensor shall derive its power and data for the lighting control network via a common low voltage 2-wire, non-polarized data line.
- .4 Sensor shall continuously monitor the ambient light level (lux).
- .5 Sensor shall broadcast to the Room Controller the existing light level when requested or when there is a change in detected light level.

- .6 Sensor shall be capable of setting light level via on-board commissioning dial.
- .7 One sensor shall permit different outputs to switch and/or control light levels as ambient light changes. Light levels shall be controlled by 'sensor only' or in combination with a with a dimming switch.
- .8 Sensor shall be capable of setting a maximum light level which cannot be exceeded during Natural Daylight operations.

Part 3 Execution

3.1 EXAMINATION

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

3.2 INSTALLATION

- .1 General
 - .1 Products must meet UL and CSA product regulatory requirements.
 - .2 Product must be installed in a controlled environment of between 14°F to 140°F (-10°C to +60°C) and be a stationary, non-vibrating, non-corrosive atmosphere and non-condensing humidity.
- .2 Room controller
 - .1 Installation shall allow for electrical rough to be done before devices arrive on-site.
 - .2 Room Controller shall have a lightweight chassis to allow for the device to be installed with integrated chase directly onto standard 4"x4" square metal junction boxes using existing knockouts with no additional mounting hardware.
 - .3 Chase nipples with locknuts shall be integrated into the chassis for ease of installation with junction boxes.
 - .4 Shall be installed with either rigid metallic conduit or flexible metallic conduit.
- .3 UL924 Relay Expansion Pack
 - 1.1.1. When installing Room Controller with UL924 relay expansion pack, the distance between the ½" chase nipples shall be spaced to fit into two back-to-back 4"x4" square metal junction box knockouts.
 - 1.1.2. Installation shall allow for electrical rough to be done before devices arrive on-site.

1.1.3. Shall have a lightweight chassis to allow for the device to be installed with integrated chase nipples directly onto standard 4"x4" square metal junction boxes using existing knockouts with no additional mounting hardware.

1.1.4. Chase nipples with locknuts shall be integrated into the chassis for ease of installation with junction boxes.

.4 Photocell

.1 Install Lighting Controls daylight sensors as per manufacturer's recommendations for closed loop control of natural daylight harvesting applications.

.2 Adhere to manufacturer's recommendations for location, wiring and programming.

.5 Ceiling Occupancy Sensor

.1 Install Lighting Controls Occupancy/Vacancy Sensors so objects do not block the coverage area. Keep away from HVAC vents and light directly from light fixtures.

.2 Adhere to manufacturer's recommendations for location, wiring and programming.

.6 Low Voltage Wiring

.1 Adhere to manufacturer's recommendations as to maximum wire length.

.2 Power and data for the lighting control network via a common low voltage 2-wire, non-polarized data line.

.7 Line Voltage Wiring

.1 Use #12AWG Section appropriately sized for the branch circuit.

.2 On-device wiring directions shall be included

3.3 FIELD QUALITY CONTROL

.1 On completion of installation, manufacturer representative shall be notified to carry out site inspection and report any inconsistencies to the Departmental Representative. Corrections are to be implemented to comply with manufacturer's report.

3.4 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

3.5 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by network lighting controls installation.

END OF SECTION

PART 1 General

1.1 PRODUCT DATA

- .1 Submit product data in accordance with Section 26 05 00 Common Work Results – Electrical and all applicable Sections.

PART 2 Products

2.1 TRANSFORMERS

- .1 Use transformers of one manufacturer throughout project.
- .2 Design 1.
 - .1 Type: ANN.
 - .2 3 phase, 600 V input, 208/120 V output, 60 Hz, 45 kVA as shown on drawings.
 - .3 Copper windings.
 - .4 Voltage taps: standard 2 ½% full capacity above and below normal.
 - .5 Insulation: Class H, 150°C temperature rise.
 - .6 Basic Impulse Level (BIL): standard
 - .7 Hipot: standard
 - .8 K13 rating
 - .9 Average sound level: 55 db maximum.
 - .10 Impedance at 170°C: 5% up to 150 KVA, 4-5% over 150 KVA.
 - .11 Enclosure: EEMAC 3R, removable metal front panel complete with sprinkler proof hood.
 - .12 Complete with external “anti-vibration pads” and “vibration isolators”.
 - .13 Mounting: floor or wall as required.
 - .14 Finish: in accordance with Section 26 05 01 Common Work Results - Electrical.
- .3 Two winding or T connected transformers are not acceptable.

2.2 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 Common Work Results - Electrical.
- .2 Label size: 7.

2.3 APPROVED MANUFACTURERS

- .1 Approved Manufacturers: Rex, Delta, Cutler Hammer, Square D, Hammond

PART 3 Execution

3.1 INSTALLATION

- .1 Mount dry type transformers in accordance with manufacturer's recommendations.
- .2 Wall-mount dry type transformers up to 75 kVA.
- .3 Ensure adequate clearance around transformer for ventilation as per CEC
- .4 Install transformers in level upright position.
- .5 Remove shipping supports only after transformer is installed and just before putting into service.
- .6 Loosen isolation pad bolts until no compression is visible.
- .7 Make primary and secondary connections in accordance with wiring diagram.
- .8 Energize transformers after installation is complete.
- .9 Mount floor mounted transformers on 100mm concrete housekeeping pads.

END OF SECTION

PART 1 General

I.1 RELATED WORK

- .1 Refer to all sections of the specification for related work.

I.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with 26 05 00 Common Work Results – Electrical.
- .2 Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.
- .3 Provide shop drawing of specific product and clearly select equipment model and number. General catalogues' information is not acceptable.

I.3 OPERATION AND MAINTENANCE DATA

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 26 05 00 Common Work Results – Electrical.

I.4 PLANT ASSEMBLY

- .1 Install circuit breakers in panelboards before shipment.
- .2 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.

PART 2 Products

2.1 PANELBOARDS

- .1 Panelboards: product of one manufacturer throughout project.
- .2 120/208V central distribution panels (CDP) bus and breakers rated “minimum” 22 KA RMS or as required to meet coordination study.
- .3 120/208V branch circuit panelboards bus and breakers rated “minimum” 22 KA RMS or as required.
- .4 Sequence phase bussing such that circuit breakers shall be numbered vertically in consecutive order, with each breaker identified by permanent number identification as to circuit number and phase.

- .5 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as required.
- .6 Two keys for each panelboard and key panelboards alike.
- .7 Copper bus with neutral of same ampere rating as mains.
- .8 Mains: suitable for bolt-on breakers.
- .9 Trim and door finish: baked grey enamel.
- .10 Double tub panels to have tubs bolted together with one common trim.
- .11 Flush or surface-mounted tubs as required.
- .12 Load centres shall not be accepted.
- .13 All surface mounted panelboards shall be sprinklerproof.

2.2 BREAKERS

- .1 Breakers: to Section 26 28 21 Moulded Case Circuit Breakers.
- .2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.

2.3 TRANSIENT VOLTAGE SURGE SUPPRESSION

- .1 Panelboards to be complete with integrally mounted transient voltage surge suppression where indicated.

2.4 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 Common Work Results – Electrical.
- .2 Nameplate for each branch circuit panelboard size 4 engraved to indicate panel designation and voltage.
- .3 Nameplate for each circuit in distribution panelboards size 3 engraved to indicate each respective load.
- .4 Complete circuit directory with typewritten legend showing location and load of each circuit.

2.5 MANUFACTURERS

- .1 Acceptable manufacturers: Cutler Hammer, Schneider, Square D, Siemens.

PART 3 Execution

3.1 INSTALLATION

- .1 Locate panelboards as indicated and mount securely, plumb, true and square to adjoining surfaces.
- .2 Install surface mounted panelboards on plywood painted backboards. Where practical, group panelboards on common backboard.
- .3 Mount panelboards to height specified in Section 26 05 00 Common Work Results – Electrical or as required.
- .4 Connect loads to circuits as indicated.
- .5 Connect neutral conductors to common neutral bus. Common neutrals shall be shared by vertically adjacent breakers. Common neutrals shall be identified with mylar/cloth wire markers showing circuit numbers of the circuits sharing the neutral.

END OF SECTION

Part I General

I.1 RELATED REQUIREMENTS

- .1 This Section covers items common to Sections of Division 26, 27 and 28. These sections supplement requirements of Division I.

I.2 REFERENCES

- .1 CSA International
 - .1 CSA C22.2 No.42-10, General Use Receptacles, Attachment Plugs and Similar Devices.
 - .2 CAN/CSA C22.2 No.42.1-00(R2009), Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).
 - .3 CSA C22.2 No.55-M1986(R2008), Special Use Switches.
 - .4 CSA C22.2 No.111-10, General-Use Snap Switches (Bi-national standard, with UL 20).

I.3 ACTION AND INFORMATIONAL SUBMITTALS

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

I.4 CLOSEOUT SUBMITTALS

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

I.5 DELIVERY, STORAGE AND HANDLING

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

Part 2 Products

2.1 RECEPTACLES

- .1 Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, to: CSA C22.2 No.42 with following features:
 - .1 White urea moulded housing.
 - .2 Suitable for No. 10 AWG for back and side wiring.
 - .3 Break-off links for use as split receptacles.
 - .4 Eight back wired entrances, four side wiring screws.
 - .5 Triple wipe contacts and rivetted grounding contacts.
- .2 Duplex receptacles, NEMA No. 5-20 R, T slot, 125 VAC, U ground, with the following features:
 - .1 Nylon face.
 - .2 Suitable for #10 AWG back and side wiring.
 - .3 Break-off links for use as split receptacles.
 - .4 Double wipe contacts and non-riveted grounding contacts.
 - .5 Aluminum yokes, blades or terminals or with CU/AL rating will not be accepted.
- .3 Single Receptacles, NEMA No. 5-30R, 125V, 30A to CSA 22.2 No. 42 with the following features:
 - .1 Black face
 - .2 Heavy galvanized steel mounting strap for corrosion resistance.
 - .3 Flush mounting within single gang box.
 - .4 Wiring from back or bottom
- .4 Ground fault circuit interrupting receptacle (GFCI), 15A or 20A as indicated 125V, nylon face, feed-thru feature, contrasting colour band on reset button, screw terminals, white-coloured face.
- .5 Other receptacles with ampacity and voltage as indicated.
- .6 Receptacles of one manufacturer throughout project.

2.2 COVER PLATES

- .1 Cover plates for wiring devices to: CSA C22.2 No.42.1.
- .2 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.
- .3 Stainless steel, 1 mm thick cover plates, thickness 2.5 mm for wiring devices mounted in flush-mounted outlet box.
- .4 Cast cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.

2.3 SOURCE QUALITY CONTROL

- .1 Cover plates from one manufacturer throughout project.

Part 3 Execution

3.1 EXAMINATION

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

3.2 INSTALLATION

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

3.3 CLEANING

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

3.4 PROTECTION

- .1 Protect installed products and components from damage during construction.

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

END OF SECTION

PART I General

I.1 RELATED WORK

- .1 Refer to all sections of the specification for related work.

I.2 REFERENCES

- .1 CSA International
 - .1 CSA C22.2 No. 5-[09], Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, and NMX-J-266-ANCE-2010).

I.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section [01 33 00 - Submittal Procedures].
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for circuit breakers and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Include time-current characteristic curves for breakers with interrupting capacity of 22,000 A symmetrical (rms) and over at system voltage with ampacity of 400A and over.
- .4 Certificates:
 - .1 Prior to installation of circuit breakers in either new or existing installation, Contractor must submit 3 copies of a production certificate of origin from the manufacturer. Production certificate of origin must be duly signed by factory and local manufacturer's representative certifying that circuit breakers come from this manufacturer and are new and meet standards and regulations.
 - .1 Production certificate of origin must be submitted to Consultant for approval.
 - .2 Delay in submitting production of certificate of origin will not justify any extension of contract and additional compensation.
 - .3 Any work of manufacturing, assembly or installation to begin only after acceptance of production certificate of origin by Consultant. Unless complying with this requirement, Consultant reserves the right to mandate manufacturer listed on circuit breakers to authenticate new circuit breakers under the contract, and to Contractor's expense.
 - .4 Production certificate of origin must contain:
 - .1 Manufacturer's name and address and person responsible for authentication. Person responsible must sign and date certificate.
 - .2 Licensed dealer's name and address and person of distributor responsible for Contractor's account.

- .3 Contractor's name and address and person responsible for project.
- .4 Local manufacturer's representative name and address. Local manufacturer's representative must sign and date certificate.
- .5 Name and address of building where circuit breakers will be installed.
Include:
 - .1 Project title:
 - .2 List of circuit breakers

1.4 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 26 05 00 - Common Work Results - Electrical

PART 2 Products

2.1 BREAKERS – GENERAL

- .1 Moulded-case circuit breakers, ground-fault circuit-interrupters to CSA C22.2 No. 5
- .2 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation [with temperature compensation for 40 degrees C ambient].
- .3 Plug-in moulded case circuit breakers: quick- make, quick-break type, for manual and automatic operation [with temperature compensation for 40 degrees C ambient].
- .4 Common-trip breakers: with single handle for multi-pole applications.
- .5 Bolt-on moulded case circuit breakers, quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40°C (104°F) ambient.
- .6 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting. Trip settings on breakers with adjustable trips to range from 3-10 times current rating.
- .7 Circuit breakers with interchangeable trips as required.
- .8 To be of same manufacturer as panelboards.

2.2 THERMAL MAGNETIC BREAKERS

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

OPTIONAL FEATURES

- .2 Include, as required:
 - .1 on-off locking devices
 - .2 under-voltage release
 - .3 handle mechanism
 - .4 shunt trip

2.3 MANUFACTURERS

- .1 Acceptable manufacturers: To be compatible with existing panels.

PART 3 Execution

3.1 EXAMINATION

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

3.2 INSTALLATION

- .1 Install circuit breakers according to manufacturer's recommendations.
- .2 Install on-off locking devices for breakers feeding fire alarm panel, security panels, etc.
- .3 Paint fire alarm breaker red.

END OF SECTION

PART 1 General

1.1 RELATED WORK

- .1 Refer to all sections of the specification for related work.

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 26 05 00 Common Work Results - Electrical.

PART 2 Products

2.1 DISCONNECT SWITCHES

- .1 Fusible and non-fusible disconnect switch in EEMAC `3R' enclosure for interior sprinkler proof application, unless otherwise indicated.
- .2 Bus duct plug-in type to match existing.
- .3 Provision for padlocking in on-off position.
- .4 Mechanically interlocked door to prevent opening when handle in ON position.
- .5 Fuses: size as required.
- .6 Fuseholders: suitable without adaptors, for type and size of fuse indicated.
- .7 Quick-make, quick-break action.
- .8 ON-OFF switch position indication on switch enclosure cover.

2.2 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 Common Work Results - Electrical.
- .2 Indicate name of load controlled on size 4 nameplates.

2.3 APPROVED MANUFACTURERS

- .1 Approved manufacturers: Cutler Hammer, Square D, Siemens.

PART 3 Execution

3.1 INSTALLATION

- .1 Install disconnect switches complete with fuses only where specifically indicated.
- .2 Install circuit disconnect switches where indicated or where required by the inspection authorities and/or for equipment supplied by other trades.

END OF SECTION

Part I General

I.1 RELATED REQUIREMENTS

- .1 This Section covers items common to Sections of Division 26, 27 and 28. These sections supplement requirements of Division I.
- .2 REFERENCES
- .3 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE)
 - .1 ANSI/IEEE C62.41-1991, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
- .4 ASTM International Inc.
 - .1 ASTM F1137-00(2006), Standard Specification for Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners.
- .5 Canadian Standards Association (CSA International)
- .6 ICES-005-07, Radio Frequency Lighting Devices.
- .7 Underwriters' Laboratories of Canada (ULC)

I.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Provide complete photometric data prepared by independent testing laboratory for luminaires where specified, for approval by Departmental Representative.
 - .3 Photometric data to include: spacing criterion.
- .3 Quality assurance submittals: provide following in accordance with Section 01 45 00 - Quality Control.
 - .1 Manufacturer's instructions: provide manufacturer's written installation instructions and special handling criteria, installation sequence and cleaning procedures.

I.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Divert unused metal materials from landfill to metal recycling facility.

- .4 Disposal and recycling of fluorescent lamps as per local regulations.
- .5 Disposal of old PCB filled ballasts.

Part 2 Products

2.1 LUMINAIRES

- .1 As specified in the luminaire schedule.

2.2 DRIVERS

- .1 LED Drivers
- .2 Reliable and consistent operation
- .3 High efficiency >90%
- .4 Greater than 0.9 PF and Less than 20% THD
- .5 Greater than 50,000 hrs life time
- .6 5-year limited warranty
- .7 ROHS compliance
- .8 Safety approbations (UL, CSA, CE, ENEC, PSE, SELV or CQC)
- .9 Dimmable and Programmable.
- .10 Designed to meet the needs of LED lighting
- .11 Available in either dedicated input voltage or Intellivolt options
- .12 Dimmable
- .13 The Adjustable Output Current (AOC) feature
- .14 Specific dimmable versions to enable use of lighting controls to help increase energy saving through a wide variety of protocols, such as 0-10V

2.3 FINISHES

- .1 Light fixture finish and construction to meet ULC listing and CSA certification related to intended installation.

2.4 OPTICAL CONTROL DEVICES

- .1 As indicated in luminaire schedule.

2.5 LUMINAIRES

- .1 As indicated in luminaire schedule.

Part 3 Execution

3.1 INSTALLATION

- .1 Locate and install luminaires as indicated.
- .2 Provide adequate support to suit ceiling system.

3.2 WIRING

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

3.3 LUMINAIRE SUPPORTS

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

3.4 LUMINAIRE ALIGNMENT

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

3.5 CLEANING

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

END OF SECTION

Part 1 General

I.1 RELATED REQUIREMENTS

- .1 This Section covers items common to Sections of Division 26, 27 and 28. These sections supplement requirements of Division 1.

I.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.2 No.141-02, Unit Equipment for Emergency Lighting.
 - .2 CSA C860-01(December 2002), Performance of Internally-Lighted Exit Signs.
- .2 National Fire Protection Association (NFPA)
 - .1 NFPA 101-2006, Life Safety Code.

I.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 81 01 - Hazardous Materials.

Part 2 Products

2.1 STANDARD UNITS

- .1 Exit lights: bilingual to CSA C22.2 No.141 and CSA C860.
- .2 Housing: extruded aluminum minimum 1.0 mm thick, satin aluminum enamel finish
- .3 Face/back plates: cast aluminum alloy
- .4 Lamps: LED-5W 347 V 50,000 hours.
- .5 Operation: designed for 50,000 hours of continuous operation without relamping.
- .6 Letters: 150 mm high x 19 mm, with 13 mm thick stroke, white on red glass reading EXIT-SORTIE.
- .7 Face plate to remain captive for relamping.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install exit lights to manufacturer's recommendations, listing requirements, NFPA standard and local regulatory requirements.
- .2 Connect fixtures to exit light circuits.
- .3 Connect emergency lamp sockets to emergency circuits.
- .4 Ensure that exit light circuit breaker is locked in on position.

3.3 CLEANING

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

END OF SECTION