

## PART 1 - GENERAL

### 1.1 GENERAL

- .1 This Section covers items common to Sections of Division 26, 27, 28 and portions of 33. This section supplements requirements of Division 1.
- .2 Refer to Section 01 91 13 for commissioning requirements.

### 1.2 CODES AND STANDARDS

- .1 Do complete installation in accordance with CSA C22.1-2012, and local regulations, except where specified otherwise.
- .2 Do overhead systems in accordance with CAN/CSA-C22.3 No. 1 and underground systems in accordance with CAN/CSA C22.3 No. 7, except where specified otherwise.
- .3 Abbreviations for electrical terms: to CSA Z85-1983.
- .4 Comply with the requirements of the "National Energy Code of Canada for Buildings 2011."
- .5 CAN3 C235-83(R2010).

### 1.3 CARE, OPERATION AND START-UP

- .1 Instruct operating personnel in the operation, care and maintenance of all equipment.
- .2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components.
- .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 all aspects of its care and operation.

### 1.4 VOLTAGE RATINGS

- .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.

### 1.5 PERMITS, FEES AND INSPECTION

- .1 Submit to the Electrical Inspection Department, Municipal Authority and supply authority the necessary number of drawings and specifications, for examination and approval prior to commencement of work. Submit this information within twenty (20) working days of the award of Tender and provide the Departmental Representative with written notice at the time this has been submitted.
- .2 Provide the Departmental Representative with a copy of the electrical Inspection Department and supply Authority Plans Review Report, immediately upon receipt. No shop drawings will be reviewed prior to receipt

of the Plans Review Report from the Contractor.

- .3 Obtain all necessary permits including an Electrical Wiring Permit for electrical work and Communications Cabling Permit for communications cabling work from the authority having jurisdiction, prior to commencement of work. Provide a copy of each permit to the Departmental Representative upon receipt. The permits are to be properly displayed on the work site.
- .4 Upon specific request, the Departmental Representative will provide, to the Contractor, up to a maximum of three (3) copies of the drawings and specifications required for submittal to the Electrical Inspection Department and Supply Authority. These drawings and specifications will be provided to the Contractor at no cost, unless specified otherwise.
- .5 Arrange for all required inspections to be conducted by the authority having jurisdiction. Provide a copy of all inspection reports to the Departmental Representative immediately upon receipt. Notify the Departmental Representative immediately of changes required by the authority having jurisdiction.
- .6 Furnish Certificates of Acceptance from authorities having jurisdiction upon completion of work. Include a copy in the Operation and Maintenance Manual.
- .7 Pay all associated fees, including necessary inspections and inspection department representation occurring outside normal working hours.

#### 1.6 MATERIALS AND EQUIPMENT

- .1 Provide materials and equipment in accordance with the specifications, drawings and all applicable certification organizations.
- .2 Equipment and material to be CSA certified. Where there is no alternative to supplying equipment which is not CSA certified, obtain special approval from the authority having jurisdiction.
- .3 Factory assemble control panels and component assemblies.
- .4 Unless otherwise indicated, the equipment listed on the project equipment schedules and shown on the drawings is the "basis of design equipment", the Contractor may utilize the alternates listed in the project documents or submit alternates for approval to this equipment that meet the technical and quality requirements of the project specifications. If there are necessary changes to any building system to accommodate these alternates, coordinate the changes and provide at no additional cost to the Contract.

#### 1.7 FINISHES

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two (2) coats of finish enamel.
  - .1 Paint outdoor electrical equipment "equipment green" finish to EEMAC Y1-1.
  - .2 Paint indoor switchgear and distribution enclosures light grey to EEMAC 2Y-1.
- .2 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .3 Clean and prime exposed non- galvanized hangers, racks and fastenings to prevent rusting.

**1.8 EQUIPMENT IDENTIFICATION**

.1 Identify electrical equipment with nameplates and labels as specified herein.

.2 Identification:

.1 All switchboards, panels, disconnect switches, receptacles, voice/data, transformers, control panels, fire alarm devices, magnetic starters, TOL's, etc. are to be provided with "lamicoid" nameplates as further described herein. Care is to be taken to ensure that all plates are affixed true and level, and plumb in all instances.

.2 Affix nameplates to all "metal" surfaces with steel type "pop- rivets".

.3 Affix nameplates to other types of surfaces with contact type cement.

.4 Affix nameplates to building "exterior" surfaces with nylon inserts and self-tapping screws unless specifically indicated otherwise.

.5 Apply contact type cement to complete rear side of plate, as opposed to several locations or areas on same.

.6 Lamicoid nameplates installed on distribution panelboards, splitter troughs and transformers must indicate the following:

.1 Designated name of equipment.

.2 Amperage of overcurrent protection device.

.3 Voltages, number of phases and wires.

.4 Designation of power source.

Example

PANEL H - 150 AMPS

120/208V - 3PH - 4W

FED FROM MAIN SWITCHBOARD #QMS-1

.7 Lamicoid nameplates installed on combination starters, magnetic starters, manual starter and all various systems controls, control panels, disconnect switches, etc., must contain the following information:

.1 Designated name of equipment.

.2 Designated name of power source.

.3 Branch circuit breaker number(s) where possible.

.4 Voltage(s).

EXHAUST FAN NO. 5

PANEL H - CCT. NO. 17

120V - PH

SUPPLY FAN NO. 3

M.C.C. NO. 1

600V - 3 PH

.8 Lamicoid nameplates installed on fusible type disconnect switches are to also indicate maximum designated/designed fuse size.

.9 Install lamicoid nameplates on all junction and/or pull boxes sized 150 mm x 150 mm and larger indicating name of system, designated panel name and electrical characteristics where applicable.

.10 Install lamicoid nameplates adjacent to each overcurrent devices located in switchboards, CDP panels, etc. They need only indicate designated name and/or number of equipment they feed. Unused O.C. devices are to be identified as spare(s).

.11 Lamicoid nameplates installed on "main" service entrance switches, or "main" entrance switchboards to indicate the following information on minimum size 150 mm x 50 mm plate complete with two lines of 13 mm high lettering (Size #8 nameplate):

Example:

MAIN BREAKER 800 AMPS

346/600V, 3PH, 4W

Example:

MAIN SWITCH 200 AMPS

120/208V, 3PH, 4W

.12 Install an additional "lamicoid" nameplate on all, or any piece of electrical equipment, or apparatus (i.e., Main Switchboard, CDP panels, Panelboards, etc.), that may contain overcurrent devices (i.e., circuit breakers and/or fuses), that have been designed for, and incorporate interrupting capacity sized "larger" than 10 KAIC.

Example:

Min, interrupting capacity of breakers  
installed in this panel to be not less  
than 22 KAIC

Example:

Min. interrupting capacity of fuses  
installed in this MCC to be not less  
than 100 KAIC

.13 Install lamicoïd nameplates above all types of receptacles and abutted directly to tops of their respective device plates. Identification is to indicate respective panel source complete with associated circuit breaker number(s) as per the following:

.1 1.5mm x 13mm high complete with 6 mm white letters on black face, directly above all receptacles. Plate to be identical width as finish device plate.

Example: PANEL H - 20

.14 Identify lamicoïd nameplates above 120V receptacles protected by GFCI circuit breakers, or GFCI type receptacles as per the following:

.1 1.5mm thick x 19mm wide complete with 6 mm white letters on black face above all receptacles. Identical width as finish device plate (EXAMPLE: GFCI Protected Panel H-26).

.15 Apply lamicoïd nameplate(s) for power/voice/data outlets above face of finish plate, complete with information as specified in section 27 05 13.

.1 1.5mm thick x 19mm wide complete with 6mm white letters on black face above all receptacles. Identical width as finish device plate.

.16 All addressable fire alarm devices are to be lamicoïd identified.

.1 Lamicoïd identification is to be chain hung on mechanical items (pressure switches, supervisory switches, etc.).

.2 Manual pull station lamicoïd plate to be similar to typical receptacle lamicoïd plate.

.3 Lamicoïd wording to match physical location and annunciator display address.

.17 Lamicoïd 3mm thick plastic engraving sheet, white letters on black face, for all electrical systems except fire alarm which shall have red face with white letters.

.1 1.5mm thick nameplates above receptacles as previously indicated, with top left and right corners to be rounded off.

.2 Lettering on lamicoïd nameplates are not to "start", nor "end" nearer than 13mm from either, or both ends of said plates. Size of lettering, including overall lengths of various plates shall be as indicated in the following chart.

NAMEPLATE SIZES

Size 1	9mm x 50mm	1 line	5mm high letters
Size 2	13mm x 70mm	1 line	6mm high letters
Size 3	16mm x 75mm	2 lines	5mm high letters
Size 4	19mm x 90mm	1 line	9mm high letters
Size 5	6mm x 90mm	2 lines	13mm high letters
Size 6	25mm x 100mm	1 line	13mm high letters
Size 7	25mm x 100mm	2 lines	6mm high letters
Size 8	50mm x 150mm	2 lines	13mm high letters

- .3 Wording on nameplates and labels to be approved by Departmental Representative prior to manufacture.
- .4 Allow for average of forty (40) letters per nameplate and label.
- .5 Identification to be English.
- .6 Provide lamicoid nameplates installed on, or adjacent to, all various systems' control panels and/or cabinets complete with information as indicated. Nameplates to reflect individual system's assigned name, and where applicable, shall also indicate both designated panel name and associated branch circuit breaker number(s).
  - .1 Fire alarm panels
  - .2 Security panels
  - .3 Energy management panels
  - .4 Communication panels
- .7 Control Transformers:
  - .1 Concealed control transformers located within ceiling spaces are to have lamicoid nameplates installed adjacent to same indicating their identified system, primary power source including designated panel name, complete with associated branch circuit breaker number(s).
  - .2 Install a second plate with identical information on underside of room grid system or access opening frame directly below control transformer, so as to identify its concealed location directly above same.
  - .3 Identify all control transformers installed in either control cabinets or on walls adjacent to same, with lamicoid nameplates containing information as previously indicated.
- .8 Junction and pull boxes: indicate system and voltage.
- .9 Co-ordinate names of equipment and systems with other trades to ensure that equipment identification is consistent.
- .10 In addition to required nameplates and colour coding, junction boxes to have the panel and circuit numbers of all wiring contained within listed on the coverplate. Neatly write list using black indelible marker.
- .11 Colour code all electrical junction boxes, pull boxes and conduit fittings as follows:
  - .1 Apply colour coding prior to installation of boxes/equipment.
  - .2 Where primary colour only is indicated:
    - .1 Colour inside and outside of box.
    - .2 Colour all cover plates.
  - .3 Where primary and secondary colours are indicated:
    - .1 Paint inside and outside of box with the primary colour.
    - .2 Diagonally apply to each half of the cover plate the primary and secondary colours.
- .12 Where a lamicoid identified item is installed above an accessible ceiling, provide two (2) lamicoid plates, one (1) at the item location and one (1) directly below on the underside of the ceiling.

#### 1.9 WIRING IDENTIFICATION

- .1 Identify wiring with self-laminating, permanently mechanically imprinted labels on both ends of each conductor and cable utilized. Identify conductors and cables in each junction or pull box through which they pass. Install labels in a "flagged" manner around individual conductors.
- .2 Maintain phase sequence and colour coding throughout.
- .3 All conductors are to have their insulation colors identified as follows:
  - .1 Phase A - Red

- .2 Phase B - Black
  - .3 Phase C - Blue
  - .4 Neutral - White
  - .5 Bond - Green
  - .6 Ground - Green
- .4 Color coded "Conductor Insulation" as per the following:
- .1 All sizes of phase conductors up to and including #2AWG.
  - .2 All sizes of neutral, bond and/or ground conductors up to and including #3/0AWG.
  - .3 Approved colored tapes in lieu of insulation coloring may be used to identify conductors that exceed sizes as previously indicated. Labelling is to take place at both ends of all runs at a minimum of 300mm from terminations, in addition to within all boxes between both ends of the run.
- .5 Use colour coded wires in communication cables, matched throughout system.
- .6 Indicate panel and circuit number of all phase conductors i.e.: "Panel "A" - cct 3". Identify all neutral conductors bonding and ground conductors to indicate the phase conductor with which they are associated.

1.10 CONDUIT AND CABLE IDENTIFICATION

- .1 Colour code conduits, boxes and metallic sheathed cables. Colour boxes inside and outside where one colour is required. Colour boxes on inside only where two colours are required. Metal cover plates are to have both colours applied diagonally where two colours are required. Paint entire cover plate where one colour is required.
- .2 Code with paint at points where conduit or cable enters wall, ceiling, or floor, and at 15m intervals.
- .3 Colours: 25mm wide prime colour and 19mm wide auxiliary colour.

<u>System</u>	<u>Primary Colour</u>	<u>Secondary Colour</u>
0-50 volts	VIOLET	-
51 to 240 volts	YELLOW	-
241-600volts	ORANGE	-
Fire alarm	RED	-
Telephone (Voice only)	BLACK	-
Public Address and Intercom	BLUE	-
Ground or Bond	BROWN	-
Security	BRIGHT GREEN	-
Mech. Controls	RED	WHITE
Computer (data only)	BLACK	WHITE
Voice and Data	BLUE	WHITE

- .4 Identify the location of various system junction and/or pull boxes etc., where located above ceiling grid system, on underside or room side of t- bar spline, with (19mm) or (6mm on 19mm) self adhering colour coded circular shaped discs, affixed directly to spline in close proximity to where concealed box is located. Install the same type of discs on ceiling or wall access cover plates. 6mm discs are all white in colour. Affix 6mm to center or middle of of 19mm discs as system colours indicates.

<u>Various Systems</u>	<u>19mm Discs</u>	<u>6mm Discs</u>
0 to 50 volts	VIOLET	
51 to 240 volts	YELLOW	
241 to 600 volts	ORANGE	
Fire Alarm	RED	
Telephone (voice only)	BLACK	
P.A. and Intercom	BLUE	
Security	BROWN	
Ground or Bond	GREEN	
Energy Management	RED	WHITE
Computer (data only)	BLACK	WHITE
Voice and Data	BLUE	WHITE
Other		WHITE

- .5 Provide a legend of colour coding, mounted under plexiglass cover. Install in main electrical room.
- .6 Where boxes are not concealed, disks are to be fastened directly to outside of boxes after architectural painting is complete. Coverplates for such boxes are to have each branch circuit number neatly identified inside of the coverplate.

1.11 WIRING TERMINATIONS

- .1 Lugs, terminals, screws used for termination of wiring to be suitable for either copper or aluminum conductors.
- .2 Label all branch circuit wiring including phase conductors, neutral, ground and/or bonding conductors to be done on both ends of all circuit wires plus in any junction and pull boxes located between ends. Use write-on self-laminating labels. Wrap around conductor in a "U" fashion.

1.12 MANUFACTURERS AND CSA LABELS

- .1 Visible and legible after equipment is installed.

1.13 WARNING SIGNS

- .1 As specified and to meet requirements of Electrical Inspection Department and Departmental Representative.
- .2 Porcelain enamel decal signs, minimum size 170mm x 250mm.

1.14 SINGLE LINE ELECTRICAL DIAGRAMS

- .1 Provide single line electrical diagrams under plexiglass as follows:
  - .1 Electrical distribution system: locate in main electrical room.
  - .2 Include a legend of colour coding for the various systems identified in item 10-conduit and cable identification.
- .2 Drawings: Full drawing size in main electrical room and 610mm x 610mm (minimum) size drawing in penthouse.

- .3 Provide 610 x 610mm size drawings indicating riser diagrams for the following systems:
  - .1 Communications
  - .2 Fire Alarm
  - .3 Security
  - .4 Public Address
  - .5 Personal Protection Alarm (PPA)

#### 1.15 LOCATION OF EQUIPMENT

- .1 Do not install outlets back-to-back in wall; allow minimum 150mm horizontal clearance between boxes. Do not install boxes back to back in the same stud space.
- .2 Change location of equipment at no extra cost or credit, providing distance does not exceed 3m, and information is given before installation.
- .3 Locate light switches on latch side of doors. Locate disconnect devices in mechanical rooms on latch side of doors.

#### 1.16 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 Mounting heights for devices to conform with NBCC and NS Building Code regulations for Barrier Free design.
- .4 Install electrical equipment at following heights unless otherwise indicated.
  - .1 Local switches: 1200mm
  - .2 Wall receptacles:
    - .1 General: 450mm
    - .2 Above top of continuous baseboard heater: 200mm, minimum 450mm AFF.
    - .3 Above top of counters or counter backsplash: 200mm
    - .4 In mechanical rooms: 1200mm
  - .3 Panelboards: as required by Code or as indicated.
  - .4 Wall mounted telephone and data outlets:
    - .1 General: 450mm
    - .2 Above top of continuous baseboard heater: 200mm, minimum 450mm AFF.
    - .3 Above top of counters or counter backsplash: 150mm
    - .4 In mechanical rooms: 1200mm
  - .5 Fire alarm stations: 1200mm
  - .6 Fire alarm signals: 2300mm
  - .7 Wall mounted exit signs and Emergency Lights: 2300
  - .8 Access Control Card Readers: 1200mm
  - .9 Wall mounted door intercom stations: 1500mm
  - .9 Fire alarm panel: LCD display at 1500mm

#### 1.17 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 Submit, at completion of Work, report listing phase and neutral currents on panelboards, dry-core transformers, operating under normal load. State hour and date on which each load was measured, and voltage at time of test.

#### 1.18 CONDUIT AND CABLE INSTALLATION

- .1 Install conduit and sleeves prior to pouring of concrete.
- .2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
- .3 Arrange and pay for holes through exterior walls and roof to be flashed and made weatherproof.

#### 1.19 FIRESTOPPING

- .1 Provide firestopping and smoke sealing of all cable, cabletrough or conduit penetrations through fire resistant separations as specified in Section 07 84 00.

#### 1.20 FIELD QUALITY CONTROL

- .1 Conduct and pay for following tests:
  - .1 Circuits originating from branch distribution panels.
  - .2 Lighting and its control.
  - .3 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
  - .4 Systems: fire alarm system, security/access control system, video intercom system, cctv system, digital metering system and personal protection alarm system.
- .2 Furnish manufacturer's certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions.
- .3 Insulation resistance testing.
  - .1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
  - .2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
  - .3 Check resistance to ground before energizing.
- .4 Carry out tests in presence of Departmental Representative.
- .5 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .6 Submit typed test results for Departmental Representative's review and inclusion in the Operation and Maintenance Manual.

#### 1.21 COORDINATION OF PROTECTIVE DEVICES

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

1.22 DEMONSTRATION, OPERATING AND MAINTENANCE INSTRUCTIONS

- .1 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, troubleshooting and servicing all systems and equipment, during regular work hours, prior to acceptance.
- .2 Use as-built drawings, operation and maintenance manual, audio visual aids, etc. as part of instruction materials.
- .3 Allow for a minimum of two (2) eight hour working days to provide instruction and demonstration. This is in addition to training specified elsewhere.

1.23 WASTE MANAGEMENT AND DISPOSAL

- .1 Collect, separate and recycle all site generated waste materials in accordance with Section 01 74 22 - Construction Waste Management.

PART 2 - PRODUCTS                      Not applicable.

PART 3 - EXECUTION                      Not applicable.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 REFERENCES

- .1 CSA C22.2 No. 65-2013, Wire Connectors.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- .1 Pressure type wire connectors with current carrying parts of copper sized to fit copper conductors as required. Provide for all panels including main switch board and main transformer.
- .2 Spring type pressure wire connectors: with current carrying parts of copper and copper alloy sized to fit copper conductors 10 AWG or less. Connectors to be complete with appropriate size insulating cap.
- .3 Clamps or connectors for armoured cable, liquid tight flexible metal conduit.
- .4 Bushing stud connectors are not acceptable.

## PART 3 - EXECUTION

### 3.1 MATERIALS

- .1 Make all connections and terminations electrically and mechanically secure. Sizes of connectors shall be as per manufacturer's recommendations for various sizes and combinations of wire sizes.
- .2 Make all joints required in branch wiring #10 and smaller utilizing spring type pressure wire connectors. Wire connectors are to be plier tightened. Cap is to completely fit or cover all enclosed conductors as required.
- .3 Make joints for all other wiring utilizing colour keyed compression type connectors complete with compression tools. A first layer of compound type tape is followed by an additional layer of vinyl tape. Approved alternative for wire connections up to, and including #6 may be colour coded wing-nut.

**END OF SECTION**

PART 1 - GENERAL

1.1 REFERENCES

- .1 CSA C22.2 No. 0.3-2009, Test Methods for Electrical Wires and Cables.
- .2 CSA C22.2 No. 208-03(R2013), Fire Alarm and Signal Cable.

1.2 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00.

1.3 OPERATION AND MAINTENANCE DATA

- .1 Submit operation and maintenance data for incorporation into manual specified in Section 01 78 00.

1.4 RELATED WORK

- .1 Electrical General Requirements: Section 26 05 00.

PART 2 - PRODUCTS

2.1 BUILDING WIRES

- .1 Conductors: to be soft drawn copper of 98% conductivity; stranded for 12 AWG and larger. Minimum size: 12 AWG.
- .2 Copper conductors sized as indicated or as required by C.E.C., with 600 V insulation of chemically cross-linked thermosetting polyethylene material rated RW90-XLPE.
- .3 Grounding and bonding conductors sized up to and including #10 AWG are to have green coloured RW90 cross linked insulation. Type TW75 green coloured insulation is acceptable for sizes #8 AWG and larger.

2.2 ARMOURED CABLES

- .1 Conductors: insulated, copper, size as indicated, minimum #12 AWG.
- .2 Type: AC90.
- .3 Armour: interlocking type fabricated from aluminum strip.
- .4 Connectors: designed for cable.
- .5 Cable ties to Section 26 05 29 - Fastening and Supports.
  - .1 6mm dia threaded rods to support suspended channels.

### 2.3 CONTROL CABLES

- .1 Type LVT: two (2) soft annealed copper conductors, sized as indicated, with thermoplastic insulation, outer covering of thermoplastic jacket.
- .2 Control circuit wiring 50V and less: CAT 6 with black jacket. FT6 rated.

### 2.4 SECURITY SYSTEM CABLING

- .1 FT6 rated.
- .2 Insulated copper conductors, size and type as indicated or required by manufacturer.
- .3 Bright Green coloured PVC outer jacket.

### 2.5 FIRE ALARM SYSTEM CABLING

- .1 Type FAS 105 to CSA C22.2 No. 208, PVC insulation size and quantity of conductors as per manufacturer's requirements. Red PVC outer jacket.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF BUILDING WIRES

- .1 Install wiring as follows:
  - .1 In conduit systems in accordance with Section 26 05 34.

### 3.2 INSTALLATION OF FIRE ALARM CABLES

- .1 Install fire alarm cables in EMT.
- .2 Fire alarm cabling will be permitted to be installed in flexible metal conduit for final connection to various fire alarm devices installed upon flush mounted outlet boxes in finished ceiling tiles and to sprinkler devices. Liquid-tight flexible metal conduit is not exceed 5m in total length. Minimum size 12mm.

### 3.3 INSTALLATION OF ARMOURED CABLES

- .1 A home run is defined as that portion of the branch circuit wiring that runs between the applicable panelboard and the area or room in which it either:
  - .1 terminates at the applicable branch circuit device, or
  - .2 makes a splice for final connection to the applicable branch circuit device.
- .2 AC-90 will only be permitted for branch circuit wiring drops from ceiling junction boxes to light fixtures installed in fully exposed or concealed ceiling spaces, within the same room requiring electrical power. The installation of AC-90 cable for branch circuit wiring home runs or runs between rooms or in areas with linear metal panel ceilings is not acceptable.
- .3 The grouping together of AC-90 cables to form a "bundle" for securing purposes is acceptable provided:
  - .1 In addition to securing AC- 90 cables at 1.5m (60") intervals to structure, multiple or bundled groups

- of armoured cables shall be tye-wrapped together at mid-point between each structure support and are to be secured to structure at 1.5m (60") intervals, and also secured together between each structure support at 1.5m (60") intervals.
- .2 Limit grouping of AC-90 cables to a maximum of eight (8) current carrying conductors, including associated oversized neutrals, where phase sharing occurs.
- .4 Install concealed, parallel and perpendicular to building lines and shall be adequately secured to the building structure at not less than 1.5m (60") intervals in such a manner as to ensure they are protected from potential types of mechanical damage occurring. Install independent supports for cabling in ceiling spaces, and do not use those of other trades. Do not secure cables to mechanical piping systems, ducts or suspended ceiling support wires. The laying of un-supported cables directly atop the ceiling grid system is strictly prohibited.
- .5 Always install and secure surface cables directly to the underside of ceiling slabs or metal decking where located in concealed ceiling spaces.
- .6 The following examples incorporate uses of both common and dedicate branch circuit neutral conductors:
- .1 Maximum of two (2) runs of #12/4 conductor cables including common (oversized) branch circuit neutrals in each.
- .2 Maximum of two (2) runs of #12/3 conductor cables, including oversized branch circuit neutrals (if net 3 phase 3 wire) plus one (1) run of #12/2 cable.
- .3 Maximum of four (4) runs of #12/2 conductor cables, each including a separate, dedicated branch circuit neutral conductor.
- .7 Where dedicated or separate branch circuit neutral conductors are non phase sharing they need not be sized larger than phase conductors they are accompanying unless specifically indicated otherwise.
- .8 Originate all AC-90 fixture feeds from the sides of outlet boxes and not from the box cover. Where three (3) and/or four (4) fixture drops extend from any one outlet box, the box must not be sized smaller than 4-11/16" square.
- .9 Fixture drop is defined as that portion of AC-90 cable or flexible conduit being used to make final connection between accessible type junction or outlet box located in concealed or exposed ceiling space and its respective light fixture.
- .1 Fixture drops are not to exceed 5m (15') in total length unless specifically indicated otherwise.
- .2 There shall be not more than four (4) drops permitted to be fed from any one box regardless of its size. All AC-90 cables used for fixture drops are to be secured within 300mm (12") of the junction box. Each light fixture is to be complete with its own separate fixture drop originating from junction box located in the same room as the fixture. An exception shall be made for recessed down lights which may be wired from one fixture to another if they have integral junction boxes and the luminaire access opening is 150mm (6") or greater in diameter.
- .3 Wire each light fixture with a separate "whip" emanating from an overhead junction box.
- .4 Both #12 AWG and #14 AWG type AC-90 armoured cables may be used where the total fixture drop loads do not exceed the following:
- .1 5000W @347V, #12AWG
- .2 3500W @347V, #14AWG
- .3 1800W @120V, #12AWG
- .4 1300W @120V, #14AWG
- .10 Separate pig-tail type leads shall be provided in each light fixture junction/outlet box for final connection to fixture drops. These pig-tails are to be only connected to light fixture returns and associated neutral conductors.

### 3.4 INSTALLATION OF CONTROL CABLES

- .1 Install control cables. Complete with bonding conductor, minimum 21mm conduit and #14AWG bonding conductor.
- .2 Bond control cable shield where required.
- .3 Building management system controls wiring methods to be installed in accordance with Section 27 05 28 and 27 05 13 (per voice and data structured cabling).

### 3.5 INSTALLATION OF CABLES: GENERAL

- .1 Support cables independently of supports used for equipment of other trades; do not support from or secure cables to ductwork, piping and ceiling hanger wires.
- .2 Do not lay cables on top of suspended ceiling grids and tiles.
- .3 Install cables in a neat and professional manner, so as to conserve headroom. Correct any unacceptable work at no additional cost to the Contract.
- .4 Install cables parallel and perpendicular to building lines.
- .5 Secure cables to underside of metal decking.
- .6 Make the tie-wrapping of the neutral conductor with its respective phase conductors at the closest point of entry within all panelboards, pull boxes, junction boxes and outlet boxes, etc.
- .7 All branch circuits which do not have neutral conductors are to have their respective phase conductors type-wrapped together in accordance with Clause 3.5.6 above.
- .8 Twist together all stranded conductors prior to any types of terminations taking place, but not necessarily limited to: receptacles, light switches, neutral terminal strips, bonding terminal strips, circuit breakers, disconnect switches, starters, contactors, relays, all types of termination lugs, panelboards, etc.

### 3.6 INSTALLATION OF SECURITY, ACCESS CONTROL AND CCTV SYSTEM CABLING

- .1 Install all security, CCTV, personal protection alarm and public address system wiring in dedicated conduit in its entirety unless noted otherwise.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 RELATED WORK

- .1 Wires and Cables 0-1000V: Section 26 05 21

### 1.2 REFERENCES

- .1 IEEE 837-2002, Qualifying Permanent Connections Used in Substation Grounding.
- .2 CSA C22.2 No. 41-2007(R2013), Grounding Equipment.

## PART 2 - PRODUCTS

### 2.1 EQUIPMENT

- .1 Clamps for grounding of conductor: size as required and suitable for application.
- .2 Rod electrodes: copper clad steel 19mm dia by 3m long.
- .3 Direct buried grounding conductors: bare stranded copper of 98% conductivity, soft annealed, size as indicated.
- .4 Insulated grounding and bonding conductors: soft drawn stranded copper of 98% conductivity, type RW90 (green coloured insulation as indicated in 26 05 00, item 10 - Wiring Identification).
- .5 Ground bus: copper, minimum size 6mm x 75mm x 600m size and as indicated, complete with insulated supports, fastenings, connectors.
- .6 Ground connections to take place on the ground bus to be as follows:
  - .1 For wire sizes 6 AWG and smaller: copper, one-hole, short barrel (single crimp) lugs.
  - .2 Wire larger than 6 AWG to be two-hole, long barrel (dual crimp) lugs.
- .7 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.
- .8 Copper compression type, long barrel, two hole type lugs unless specified otherwise.
- .9 Copper compression type connectors (cable to cable, cable to ground rod, etc.).

### 2.2 MANUFACTURERS

- .1 Acceptable manufacturers: FCI- Burndy Corporation, Erico Inc., Thomas & Betts, IlSCO.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION GENERAL

- .1 Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories. Conform to the requirements of the Departmental Representative, applicable codes and the local electrical inspection authority having jurisdiction.
- .2 Install connectors in accordance with manufacturer's instructions.
- .3 Protect exposed grounding and bonding conductors from mechanical injury.
- .4 Make buried connections, and connections to electrodes using inspectable copper crimp type compression connectors.
- .5 Use mechanical connectors for grounding and bonding connections to equipment provided with lugs.
- .6 Soldered joints not permitted.
- .7 Install insulated bonding conductor in all conduits.
- .8 Install separate insulated bonding conductor to outdoor lighting standards.
- .9 Connect building structural steel to ground as indicated on the drawings.
- .10 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.
- .11 Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at load end.
- .12 Ground secondary service pedestals.
- .13 The 'feed' bonding conductor shall be secured (wrapped around unbroken) to the grounding screw of each outlet/device box, before connecting to the other grounding conductors and/or providing a "pig-tail" lead for device terminations.
- .14 Twist together all ground/bond wires with a screw-on type wire connector, and then placed in the rear of the outlet box.
- .15 Bond all conduits containing insulated ground conductor(s) at both ends.
- .16 Bend radius of all grounding/bonding conductors to a minimum of 200mm diameter.

#### 3.2 ELECTRODES

- .1 Install rod electrodes and make grounding connections.
- .2 Bond separate, multiple electrodes together.
- .3 Make special provision for installing electrodes that will give acceptable resistance to ground value where rock or sand terrain prevails. Ground as indicated.

**3.3 SYSTEM AND CIRCUIT GROUNDING**

- .1 Install system and circuit grounding connections to neutral of secondary systems.
- .2 The main incoming ground conductor is to run unbroken to the main electrical service entrance overcurrent device ground bus and then to the wall mounted ground bus.

**3.4 EQUIPMENT GROUNDING**

- .1 Install grounding/bonding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, transformers, duct systems, frames of motors, starters, control panels, building steel work, distribution panels, outdoor lighting, metallic waste water piping systems, metallic rain water leader systems, metallic gas fuel piping systems.

**3.5 GROUNDING BUS**

- .1 Install copper grounding bus mounted on insulated supports in electrical and telecommunications rooms.
- .2 Ground items of electrical equipment to ground bus as indicated herein and on the Drawings.

**3.6 COMMUNICATION SYSTEMS**

- .1 Telecommunications: provide grounding and bonding in accordance with BICSI Telecommunications Distribution Methods Manual (TDMM), 12th Edition.

**3.7 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Electrical General Requirements.
- .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 Where applicable, disconnect ground fault indicator during tests.

**END OF SECTION**

PART 1 - GENERAL

Not applicable.

PART 2 - PRODUCTS

2.1 SUPPORT CHANNELS

- .1 U shape, size 40mm x 40mm, hot-dipped galvanized steel, surface mounted, suspended or set in poured concrete walls and ceilings unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Secure equipment to solid masonry, tile and plaster surfaces with lead anchors or nylon shields.
- .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. Provide additional supports as necessary.
- .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 within 1m of each outlet box, junction box, pull box, cabinet or conduit fittings with spacing between supports as per CEC to building construction or support system using straps.
  - .1 One-hole zinc plated steel straps to secure surface conduits and cables smaller than 41mm.
  - .2 Two-hole zinc plated steel straps for conduits and cables 41mm and larger.
  - .3 Beam clamps to secure conduit to exposed steel work.
- .7 Suspended support systems.
  - .1 Support individual cable or conduit runs with 9mm dia threaded rods and spring clips.
  - .2 Support two (2) or more cables or conduits on channels supported by 9mm dia threaded rod hangers where direct fastening to building construction is impractical.
- .8 For surface mounting of two or more conduits use channels at 1.5m oc spacing.
- .9 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .10 Verify there is 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.
- .13 Install fastenings and supports as required for each type of equipment, cables and conduits, and in

accordance with manufacturer's installation recommendations.

- .14 Fasten individual and multiple runs of armoured cables to structure and in bundles as permitted in 26 05 21 - Wire and Cables 0-1000 Volts.
- .15 Various suspended types of junction, pull and/or outlet boxes as well as conduits, are to be supported with minimum size 9mm threaded rod, nuts and flat washers. Threaded rods to be secured to boxes with one flat washer and nut installed on both sides of box.
  - .1 One (1) rod required for all type boxes sized 150mm x 150mm and smaller (22,500mm<sup>2</sup> and smaller).
  - .2 Two (2) rods required for boxes sized 22,500mm<sup>2</sup> and larger, up to and including those sized 300mm x 300mm (90,000mm<sup>2</sup>).
  - .3 Minimum of four (4) rods required for all boxes sized larger than 90,000mm<sup>2</sup>.
- .16 Cut off all excess rod within 13mm of channel bottom. In addition to C.E.C. minimum conduit spacing requirements, all suspended conduit runs containing horizontal or vertical elbows are to have one additional support rod installed not greater than 300mm and mid point of "all" 90 bends. Maximum spacings between conduit support channels will be as dictated by smallest size conduit(s) being supported and/or secured to same.
- .17 In addition to the CEC minimum conduit spacing requirements, all suspended conduit runs containing horizontal or vertical elbows are to have one (1) additional support rod installed not greater than 300mm from midpoint of all 90 bends. Maximum spacing between conduit support channels will be dictated by smallest size conduit(s) being supported and/or secured to same.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data for cabinets in accordance with Section 01 33 00.

## PART 2 - PRODUCTS

### 2.1 SPLITTERS

- .1 Sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position. Interior units shall be CSA Type 1 enclosure.
- .2 Exterior units shall be CSA Type 4X, 304 or 316 stainless steel.
- .3 Main and branch lugs or Connection bars to match required size and number of incoming and outgoing conductors as indicated.
- .4 At least three spare terminals on each set of lugs in splitters.

### 2.2 JUNCTION AND PULL BOXES

- .1 Type C: welded steel construction, hinged cover, catch with hasp. Provision for locking. Surface mounting.
- .2 Type D: welded steel construction with screw-on flat covers for surface mounting. Surface or flush mounting as indicated. Covers with 25mm minimum extension all around, for flush-mounted pull and junction boxes.
- .3 Junction and pull boxes larger than 125mm x 125mm shall be Type "E", complete with continuously hinged door. Junction and pull boxes 125mm x 125mm and smaller to be complete with screw cover.
- .4 Single gang "sectional" type devices boxes being used in steel stud walls for the installation of both metallic and non-metallic type cables, not to be sized smaller than 250mm, complete with wrap around type bracket.
- .5 Two (2) or more flush installed sectional boxes, ganged together on boxes sized 100mm<sup>2</sup> and larger (intended for devices), are to have an additional support bracket installed on opposite side of box, not presently secured to metal stud.
- .6 Where larger sized devices or other types of "flush" outlet or junction boxes may be required, use suitably sized 100mm x 100mm (4x4") deep or 118 mm (4-11/16") square boxes complete with appropriate sized extension tile rings. The use of plaster rings in lieu of tile type extension rings is not acceptable.
- .7 Junction boxes 150mm x 150mm (6"x6") used in branch circuit wiring are to be complete with bonding terminal strips.
- .8 Junction and conduit boxes for the sewage lift station shall be rated for the hazardous area classification noted on the drawings. Boxes shall be dye-cast copper-free aluminum with factory threaded hubs. Provide terminal blocks (rated minimum 30A, 600V) in junction boxes used to connect cabling from devices (pumps and floats) located in the wet well.

### 2.3 CABINETS

- .1 Type E: sheet steel, hinged screw- to-lock, door and return flange overlapping sides, handle, and catch, for surface mounting.

### PART 3 - EXECUTION

#### 3.1 SPLITTER INSTALLATION

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

#### 3.2 JUNCTION, PULL BOXES AND CABINETS INSTALLATION

- .1 Install pull boxes in inconspicuous but accessible locations.
- .2 Mount cabinets with top not higher than 2m above finished floor.
- .3 Only main junction and pull boxes are indicated. Install pull boxes so as not to exceed 30m of conduit run between pull boxes.
- .4 Where located above accessible ceiling systems, locate enclosures within 750mm (30") of ceiling.
- .5 Suspend enclosures on 9mm plated steel threaded rod or rods secured to enclosure with one flat washer and one nut on both sides of box.
- .6 Provide number of threaded rod supports as follows:
  - .1 Boxes up to 120mm square: one (1) rod.
  - .2 Boxes from 120mm to 200mm square: two (2) rods.
  - .3 Boxes with dimensions above 200mm: four (4) rods.
- .7 Concealed junction or outlet boxes feeding a maximum of two fixture drops shall not be sized smaller than 100mm<sup>2</sup>.
- .8 Bond pull boxes and cabinets to ground utilizing a bonding conductor.

#### 3.3 IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00.
- .2 Identify the location of concealed boxes installed above drywall ceilings or behind walls on the room side of access opening frames with properly colour coded identification disks.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 REFERENCES

- .1 CSA C22.1-2012, Canadian Electrical Code, Part 1.

## PART 2 - PRODUCTS

### 2.1 OUTLET AND CONDUIT BOXES GENERAL

- .1 Size boxes in accordance with CSA C22.1.
- .2 100 mm square or larger outlet boxes as required for all devices.
- .3 Gang boxes where wiring devices are grouped.
- .4 Blank cover plates for boxes without wiring devices.

### 2.2 SHEET STEEL OUTLET BOXES

- .1 Electro-galvanized steel flush device boxes for flush installation, minimum size 100mm square and c/w extension and tile rings as required.
- .2 Electro-galvanized steel utility boxes for outlets connected to surface- mounted conduit, minimum size 100mm square.
- .3 100mm square or octagonal outlet boxes for lighting fixture outlets.
- .4 100mm square outlet boxes with extension and tile rings for flush mounting devices in finished walls.

### 2.3 MASONRY BOXES

- .1 Electro-galvanized steel masonry 100mm square boxes for devices flush mounted in exposed block walls.

### 2.4 CONCRETE BOXES

- .1 100mm square electro-galvanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

### 2.5 CONDUIT BOXES

- .1 Cast FS or FD ferrous boxes with factory-threaded hubs and mounting feet for all surface wiring of devices (switches, receptacle, thermostats and similar devices) installed lower than 2.4m AFF. Matching steel type FS metal device plates specifically made for FS and FD boxes are to utilize four (4) point fastening.

## 2.6 FITTINGS-GENERAL

- .1 Bushing and connectors with nylon insulated throats.
- .2 Knock-out fillers to prevent entry of debris.
- .3 Conduit outlet bodies for conduit up to 35mm and pull boxes for larger conduits.
- .4 Double locknuts and insulated bushings on sheet metal boxes.
- .5 Cast EYS and EYD type seal fittings with factory threaded hubs, rated for hazardous areas as noted on the drawings.

## 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 6mm of opening.
- .4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.
- .5 Install flush mounted boxes in all finished areas unless otherwise indicated.
- .6 Install surface mounted boxes in service rooms and above ceilings unless otherwise indicated.
- .7 Install flush mounted boxes in outside of exterior walls unless otherwise indicated.
- .8 Install type FS or FD boxes for all outlets (regardless of system type involved) to be surfaced mounted less than 2.4m AFF.
- .9 Install concealed boxes in accessible locations.
- .10 Flush installed 100mm or 120mm square box being used as a pull box or junction box shall have installed a single or double gange tile ring and blank cover installed on the box.
- .11 Do not use sectional type boxes with rigid galvanized steel conduit, rigid PVC conduit or EMT.
- .12 In metal drywall partitions, install a short piece of metal stud (same width as wall) on non-supported side of box and secure to box.

**END OF SECTION**

PART 1 - GENERAL

1.1 LOCATION OF CONDUIT

- .1 Drawings do not indicate all conduit runs. Those indicated are in diagrammatic form only.

1.2 REFERENCES

- .1 CSA C22.2 No. 45.1-07(R2012), Rigid Metal Conduit - Steel.  
.2 CSA C22.2 No. 56-2004(R2009), Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.  
.3 CSA C22.2 No. 83-1985(R2013), Electrical Metal Tubing.  
.4 CSA C22.2 No. 211.2-2006, Rigid PVC (Unplasticized) Conduit.

1.3 TRADE SIZE

- .1 The following are Metric trade sizes and Imperial trade size equivalent based on CEC Metric Units.

<u>Metric (mm)</u>	<u>Imperial (inch)</u>
12	3/8
16	1/2
21	3/4
27	1
35	1-1/4
41	1-1/2
53	2
63	2-1/2
78	3
91	3-1/2
103	4
129	5
155	6

1.4 RELATED WORK

- .1 Section 26 05 29: Fastenings and Supports

PART 2 - PRODUCTS

2.1 OUTLET AND CONDUIT BOXES - GENERAL

- .1 Size boxes in accordance with CSA C22.1.  
.2 100 mm square or larger outlet boxes as required for special devices.

- .3 Gang boxes where wiring devices are grouped.
- .4 Blank cover plates for boxes without wiring devices.

## 2.2 CONDUITS

- .1 Rigid galvanized steel threaded conduit, fittings and connectors: to CSA C22.2 No. 45.1.
- .2 Electrical metallic tubing (EMT) with steel set screw couplings: to CSA C22.2 No. 83.
- .3 Rigid pvc conduit, fittings; couplings and connectors: to CSA C22.2 No. 211.2.
- .4 Flexible aluminum conduit and liquid-tight flexible metal conduit: to CSA C22.2 No. 56.

## 2.3 CONDUIT FASTENINGS

- .1 One hole steel straps to secure surface conduits smaller than 41mm. Two hole steel straps for conduits 41mm and larger.
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for two or more conduits at 1.5m oc.
- .4 9mm dia threaded rods to support suspended channels.

## 2.4 CONDUIT FITTINGS

- .1 Fittings: manufactured for use with conduit specified. Coating: same as conduit.
- .2 Conduit fittings (LB, LL, LR) are to be used for 90 bends. "Ells", or corner pulling "Elbows" are prohibited.
- .3 Waterproof type connectors shall be used on all conduit runs connecting equipment.
- .4 Plastic screw on bushings for conduit ends.

## 2.5 GENERAL FITTINGS

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

## 2.6 EXPANSION FITTINGS RIGID CONDUIT

- .1 Weatherproof expansion fittings with internal bonding assembly suitable for 200mm linear UIT

- .2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19mm deflection in all directions.
- .3 Weatherproof expansion fittings for linear expansion at entry to panel.

## 2.7 FISH CORD

- .1 Polypropylene: minimum 3mm diameter.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- .1 Install conduits as high as possible 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 and in unfinished areas. Install conduits as high as possible and secured to building structure with approved supports.
- .3 Use EMT for all concealed wiring unless otherwise indicated, minimum size, 21mm dia.
- .4 Use rigid galvanized steel threaded conduit in hazardous areas or areas subject to mechanical damage, minimum size, 21mm dia.
- .5 Use rigid PVC conduit underground: minimum size 21mm dia.
- .6 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment, minimum size 21mm dia.
- .7 Minimum conduit size for lighting and power circuits: 21mm dia.
- .8 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .9 Mechanically bend steel conduit over 21mm dia.
- .10 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .11 Install fish cord in empty conduits.
- .12 Where conduits become blocked, remove and replace blocked section. Do not use liquids to clean out conduits.
- .13 Dry conduits out before installing wire.
- .14 Install insulated copper bonding conductor in all conduit runs. Minimum size: #14 AWG or Table 16 of C.E.C. which ever is larger.
- .15 Non-connected PVC or steel raceways protruding up through open bottoms of free-standing equipment require PVC bell ends and steel type "ground bushings" installed on ends of respective types of conduits. Extend conduits a minimum of 50mm (2") above housekeeping pad or concrete trough.

- .16 Install plastic bushings in all EMT sized 35mm and larger before pulling in conductors.
- .17 Use rain tight EMT connectors and couplings complete with o-rings on vertical portion of conduit runs where terminating into tops of electrical equipment.
- .18 Unless indicated otherwise, use liquid tight flexible metal conduit complete with matching connectors for final connection between EMT and applicable control device. Junction or pull boxes may also be used to make this transition.
- .19 Bond EMT conduit stubs to ground as required by the CEC.
- .20 Where construction consists of metal Q-deck and steel joists (roof deck), install conduits as follows:
  - .1 In such a manner that the nearest outside surface of the conduit is not less than 38mm (1.5") from the nearest surface of the metal roof deck. Typically, this would involve the installation of conduits on the underside of the top flange, secured with beam clamps or canstrut.
  - .2 Installation of conduits or raceways between the top flange of a steel support structure and a steel roof deck is not permitted due to the possible penetration of roof deck mechanical screws or fasteners.
- .21 Where construction consists of metal Q-deck and steel joists (non-roof deck), conduits are to be installed as follows:
  - .1 Between the top flange of a steel support structure and the Q-deck.
  - .2 Where conduit sizes preclude the above mentioned method, install as high as possible in the space to conserve headroom.

### 3.2 SURFACE CONDUITS

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5m 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 76mm parallel to steam or hot water lines with minimum of 25mm at crossovers.

### 3.3 CONDUITS UNDERGROUND

- .1 Slope conduits to provide drainage.
- .2 Waterproof joints (pvc excepted) with heavy coat of bituminous paint.
- .3 Conduits are only permitted to be installed below floors and are not to be installed in concrete floors unless specifically indicated otherwise.
- .4 Install PVC conduits sized 35mm (1½") and larger in trenches not less than 300mm in depth from underside of concrete floor slab to bottom of trench. Place conduits on a 50mm bed of sand and are to have a second 50mm bed of sand placed on top. Conduits to be completely surrounded by sand prior to backfilling taking place.

- .5 Wiring for all various systems devices and/or outlets installed below ground floor concrete floor slabs may be performed utilizing minimum 21m PVC rigid conduit. Transition from PVC rigid thick wall conduit to rigid steel threaded conduit is to take place below the floor slab.
- .6 All underground conduit to be up sized one (1) trade size above the minimum code requirement.
- .7 Rigid PVC (thick wall) conduit will be permitted to be direct buried.
- .8 Underground and underslab conduits are only permitted to be installed where specifically indicated.
- .9 Install PVC conduits sized 32mm in diameter and larger in trenches not less than 300mm in depth from underside of concrete floor slab to bottom of trench. Place conduits on a 50mm bed of sand and have a second 50mm of sand placed on top. Completely surround the conduits with sand prior to backfilling taking place.
- .10 Conduit installation is not to influence the thickness of the floor slab.
- .11 Do not run conduits along concrete walls installed to reinforce wall installations.
- .12 PVC conduits of all sizes prior to turning-up through floor slabs, unless specifically indicated otherwise, are to have transition to rigid steel threaded conduit take place as previously indicated.
- .13 The installation of PVC type conduits above ground is prohibited.
- .14 Up-size all underground conduits at least one trade size above the minimum code requirement for ease of pulling.
- .15 Only use rigid Types EB1 and DB2/ES2 PVC (thinwall) Conduit (CSA C22.2 211.1) where embedded in concrete.
- .16 Rigid PVC (thick wall) Conduit (CSA C22.2 211.2) will be permitted to be direct buried.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 RELATED WORK

- .1 Electrical general requirements: Section 26 05 00.

## PART 2 - PRODUCTS

### 2.1 CABLE PROTECTION

- .1 Protection materials and methods as indicated on drawings.

## PART 3 - EXECUTION

### 3.1 CABLE INSTALLATION IN DUCTS

- .1 Install cables as indicated in ducts.
- .2 Do not pull spliced cables inside ducts.
- .3 Install multiple cables in duct simultaneously.
- .4 Use CSA approved lubricants of type compatible with cable jacket to reduce pulling tension.
- .5 To facilitate matching of colour coded multi-conductor control cables reel off in same direction during installation.
- .6 Before pulling cable into ducts and until cable ends are properly terminated, seal ends of lead covered cables with wiping solder, seal ends of non- leaded cables with moisture seal tape.
- .7 After installation of cables, seal duct ends with duct sealing compound.

### 3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Electrical General Requirements.
- .2 Perform tests using qualified personnel. Provide necessary instruments and equipment.
- .3 Check phase rotation and identify each phase conductor of each feeder.
- .4 Check each feeder for continuity, short circuits and grounds. Confirm resistance to ground of circuits is not less than 50 megohms.
- .5 Pre-acceptance tests.
  - .1 After installing cable but before terminating, perform insulation resistance test with 1000 V megger on each phase conductor.
  - .2 Check insulation resistance after each termination to ensure that cable system is ready for acceptance testing.

- .6 Provide Departmental Representative with list of test results showing location at which each test was made, circuit tested and result of each test.
- .7 Remove and replace entire length of cable if cable fails to meet any of test criteria.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 SECTION INCLUDES

- .1 Materials, components, cabinets, instruments and installation for metering and switchboard Instruments.

### 1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 19 – Construction/Demolition Waste Management and Disposal
- .3 Section 26 05 00 – Common Work Results – Lighting Equipment

### 1.3 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Indicate meter, instrument, outline dimensions, panel/enclosure drilling dimensions and include cutout template.
- .3 Provide wiring diagrams for meters, metering cabinets and overall metering system.

### 1.4 WASTE MANAGEMENT AND DISPOSAL

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

## PART 2 - PRODUCTS

### 2.1 METER

- .1 Main Switchboard
  - .1 Digital power and energy meter with the following features:
    - .1 Large, backlit LCD display which can present real-time and timestamped historical parameters, graphical trends and histograms measurement accuracy standards.
    - .2 Meets IEC 62053-22 Class 0.2S and ANSI C12.20 0.2 Class 10 and 20.
    - .3 Power and energy.

- .1 V L-L, L-N per phase, min/max, unbalance.
- .2 Frequency: present, min/max.
- .3 Current per phase and L4 and L5.
- .4 Power: kW, kvar, kVA per phase and total.
- .5 Demand: kW, kvar, kVA
- .6 Energy: kWh, kvarh, kVAh, rec/del.
- .7 Power factor.
- .4 Power quality measurements to include:
  - .1 Sag/swell, harmonics monitoring.
  - .2 Harmonics: individual, even, odd up to 63<sup>rd</sup>.
  - .3 Symmetrical components: zero, positive, negative.
  - .4 256 samples per cycle sampling rate.
  - .5 Disturbance direction detection.
- .5 Logging and recording to include:
  - .1 5Mb memory.
  - .2 /max, historical and waveform logging.
  - .3 Timestamp resolution in 0.001 seconds.
  - .4 Historical trend information via front panel display.
  - .5 CPS time synchronization.
- .6 Communication and I/O
  - .1 RS-232/RS485, RS-485, Ethernet, Optical
  - .2 1 internal modem.
  - .3 4 Analog inputs.
  - .4 4 Analog outputs.
  - .5 16 digital status inputs.
  - .6 4 digital status outputs.
  - .7 3 relay outputs.
  - .8 Onboard web server.
- .7 Setpoints, alarming and control
  - .1 65 setpoint / ½ cycle.
  - .2 Math, logic, trig, log, linearization formulas.
  - .3 Call-out single and multi-condition alarms.
- .2 Digital metering package to including all necessary CT's, PT's, test blocks, wiring, communications devices, terminal strips, etc. Metering equipment to be installed in the main switchboard.
- .3 Digital metering package to be compatible with the digital metering network and software package.
- .4 Digital metering package to be suitable for the voltage, phase and current ratings of the equipment or loads in which it is metering.
- .5 Standard of acceptance: ION Power Measurements 7650.
- .2 Individual Metered Loads.
  - .1 Digital power and energy meter with the following features:
    - .1 4 line backlit LCD display which can present real-time and historical parameters.
    - .2 Power and energy.
      - .1 V L-L, L-N per phase, min/max, unbalance.
      - .2 Frequency: present, min/max.
      - .3 Current per phase.
      - .4 Power: kW, kvar, kVA per phase and total.
      - .5 Demand: kW, kvar, kVA.
      - .6 Energy: kWh, kvarh, kVAh, rec/del.
      - .7 Power factor.
    - .3 Power quality measurements to include:
      - .1 Harmonics: individual, even, odd up to 15<sup>th</sup>.
      - .2 32 samples per cycle sampling rate.

- .4 Logging and recording to include:
  - .1 300kB memory.
  - .2 Min/max logging.
  - .3 Timestamp resolution in 0.001 seconds.
  - .4 Historical logs, maximum 32 channels.
- .5 Communication and I/O
  - .1 2 x RS-485 port, 1 Ethernet port, 1 optical port.
  - .2 1 internal modem.
  - .3 4 Analog inputs.
  - .4 4 Analog outputs.
  - .5 4 digital status inputs.
  - .6 4 digital relay outputs.
  - .7 Onboard web server.
- .6 Setpoints, alarming and control
  - .1 1 setpoints/second.
  - .2 Math, logic, trig, log, linearization formulas.
  - .3 Single and multi-condition alarms.
- .2 Digital metering package to be remotely mounted from panelboard/load in which it serves. Metering equipment including all necessary CT's, PT's, test blocks, wiring, communications devices, terminal strips, etc. are to be installed in a CSA Type 1 cabinet located immediately adjacent or above the panelboard or load in which it meters. Where possible, multiple loads are to have metering equipment installed in a common enclosure. Digital meter displays are to be remotely mounted from the metering cabinet in a CSA Type 1 cabinet. Where possible, multiple meters located within the same room are to be installed in a common enclosure. Coordinate cabinet locations and sizing with Consultant during the shop drawing process.
- .3 Digital metering package to be compatible with the digital metering network and software package.
- .4 Digital metering package to be suitable for the voltage, phase and current ratings of the equipment or loads in which it is metering.
- .5 Standard of acceptance: ION Power Measurements PM8000.
- .3 Branch Circuit Panelboards.
  - .1 Digital power and energy meter with the following features:
    - .1 4 line backlit LCD display which can present real-time and historical parameters.
    - .2 Power and energy.
      - .1 V L-L, L-N per phase, min/max, unbalance.
      - .2 Frequency: present, min/max.
      - .3 Current per phase, 3-Phase Average, % Unbalanced.
      - .4 Power: kW, kvar, kVA per phase and total.
      - .5 Demand: kW, kvar, kVA.
      - .6 Energy: kWh, kvarh, kVAh, rec/del.
      - .7 Power factor.
    - .3 Power quality measurements to include:
      - .1 Harmonics: individual, even, odd up to 31<sup>st</sup>.
      - .2 32 samples per cycle sampling rate.
    - .4 Logging and recording to include:
      - .1 300kB memory.
      - .2 Min/max logging.
      - .3 Timestamp resolution in 0.001 seconds.
      - .4 Historical logs, maximum 32 channels.
    - .5 Communication and I/O
      - .1 2 digital inputs.
      - .2 2 digital outputs
      - .6 2 relays.

- .7 Ethernet port with Modbus TCP protocol
- .6 Setpoints, alarming and control
  - .1 1 setpoints/second.
  - .2 Math, logic, trig, log, linearization formulas.
  - .3 Single and multi-condition alarms.
- .2 Digital metering package to be factory mounted in the panelboard which it serves. Metering equipment including all necessary CT's, PT's, test blocks, wiring, communications devices, terminal strips, etc. are to be installed in a CSA Type 1 cabinet located immediately adjacent or above the panelboard or load in which it meters.
- .3 Digital metering package to be compatible with the digital metering network and software package.
- .4 Digital metering package to be suitable for the voltage, phase and current ratings of the equipment or loads in which it is metering.
- .5 Standard of acceptance: ION Power Measurements PM5000.

## 2.2 DIGITAL METERING SOFTWARE

- .1 Digital metering package software to provide the following to local and remote workstations:
  - .1 Historical trend analyses.
  - .2 Alarms and control functions.
  - .3 Real-time display of data
  - .4 Power quality analyses.
  - .5 Custom reporting
- .2 Automated data acquisitions from various sites and devices.
- .3 SQL 2005 Express Edition database.
- .4 Web-enabled real-time monitoring.
- .5 Web-enabled real-time reporting.
- .6 Trend analysis.
- .7 Power quality analyses and compliance reporting.
- .8 Alarming and events.
- .9 Manual and automated control
- .10 OPC DA client.
- .11 Software package to be most recent edition and support digital metering equipment.
- .12 Provide all necessary web-servers, modems, switches as necessary to make a fully operational and functional metering system.
- .13 Provide 1-year internet connection cost associated with commissioning, operating and maintaining the software
- .13 Standard of acceptance: ION Enterprise.

### 2.3 TEST TERMINAL BLOCKS

- .1 Test terminal blocks: as required.

### 2.4 SHOP INSTALLATION

- .1 Install meters and instrument transformers in separate compartment of switchboard, and in separate grouped enclosure for branch panelboards and individual loads as required.
- .2 Ensure adequate spacing between current transformers installed on each phase.
- .3 Verify correctness of connections, polarities of meters, instruments, potential and current transformers, transducers, signal sources, electrical supplies.
- .4 All items affecting CSA certification shall be factory installed (CT's, PT's, etc.).

## PART 3 - EXECUTION

### 3.1 METERING INSTALLATION

- .1 Install meters and instruments on location free from vibration and shock.
- .2 Make connections in accordance with manufacturers requirements.
- .3 Connect meter and instrument transformer cabinets to ground.
- .4 Install software in BMS system PC.
- .5 Program and calibrate all metering equipment.
- .6 Provide system programming as necessary to link meters to software. Connect meters to data system. Coordinate with facility IT staff as necessary.

### 3.2 FIELD QUALITY CONTROL

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

**3.3 SET-UP AND COMMISSIONING**

- .1 Set-up and commission complete metering system in accordance with the manufacturer's recommendations.
- .2 Set-up and commissioning to be completed by an authorized manufacturer's representative factory trained in the installation, set-up, commissioning and operation of the equipment. Provide services for as long as necessary to fully commission the metering equipment and software.
- .3 Coordinate commissioning with the Commissioning Agent, perform all commissioning activities including functional performance testing in accordance with Commissioning specifications.

**3.4 TRAINING**

- .1 Provide selected operations and maintenance staff training in the operation, maintenance of the complete metering system.
- .2 Training to be provided by an authorized manufacturer's representative factory trained in the installation, set-up, commissioning and operation of the equipment.
- .3 Utilize Operation and Maintenance manual, on-site review of equipment and classroom style materials to provide training.
- .4 Allow for a minimum of 4 hours of site training on equipment and 8 hour of training related to the metering software. Training is to be coordinated with the Commissioning Agent and be scheduled a minimum of 3 weeks in advance at locations determined by the Departmental Representative.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00.
- .2 Indicate:
  - .1 Impedance
  - .2 No load losses.
  - .3 Total load losses.
  - .4 Noise level.
  - .5 X/R ratio.
  - .6 Winding configuration and voltages.
  - .7 Taps.
  - .8 Enclosure dimensions.
  - .9 Mounting.
  - .10 Insulation rating.
  - .11 Temperature rise.
  - .12 Rating.
  - .13 Weight.
  - .14 Efficiencies.

### 1.2 OPERATION AND MAINTENANCE DATA

- .1 Provide operation and maintenance data for dry type transformers for incorporation into Manual specified in Section 01 78 00.
- .2 Include matrix of installed transformers tap settings for each transformer.
- .3 Include matrix of primary and secondary winding megger results.

### 1.3 REFERENCES

- .1 CSA C802.2-06, Minimum Efficiency Values for Dry-Type Transformers.
- .2 NEMA ST-20, Dry-Type Transformers for General Application.

## PART 2 - PRODUCTS

### 2.1 TRANSFORMERS

- .1 Use transformers of one manufacturer throughout project.
- .2 Design 1.
  - .1 Type: dry, epoxy vacuum impregnation.
  - .2 3 phase, kVA as indicated, 600 V input, 120/208 V output, 60 Hz.
  - .3 Voltage taps: -5.0%, -2.5%, 0%, +2.5% and 5.0% of rated voltage.
  - .4 Insulation: Class H (220°C), 150°C temperature rise.
  - .5 Basic Impulse Level (BIL): to NEMA ST-20.

- .6 Hipot: standard.
- .7 Average sound level: standard.
- .8 Impedance at 170 C: standard.
- .9 Enclosure: EEMAC 2, ventilated removable metal front panel and hood, drip proof.
- .10 Mounting: Floor mounting only.
- .11 Finish: in accordance with Section 26 05 00 - Electrical General Requirements.
- .12 Winding configuration: Delta primary, grounded Y secondary. All windings copper.
- .13 Options:
  - .1 Vibration isolators.
  - .2 Dual rated spade type transformer lug for ground/bonding of transformers.
- .14 Electrostatically shielded.
- .15 Acceptable Manufacturers:
  - .1 Delta
  - .2 Siemens
  - .3 Hammond

## 2.2 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Electrical General Requirements.
- .2 Label size: 7.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- .1 Securely mount dry type transformer on concrete housekeeping pad or steel mounting frame. External vibration isolators to be provided on transformer support channels on each four corners and between transformer enclosure legs and mounting surface.
- .2 Transformers containing electrical termination points located on both front and rear sides of same are not acceptable.
- .3 Confirm adequate clearance around transformer for ventilation.
- .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 on vibration isolators.
- .7 Megger both primary and secondary windings with 1000 V and 500 V megger and report immediately and reading below 100 megohms. Include results in O&M Manual.
- .8 Ensure transformer is on the correct tap, measure voltages on secondary of transformer under normal building loading. Adjust voltage taps to obtain rated secondary voltages. Record tap settings and include in O&M Manual.
- .9 Add lugs for copper conductors when double neutrals are used.
- .10 Provide dry type transformers complete with a Dual Rated Spade Type Transformer Lug, sized as required to

facilitate both grounding and bonding conductor requirements.

- .1 Bolt directly to transformer enclosure (chassis) with a minimum of two 3mm bolts, flat and lock washers and accompanying nuts etc.
  - .2 Provide a number of termination openings as necessary to ensure individual terminations of each ground and each bond conductor(s) is achieved.
- .11 Connect electrostatic shield and transformer neutral and case solidly to ground.
  - .12 Make primary and secondary connections in accordance with wiring diagram.
  - .13 Energize transformers after installation and testing is complete.

**END OF SECTION**

PART 1- GENERAL

1.1 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00.
- .2 Indicate on shop drawings.
  - .1 Floor anchoring method and foundation template.
  - .2 Dimensioned cable entry and exit locations.
  - .3 Dimensioned position and size of bus.
  - .4 Overall length, height and depth.
  - .5 Dimensioned layout of internal and front panel mounted components.
- .3 Include time-current characteristic curves for circuit breakers and fuses.

1.2 REFERENCES

- .1 ANSI/IEEE C62.41.1-2000, Guide on the Surge Environment by Low-Voltage (1000V or less) AC Power Circuits.
- .2 ANSI/IEEE C62.41.2-2002, Recommended Practice on Characterization of Surges in Low Voltage (1000V or less) AC Power Circuits.

1.3 MAINTENANCE DATA

- .1 Provide maintenance data for service entrance board for incorporation into manual specified in Section 01 78 00.

1.4 MAINTENANCE MATERIALS

- .1 Include manufacturer recommended maintenance materials.

PART 2 - PRODUCTS

2.1 SERVICE ENTRANCE BOARD

- .1 Rating: 600 V, 3 phase, 4 wire, amperage as indicated, short circuit current as indicated.
- .2 Cubicles: free standing, dead front, front access only, provision for addition of future distribution sections, NEMA 1 with dripshield.
- .3 Main breaker and metering section shall be bussed.
- .4 Main breaker, solid- state type overcurrent protective trip unit with independently adjustable LSIG settings.

- .5 Barrier metering sections from adjoining sections.
- .6 Digital metering.
- .7 Distribution breaker sections as indicated.
- .8 Hinged access panels with captive knurled thumb screws.
- .9 Bus bars and main connections: tin-plated or silver flashed 99.3% copper.
- .10 Bus bars to be identified with phase color coding.
- .11 Incoming wireway, suitable for back entry of conduit.

## 2.2 MOULDED CASE CIRCUIT BREAKERS

- .1 To Section 26 28 21.
- .2 Provide extension handles for all circuit breakers rated 225A and above.

## 2.3 SURGE PROTECTION DEVICE

- .1 Provide integral SPD protection as follows:
  - .1 Operation and Environment:
    - .1 Maximum Continuous Operating Voltage (MCOV). The maximum continuous operating voltage of the suppressor unit shall be greater than 115%.
    - .2 Protection Modes. Transient voltage surge suppression paths shall be provided for all possible common and normal modes (between each line and ground, neutral and ground, line to line, and each line and neutral).
  - .2 Suppression:
    - .1 The maximum peak surge current capacity per phase of the specified units, based on the standard 8 x 20 microsecond current waveform (described in ANSI/IEEE C62.41-1991), is not less than 240,000 Amps.
    - .2 Unit shall be able to withstand 1,000 sequential impulses using the category C1, 6 kV/3 kA, 8 x 20 $\mu$  waveform as described in ANSI/IEEE C62.42-1991 (IEEE Guide for Surge Voltages in Low-Voltage AC Power Circuits). The interval between impulses shall not exceed 30 seconds. The resultant peak let-through voltage of the last impulse shall not vary from the first impulse by more than 10%.
    - .3 Suppression System. The SPD unit shall include an engineered solid-state high-performance suppression system, utilizing non-linear voltage dependent metal oxide varistors or selenium cells. The suppression system's components shall not utilize gas tubes, spark gaps, silicon avalanche diodes or other components which might short or crowbar the line, thus leading to interruption of normal power flow or cause system upset of connected loads.
    - .4 The SPD clamping components must have a response time rated less than 1 nanosecond. Filter components shall respond instantaneously.
  - .3 Filtering:
    - .1 Noise Attenuation: SPD unit must be listed under UL 1283 and contain a high-frequency extended range tracking filter. The filter shall reduce fast rise-time, high-frequency, error-producing transients and electrical line noise to harmless levels thus eliminating

disturbances which may lead to system upset. Noise attenuation shall be a minimum of 45 dB at 100 kHz based on standardized insertion loss data obtained utilizing the MIL-STD-220A, 50 ohm insertion loss methodology. Only manufacturers providing a documented attenuation value at 100 kHz will be considered. Spectrum analysis data may be required for support.

- .2 Bandwidth. The SPD unit(s) for main entrance panel application shall have an effective filtering bandwidth of 180 Hz to 50 MHz.
- .4 General Features:
  - .1 Connectors: provide terminals for all of the necessary input and output power and ground connections on the SPD.
  - .2 Internal Connections. All surge current diversion connections shall be by way of low impedance wiring. Surge current diversion components shall be wired for reliable low impedance connections. No printed circuit boards shall be used for surge suppression paths.
  - .3 Enclosure: provide the specified system in a heavy duty NEMA 12 dust tight, enclosure with no ventilation openings. Indication of surge current module status must be visible without opening the door.
  - .4 Unit Status Indicators: provide red status indicators on the hinged front cover to indicate unit phase status. The absence of the red light must reliably indicate that one or more surge current diversion phases have failed and that service is needed to restore full operation.
  - .5 Fuses: use internal unit fuses rated 600 VAC or greater and with a minimum interrupting capability of 200,000A or greater.
  - .6 Identification: unit to include manufacturer's nameplate, UL rating, and a CSA approval on the exterior of the enclosure.
  - .7 Warranty: manufacturer to provide a Five-Year Warranty from date of shipment.
  - .8 Quality: testing of each unit to include but shall not be limited to quality assurance checks, a "Hi-Pot" test at two times rated voltage plus 1000 volts per UL requirements, and operational and calibration tests. Test results will be made available to the Departmental Representative upon request.

## 2.4 GROUNDING

- .1 Copper ground bus extending full width of cubicles and located at bottom.
- .2 Lugs at each end for grounding cable.

## 2.5 FINISHES

- .1 Apply finishes in accordance with Section 26 05 00 - Electrical General Requirements.
  - .1 Service entrance board exterior: gray.

## 2.6 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Electrical General Requirements.
- .2 Nameplates:
  - .1 White plate, black letters, size 7.
  - .2 Complete board labeled: as indicated
  - .3 Main disconnect labeled: "Main Breaker".
  - .4 Branch disconnects labeled: as indicated.

2.7 ACCEPTABLE MANUFACTURERS

- .1 Siemens
- .2 Cutler Hammer
- .3 Schneider Canada

PART 3 – EXECUTION

3.1 INSTALLATION

- .1 Locate service entrance board and secure to concrete housekeeping pad. The drawings indicate the basis of design equipment dimensions and the Contractor is responsible for any modifications or alterations required from utilizing equipment with different physical attributes.
- .2 Connect main secondary service to line terminals of main breaker.
- .3 Connect load terminals of distribution breaker's to feeders.
- .4 Check factory made connections for mechanical security and electrical continuity.
- .5 Ground service entrance board in accordance with Section 26 05 28 and as indicated on the drawings.
- .6 Set breaker trip settings to manufacturer recommended settings from manufacturer provided Protection Coordination Study.
- .7 Test electronic trip units to ensure proper working and protection of components. Provide test results to the Departmental Representative and for inclusion in the Operation and Maintenance Manual.
- .8 Calibrate and commission the Departmental Representative's digital metering system including remote communications and associated programming.

3.2 SOURCE QUALITY CONTROL

- .1 Notify Departmental Representative in writing a minimum of two weeks in advance that service entrance board is ready for testing.
- .2 Perform standard factory tests. Provide test results to Departmental Representative and for inclusion in Operation and Maintenance Manual.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 REFERENCES

- .1 IEEE C62.41.1-2008, guide on the Surge Environment in Low-Voltage AC Power Currents.
- .2 IEEE C62.45-2008, Recommended Practice on Surge Testing for Equipment Connects to Low-Voltage (1000V or less) AC Power Circuits.
- .3 UL 1283-2013, Electromagnetic Interference Filters.

### 1.2 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00.
- .2 Drawings to include electrical detail of panel, branch breaker type, breaker quantity, ampacity, short circuit rating, bus materials and enclosure dimension.

### 1.3 OPERATION AND MAINTENANCE DATA

- .1 Provide operation and maintenance data for panelboards for incorporation into manual specified in Section 01 78 00.
- .2 Include panel schedules.

## PART 2 - PRODUCTS

### 2.1 PANELBOARDS

- .1 Panelboards: product of one manufacturer.
- .2 250 and 600 V panelboards: bus and breakers rated as indicated.
- .3 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.
- .4 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.
- .5 Provide Digital metering in panelboards as indicated
- .6 Two (2) keys for each panelboard and key panelboards alike.
- .7 Tin-plated copper bus. Neutral to be 100% rated of mains.
- .8 Mains: suitable for bolt-on breakers.
- .9 Trim with concealed front bolts and hinges.
- .10 Trim and door finish: baked grey enamel.

- .11 Minimum of one terminal screw on factory installed neutral bar for each circuit breaker position.
- .12 Panelboards rated above 400A to be 300mm deep and 900mm wide minimum.

## 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.
- .3 Main breaker: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.
- .4 Lock-on devices for 10 % of 15 to 30 A breakers installed as indicated. Turn over unused lock-on devices to the Departmental Representative.

## 2.3 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Electrical General Requirements.
- .2 Nameplate for each panelboard size 4 engraved as indicated.
- .3 Nameplate for each circuit in distribution panelboards size 2 engraved as indicated.
- .4 Complete circuit directory with typewritten legend showing location and load of each circuit.

## 2.4 STANDARD OF ACCEPTANCE

- .1 Branch panels: Siemens P2.

## 2.5 ACCEPTABLE MANUFACTURERS

- .1 Siemens
- .2 Cutler Hammer
- .3 Schneider

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- .1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.
- .2 Mount panelboards to height specified in Section 26 05 00 - Electrical General Requirements or as indicated.
- .3 Connect loads to circuits.

- .4 Connect neutral conductors to common neutral bus with respective neutral identified.
- .5 Where more than one bonding terminal strip is present in one panel, hardwire both together using same size bonding conductor as the one that accompanies the panel feeder conductors.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 REFERENCES

- .1 CSA C22.2 No. 42-2010, General Use Receptacles, Attachment Plugs and Similar Wiring Devices.
- .2 CSA C22.2 No. 55-M1986(R2012), Special Use Switches.
- .3 CSA C22.2 No. 111-2010, General Snap Switches.

### 1.2 SHOP DRAWINGS

- .1 Submit shop drawings for each device and coverplate type as per specification Section 01 33 00.

### 1.3 OPERATIONAL AND MAINTENANCE DATA

- .1 Provide operation and maintenance data for wiring devices for incorporation into manual specified in Section 01 78 00.

## PART 2 - PRODUCTS

### 2.1 SWITCHES

- .1 Design S1:
  - .1 20 A, 120 V, specification grade, single pole, two way or three way switches.
  - .2 Manually-operated general purpose ac switches with following features:
    - .1 Terminal holes approved for No. 10 AWG wire.
    - .2 Silver alloy contacts.
    - .3 Urea or melamine molding for parts subject to carbon tracking.
    - .4 Suitable for back and side wiring.
    - .5 White nylon, heavy duty toggle.
    - .6 Integral ground terminal.
  - .3 Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.
  - .4 Switches of one (1) manufacturer throughout project.
  - .6 Approved Manufacturers:
    - .1 Hubbell
    - .2 Pass & Seymour
    - .3 Arrow Hart
    - .4 Leviton
    - .5 Bryant

### 2.2 RECEPTACLES

- .1 Design R1:
  - .1 General purpose duplex receptacles, specification grade CSA type 5- 15 R, 125 V, 15 A, U ground, with following features:
    - .1 White urea molded housing for all power receptacles.

- .2 Suitable for No. 10 AWG for back and side wiring.
  - .3 Break-off links for use as split receptacles.
  - .4 Eight back wired entrances, four side wiring screws.
  - .5 Triple wipe contacts and riveted grounding contacts.
  - .6 Approved Manufacturers:
    - .1 Hubbell
    - .2 Pass & Seymour
    - .3 Arrow Hart
    - .4 Leviton
    - .5 Bryant
- .2 Design R2:
- .1 Duplex receptacles, specification grade CSA type 5-20 R(T- Slot), 125 V, 15/20A, U ground, with following features:
    - .1 White urea molded 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.
    - .6 White nylon face.
    - .7 Acceptable Manufacturers:
      - .1 Hubbell
      - .2 Pass & Seymour
      - .3 Arrow Hart Leviton
      - .4 Bryant
- .3 Design R3:
- .1 GFI duplex receptacles. Specification grade, CSA type 5-15R, 125V, 15A, U-Ground with the following features:
    - .1 White urea moulded housing.
    - .2 Suitable for No. 10 AWG for back and side wiring.
    - .3 Eight back wired entrances, four side wiring screws.
    - .4 Triple wipe contacts and riveted grounding contacts.
    - .5 White nylon face.
    - .6 GFI test and reset buttons.
    - .7 Approved Manufacturers:
      - .1 Hubbell
      - .2 Pass & Seymour
      - .3 Arrow Hart
      - .4 Leviton
      - .5 Bryant
- .4 Design R4:
- .1 GFI duplex receptacles. Specification grade, CSA type 5-20R(T-Slot), 125V, 15A, U-Ground with the following features:
    - .1 White urea moulded housing.
    - .2 Suitable for No. 10 AWG for back and side wiring.
    - .3 Eight back wired entrances, four side wiring screws.
    - .4 Triple wipe contacts and riveted grounding contacts.
    - .5 White nylon face.
    - .6 GFI test and reset buttons.
    - .7 Approved Manufacturers:
      - .1 Hubbell
      - .2 Pass & Seymour

- .3 Arrow Hart
  - .4 Leviton
  - .5 Bryant
- .5 Design R5:
- .1 Tamper resistant general purpose duplex receptacles, specification grade CSA type 5- 15 R, 125 V, 15 A, U ground, with following features:
    - .1 White urea molded housing for all power receptacles.
    - .2 Suitable for No. 10 AWG for back and side wiring.
    - .3 Break-off links for use as split receptacles.
    - .4 Eight back wired entrances, four side wiring screws.
    - .5 Triple wipe contacts and riveted grounding contacts.
    - .6 Tamper resistant markings
    - .7 Approved Manufacturers:
      - .1 Hubbell
      - .2 Pass & Seymour
      - .3 Arrow Hart
      - .4 Leviton
      - .5 Bryant
- .6 Design R6:
- .1 Tamper resistant duplex receptacles, specification grade CSA type 5-20 R(T- Slot), 125 V, 15/20A, U ground, with following features:
    - .1 White urea molded 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.
    - .6 White nylon face.
    - .7 Tamper resistant markings
    - .8 Acceptable Manufacturers:
      - .1 Hubbell
      - .2 Pass & Seymour
      - .3 Arrow Hart Leviton
      - .4 Bryant
- .7 Design R7:
- .1 Tamper resistant GFI duplex receptacles. Specification grade, CSA type 5-15R, 125V, 15A, U-Ground with the following features:
    - .1 White urea moulded housing.
    - .2 Suitable for No. 10 AWG for back and side wiring.
    - .3 Eight back wired entrances, four side wiring screws.
    - .4 Triple wipe contacts and riveted grounding contacts.
    - .5 White nylon face.
    - .6 GFI test and reset buttons.
    - .7 Tamper resistant markings
    - .8 Approved Manufacturers:
      - .1 Hubbell
      - .2 Pass & Seymour
      - .3 Arrow Hart
      - .4 Leviton
      - .5 Bryant

- .8 Design R8:
  - .1 Tamper resistant GFI duplex receptacles. Specification grade, CSA type 5-20R(T-Slot), 125V, 15A, U-Ground with the following features:
    - .1 White urea moulded housing.
    - .2 Suitable for No. 10 AWG for back and side wiring.
    - .3 Eight back wired entrances, four side wiring screws.
    - .4 Triple wipe contacts and riveted grounding contacts.
    - .5 White nylon face.
    - .6 GFI test and reset buttons.
    - .7 Tamper resistant markings
    - .7 Approved Manufacturers:
      - .1 Hubbell
      - .2 Pass & Seymour
      - .3 Arrow Hart
      - .4 Leviton
      - .5 Bryant
- .9 Other receptacles with ampacity and voltage as indicated.
- .10 Use receptacles of one (1) manufacturer throughout project.

### 2.3 POWER AND COMMUNICATIONS SERVICE POLES

- .1 Pre-wired divided channel for power and data to provide feeds from ceiling spaces to modular furniture:
  - .1 Aluminum construction
  - .2 Grey powder coat finish.
  - .3 Recessed Duplex receptacle outlet ports
  - .4 Blank coverplates for unused ports.
  - .5 Approved Manufacturers:
    - .1 Hubbell
    - .2 Pass & Seymour
    - .3 Arrow Hart
    - .4 Leviton
    - .5 Bryant

### 2.3 COVER PLATES

- .1 Cover plates for wiring devices.
- .2 White nylon cover plates on flush mounted outlet boxes unless otherwise indicated.
- .3 Stainless steel cover plates with natural finish on flush mounted outlet boxes in service areas such as mechanical rooms, electrical rooms and telecom rooms.
- .3 Galvanized pressed steel surface covers on surface mounted outlet boxes.
- .4 Heavy duty weatherproof white in use cover plates for devices designated as weatherproof.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Switches:
  - .1 Install single throw switches with handle in "UP" position when switch closed.
  - .2 Mount toggle switches at height specified in Section 26 05 00 - Electrical General Requirements or as indicated.
  
- .2 Receptacles:
  - .1 Mount receptacles at height specified in Section 26 05 00 - Electrical General Requirements or as indicated.
  - .2 Mount receptacles with "U" ground up for vertically mounted and neutral slot at top for horizontally mounted receptacle.
  - .3 Install "Pigtail" type leads on conductors in all device or outlet boxes where feeding through to other receptacles. "Daisy-chain" or looping through of conductors from one device to another is not acceptable. Provide separate pigtail conductor leads for final termination to each receptacle for phase, neutral and bond conductors.
  - .4 Test all receptacles for polarity.
  
- .3 Cover plates:
  - .1 Protect cover plate finish with paper or plastic film until painting and other work is finished.
  - .2 Install suitable common cover plates where wiring devices are grouped.
  - .3 Do not use cover plates meant for flush outlet boxes on surface- mounted boxes.
  
- .4 Device leveler and retainer is an approved accessory for securing devices to flush installed device boxes.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 REFERENCES

- .1 CSA C22.2 No. 248.4-00(R2010), Low Voltage Fuses, Class CC.
- .2 CSA C22.2 No. 248.10-2011, Low Voltage Fuses, Class L.
- .3 CSA C22.2 No. 248.11-2011, Low voltage Fuses, Class J.

### 1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00.

### 1.3 MAINTENANCE MATERIALS

- .1 Provide six (6) spare fuses of each type and size.

### 1.4 DELIVERY AND STORAGE

- .1 Ship fuses in original containers.
- .2 Do not ship fuses installed.
- .3 Store fuses in original containers in moisture free location.

## PART 2 - PRODUCTS

### 2.1 FUSES GENERAL

- .1 Fuses: use product of one (1) manufacturer.
- .2 Low voltage fuses, types as specified, shall be CSA certified in accordance with CSA Standard C22.2 No. 248.

### 2.2 FUSE TYPES

- .1 All fuses must be high rupturing capacity (HRC) type, minimum 200kA interrupting rating (momentary RMS symmetrical).
- .2 Class J:
  - .1 Fuses rated 1 to 600 amperes, 600 VAC, shall be CSA certified Class J in accordance with Standard C22.2 No. 248.
  - .2 Where a time delay characteristic is required, fuses shall carry 500% of their ampere rating for not less than 10 seconds and shall be clearly labeled "time delay".
- .3 Class L:

- .1 Fuses rated 601 to 1200 amperes, 600 VAC, shall be CSA certified Class L in accordance with Standard C22.2 No. 248.10.
- .2 Where a time delay characteristic is required, fuses shall carry 500% of their ampere rating for not less than 10 seconds and shall be clearly labeled "time delay".
- .4 Class CC:
  - .1 Fuses rated 1 to 30 amperes, 600 VAC, shall be CSA certified Class CC in accordance with Standard C22.2 No. 248.4.
  - .2 Where a time delay characteristic is required, fuses shall carry 200% of their ampere rating for not less than 12 seconds.
- .6 Acceptable manufacturers:
  - .1 Ferraz Shawmut.
  - .2 Bussmann.
  - .3 Littlefuse.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- .1 Install fuses in mounting devices immediately before energizing circuit.
- .2 Confirm correct fuses fitted to physically matched mounting devices.
- .3 Confirm correct fuses fitted to assigned electrical circuit.
- .4 Confirm fuse size is correctly identified on equipment.
- .5 For feeder circuit fuses, use fast acting Class J and Class L fuses unless otherwise noted.
- .6 For full voltage non-reversing motor starters, full voltage reversing motor starters, full voltage multi-speed motor starters and transformers, use time delay Class J fuses.
- .7 For 600 VAC control circuits, use Class CC type fuses. Use time delay Class CC fuses upstream of control transformers and solenoids.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00.

### 1.2 OPERATION AND MAINTENANCE DATA

- .1 Provide operation and maintenance data for circuit breakers for incorporation into Manual specified in Section 01 78 00.

## PART 2 - PRODUCTS

### 2.1 BREAKERS GENERAL

- .1 Bolt-on moulded case circuit breaker: quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40 C ambient.
- .2 Multiple breakers to have single handle.
- .3 Circuit breakers to have interrupting capacity as indicated on the Drawings.

### 2.2 MAGNETIC BREAKERS

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

### 2.3 OPTIONAL FEATURES

- .1 Include:
  - .1 On-off locking device for 10% of branch breakers and all breakers supplying exit signs and fire alarm devices.

### 2.4 GROUND FAULT CIRCUIT INTERRUPTER CIRCUIT BREAKERS

- .1 Moulded case thermal magnetic circuit breaker with Class A ground fault protection

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- .1 Install circuit breakers as required, factory install breakers in all panelboards.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00.
- .2 Include:
  - .1 Dimensions.
  - .2 Enclosure type.
  - .3 Rating.
  - .4 Accessories.

### 1.2 OPERATION AND MAINTENANCE DATA

- .1 Provide operation and maintenance data for disconnect switches for incorporation into manual specified in Section 01 78 00.

## PART 2 - PRODUCTS

### 2.1 DISCONNECT SWITCHES

- .1 Heavy duty, fusible and non-fusible, horsepower rated disconnect switch in CSA Enclosure type as indicated (minimum CSA type 1 with drip hood) size as indicated.
- .2 Provision for padlocking in off switch position by three locks.
- .3 Mechanically interlocked door to prevent opening when handle in ON position.
- .4 Fuses: size as indicated, to Section 26 28 14 - Fuses - Low Voltage.
- .5 Fuseholders: suitable without adaptors, for type and size of fuse indicated.
- .6 Quick-make, quick-break action.
- .7 ON-OFF switch position indication on switch enclosure cover.
- .8 Acceptable manufacturers:
  - .1 Siemens.
  - .2 Cutler Hammer.
  - .3 Schneider.
- .9 Exterior mounted disconnect switches to be complete with NEMA 4X enclosure.

### 2.2 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Electrical General Requirements.
- .2 Indicate name of load controlled voltage panel designation and circuit numbers on size 4 nameplate.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install disconnect switches complete with fuses where required.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 REFERENCES

- .1 UL 508-2013, Industrial Control Equipment.

### 1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings in accordance with Section 01 33 00.
- .2 Indicate:
  - .1 Mounting method and dimensions.
  - .2 Starter size and type.
  - .3 Layout of identified internal and front panel components.
  - .4 Enclosure types.
  - .5 Wiring diagram for each type of starter.
  - .6 Interconnection diagrams.

### 1.3 OPERATION AND MAINTENANCE DATA

- .1 Provide operation and maintenance data for motor starters for incorporation into manual specified in Section 01 78 00.
- .2 Include operation and maintenance data for each type and style of starter.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- .1 Starters: EEMAC E14-1
  - .1 Half size starters are not acceptable.
  - .2 IEC equipment not acceptable.
- .2 Acceptable manufacturers:
  - .1 Cutler Hammer
  - .2 Schneider
  - .3 Siemens

### 2.2 MANUAL MOTOR STARTERS

- .1 Single phase manual motor starters of size, type, rating, and enclosure type as indicated, with components as follows:
  - .1 Switching mechanism, quick make and break.
  - .2 All phase conductors to have overload heaters, manual reset, trip indicating handle.
- .2 Accessories:
  - .1 Toggle switch: heavy duty labelled as indicated.
  - .2 Indicating light: LED and colour as indicated.

- .3 Locking tab to permit padlocking in "ON" or "OFF" position.

### 2.3 FULL VOLTAGE MAGNETIC STARTERS

- .1 Magnetic and combination magnetic starters of size, type, rating and enclosure type as indicated with components as follows:
  - .1 Contactor solenoid operated, rapid action type.
  - .2 Motor overload protective device in each phase, manually reset from outside enclosure.
  - .3 Wiring and schematic diagram inside starter enclosure in visible location.
  - .4 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
  - .5 Hand-off-auto selection switch in cover.
  - .6 LED pilot light indicating coil is energized.
  - .7 LED pilot light indicating unit is powered.
- .2 Combination type starters to include motor circuit interrupter with operating lever on outside of enclosure to control motor circuit interrupter, and provision for:
  - .1 Locking in "OFF" position with up to three (3) padlocks.
  - .2 Independent locking of enclosure door.
  - .3 Provision for preventing switching to "ON" position while enclosure door open.
- .3 Accessories:
  - .1 Selector switches: heavy duty labelled as indicated.
  - .2 Indicating lights: L.E.D. type and color as indicated.
  - .3 One (1) N/O and one (1) N/C spare auxiliary contacts unless otherwise indicated.
  - .4 Provide solid state protection complete with single phasing protection.
  - .5 Provide one (1) 24 VAC interposing relay complete with two (2) normally open and two (2) normally closed contacts mounted in starter enclosure. Connect relay as indicated.

### 2.4 CONTROL TRANSFORMER

- .1 Single phase, dry type, control transformer with primary voltage as indicated and 120V secondary, complete with secondary fuse, installed in with starter as indicated.
- .2 Size control transformer for control circuit load plus 20% spare capacity.

### 2.5 FINISHES

- .1 Apply finishes to enclosure in accordance with Section 26 05 00 - Electrical General Requirements.

### 2.6 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Electrical General Requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install starters, connect power and control as indicated.
- .2 Confirm fuses and overload elements are correct for the actual loads. Obtain correct information from Divisions 21, 22 and 23 prior to ordering and setting overloads.
- .3 Coordinate with Controls contractor.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Electrical General Requirements and manufacturer's instructions.
- .2 Operate switches, contactors to verify correct functioning.
- .3 Perform starting and stopping sequences of contactors and relays.
- .4 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as required.
- .5 Provide test forms to Commissioning Agent for each motor starter confirming operation and settings.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 DESCRIPTION OF SYSTEM

- .1 This specification describes the requirements for design, supply and delivery of variable speed drives. Refer to related specification sections for mechanical and process motor specifications.

### 1.2 RELATED SECTION

- .1 General Instruction: Section 01 00 50.
- .2 Submittal Procedures: Section 01 33 00.
- .3 HVAC Controls: Section 25 00 00.
- .4 Electrical General Requirements: Section 26 05 00.

### 1.3 CODES AND STANDARDS

- .1 Drives covered by this specification shall conform to the latest edition of the following Codes, Standards and Regulations where applicable:
  - .1 Canadian Standard Association.
  - .2 Institute Electrical Electronic Engineers 519 - Harmonics Generating.
  - .3 Institute Electrical Electronic Engineers 62.41 - Line Transients.
  - .4 Canadian Electrical Code, Part I – Overload, 2012 edition.

### 1.4 SHOP DRAWINGS

- .1 Provide shop drawings in accordance with specification Section 01 33 00.
- .2 Indicate:
  - .1 Outline dimensions of cabinet(s).
  - .2 Drive configuration.
  - .3 Inter-wiring of drive components.
  - .4 Schematic and wiring diagrams
  - .5 Component data sheets.
  - .6 Input/Outputs required to communicate with controls system.

### 1.5 WARRANTY

- .1 Provide warranty for all material for a period of two (2) year minimum from the Substantial Completion Date and will replace, at no cost to the Departmental Representative, faulty materials. The warranty must include the cost of all labour, travel and expenses for repairs within the warranty period.

### 1.6 OPERATION AND MAINTENANCE MANUAL

- .1 Provide operation and maintenance information in accordance with Section 01 78 00. This includes information on the drives and any required relays and other components that make up the complete package.

## 1.7 SPACE PARTS

- .1 Submit list and price of recommended spare parts to have on site to limit downtime.
- .2 Submit manufacturer's policy of providing spare parts for older equipment (e.g.: spare parts are to be available for 10 years minimum after original equipment has been manufactured).

## PART 2 - PRODUCTS

### 2.1 GENERAL

- .1 Provide variable speed drives for the motors indicated on the drawings.
- .2 Refer to the drawings for motor HP ratings and quantities.

### 2.2 POWER SUPPLY

- .1 The minimum required three phase momentary short circuit current (rms symmetrical) rating at rated voltage is as noted on the drawings.

### 2.3 DESIGN CRITERIA

- .1 Drive to be digital, pulse width modulated, modular construction, CSA approved.
- .2 The drive must convert incoming fixed frequency three phase ac power into variable voltage and variable frequency utilizing pulse width modulation.
- .3 Drive to include a full wave diode bridge rectifier to convert ac to dc. SCR and other switching power devices are not acceptable.
- .4 Drive to utilize dc capacitors to filter out bus ripple and provide smooth dc power to the transistor section.
- .5 Drive to utilize IGBT transistors to produce a pulse width modulated output. SCR's are not acceptable. The IGBT minimum Vce rating to be 1200V.
- .6 Drive main input power to be 600V, 3 phase, 60hz. Voltage tolerance shall be +10% and -15% of nominal voltage. Frequency tolerance shall be +/- 5%.
- .7 The drive must be rated to provide current to support motors at 1.15 service factor continuously.
- .8 The efficiency of the drive must be a minimum of 95% at full load and full speed.
- .9 Displacement power factor must be greater than 0.95 lagging over the entire speed range.
- .10 Provide minimum 3% input line reactors or integral line input choke. Install a CSA approved enclosure over line reactors.
- .11 Provide output dv/dt filtering downstream of the drive in accordance with the drive manufacturer's recommendations to protect the motor against high voltage spikes. Install the filter in a CSA approved enclosure.

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- .12 The drive must be able to provide full rated output current continuously, and shall be able to provide 110% of its normal duty current rating for one (1) minute every ten (10) minutes, and 130% overload for two (2) seconds.
- .13 Where a local disconnecting device is provided downstream of the VFD, the drive must be capable of accepting opening of the feeder disconnect without causing damage to the drive. Wire an auxiliary contact from each local disconnect back to the drive to prevent starting the drive on an open circuit condition.
- .14 Provide drive complete with power line loss ride through feature for a minimum of 0.5 seconds.
- .15 The drive must be capable of starting into a coasting load.
- .16 Provide most recent version of programming software and appropriate interface hardware to enable drive configuration from a laptop computer.
- .17 Provide Digital Input/Output points, complete with connection to variable frequency drive and terminal blocks for field cabling for the following as a minimum: Drive Run (drive output), Drive Fault (drive output), Drive Start/Stop command (drive input). "Drive Run" and "Drive Fault" contacts must be dry contacts, rated minimum 0.4A at 120Vac.
- .18 Provide and programmable output signal (4-20mA) to indicate motor current.
- .19 Provide a programmable analog input points to accept a 4-20mA analog signal (speed control) from an external source and, where applicable, a voltage signal from a remote potentiometer (speed control).
- .20 Protective functions:
- .1 The drive must have built in CSA approved adjustable overload protection to protect the connected motor.
  - .2 The drive must have input metal oxide varistors (MOV's) for surge protection.
  - .3 Provide complete with the following protective functions:
    - .1 Over and under voltage.
    - .2 Overcurrent.
    - .3 Ground faults.
    - .4 Drive over temperatures.
    - .5 Blown dc bus fuse.
    - .6 Overload.
    - .7 Input and output phase loss.
    - .8 Unbalance current fault.
    - .9 Motor stall protection.
  - .4 Provide for three (3) auto restart attempts following selected fault conditions.
  - .5 Drive to permit the operator to lock out the reverse operation for applications where reverse would damage equipment.
- .21 Provide each drive complete with a removable keypad for local programming, monitoring, speed control and start/stop control. Each keypad must be visible and accessible from the front of the drive or drive control panel with the door closed. Provide the keypad complete with the following minimum features:
- .1 LCD high resolution display (backlit).
  - .2 Keypad must indicate the following minimum operating conditions: drive run, drive stopped, drive fault.
  - .3 As a minimum, output speed, power, frequency and current shall be displayed continuously as selected by the user.
  - .4 Fault reset and hand-off-auto buttons.
  - .5 Present fault condition shall be displayed.
  - .6 Keypad entries shall be password protected.
  - .7 English Language.

- .22 Programming features:
  - .1 Drive must have a minimum of three (3) independently adjustable acceleration and deceleration ramps. Times are to be adjustable from 0.1 to 3200 seconds (nominal).
  - .2 Drive must have an adjustable output frequency from 25-320hz (nominal).
  - .3 Control methods available must be selectable sensorless vector and selectable Volts/hz patterns.
  - .4 Drive must have adjustable minimum and maximum speed settings.
  - .5 Drive must have an adjustable carrier frequency (nominal 1-16khz).
  - .6 Drive must have a minimum of three (3) adjustable frequency reject points to prevent system operation at resonant speed.
- .23 Drive to be sized for variable torque or constant torque load as determined by application.
- .24 Provide drive with BacNet communications with a BACnet RS-485 port as standard to interface with the Building Management System Controls. Drive supplier will verify compatibility with the control supplier at the time of the bid.
- .25 Drives to include EMI/RFI filters.

#### 2.4 ENCLOSURE

- .1 Wall mount VFD's where indicated. VFD's must be minimum NEMA 12 rated if not mounted in an enclosure. Provide enclosures, minimum NEMA 12 rated, for the line reactors, dv/dt filtering and VFD controls for each drive.
- .2 VFD's must be ventilated in accordance with manufacturers' requirements.
- .3 Enclosures must be sprinkler proof.

#### 2.5 ACCEPTABLE MATERIALS

- .1 Cuttler Hammer.
- .2 Schneider Electric.
- .3 Siemens.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- .1 Field mount VFD's where indicated on the Project Drawings. Provide 41mm, U-shaped strut (galvanized steel) on wall for mounting groups of VFD's.
- .2 Connect power, control and communications wiring (digital and analog inputs and outputs) as noted on the drawings. Coordinate HVAC controls requirements prior to the issuance of Shop Drawings.
- .3 All conduit for VFD power conductors (line and load side) must be steel (EMT or hot dipped galvanized steel).
- .4 Provide adequate spacing between VFD's for cooling in accordance with the manufacturer's requirements.

**3.2 TESTING AND COMMISSIONING**

- .1 Arrange and pay for a factory certified representative to set up and commission drive at site for proper operation to the satisfaction of the Departmental Representative. Document all testing and set- up and submit to Departmental Representative.
- .2 Provide commissioning test reports and setup/configuration parameters (hard copy and files on CD).
- .3 Coordinate with building controls system integrator during testing and commissioning of variable frequency drives to establish proper operation to the satisfaction of the Departmental Representative.

**3.3 TRAINING**

- .1 Provide a factory certified representative as required to train personnel at site.

**END OF SECTION**

PART 1 - GENERAL

1.1 REFERENCES

- .1 ANSI C62.41-2008, IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
- .2 ANSI C62.45-2008, IEEE Guide on Surge Testing for Equipment Connected to Low- Voltage AC Power Circuits.
- .3 NECA/ESNA 500-1998, Recommended Practice for installing indoor commercial lighting systems.
- .4 ANSI/IESNA RP1-2004; American national Standard practice for office lighting.
- .5 ASTM F1137-2011e1, American Society for Testing and Materials Specification for phosphate/oil and phosphate/organic corrosion protective coatings for fasteners.
- .6 FCC CFR47; USA Federal Communications Commission Frequency allocations and radio treaty matters; general rules and regulations.
- .7 IESNA LM-79, Electrical and photometric Measurements of Solid State Lighting.
- .8 IESNA LM-80, Measuring Lumen Maintenance of LED Light Sources.
- .9 IESNA TM-21, Projecting Long Term Lumen Maintenance of LED Light Sources

1.2 RELATED WORK

- .1 Submittal Procedures: Section 01 33 00

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings in accordance with Section 01 33 00.
- .2 Submit shop drawings for the following:
  - .1 Luminaire.
  - .2 Lamp/engine for each luminaire type.
  - .3 Ballast/driver for each luminaire type.
- .3 Shop Drawings:
  - .1 Shop drawings shall clearly indicate the following:
    - .1 Luminaire ID number as identified in contract documents.
    - .2 Fixture specification as identified in Part 2 and on the drawings.
    - .3 Lamp specification as identified in Part 2 and on the drawings.
    - .4 Ballast/Driver specification as identified in Part 2 and on the drawings.
    - .5 Photometric data for each luminaire type.
    - .6 Energy data for lamps and ballasts.
    - .7 IESNA TM-21 Data for each luminaire
- .4 Catalogue cuts lacking sufficient detail to indicate compliance with Contract documents will not be acceptable.
- .5 Submit complete photometric data prepared by independent testing laboratory for luminaires where specified, for review by Departmental Representative. Photometric data to include:

- .1 VCP Table, spacing criterion;
- .2 Total input watts;
- .3 Candlepower summary, candela distribution, zonal lumen summary;
- .4 Luminaire efficiency, C.I.E. type, coefficient of utilization;
- .5 Lamp type;
- .6 Lumen ratings
- .7 Summary in accordance with IES procedures.
- .8 Electronic IES file (provide on CD).

#### 1.4 OPERATION AND MAINTENANCE

- .1 Provide operation and maintenance data for inclusion in the manual specified in Section 01 78 00.

#### 1.5 WASTE AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 22.
- .2 Place materials defined as hazardous or toxic waste in designated containers.
- .3 Ensure emptied containers are sealed and stored safely for disposal.

### PART 2 - PRODUCTS

#### 2.1 LUMINAIRES

- .1 Luminaires are specified on the drawings.

#### 2.2 SPARES

- .1 Provide 5% spare LED drivers of each type to a minimum quantity of five (5).

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- .1 Locate and install luminaires as indicated. Provide and install all necessary hangars, supports, fittings, etc. as necessary for a complete installation.
- .2 Coordinate installation with all other services.

#### 3.2 WIRING

- .1 Connect luminaires to lighting circuits as indicated.
- .2 Each light fixture to have a separate "fixture drop" installed and connected to hard wired junction box or outlet box in ceiling space.

- .3 Recessed and/or surface type fluorescent light fixtures are not to be wired in a "daisy-chain" manner or have their power sources looped between fixtures, unless the fixtures are installed end-to-end or house an integral junction box.

### 3.3 LUMINAIRE SUPPORTS

- .1 Support luminaires independently of all other systems using chain, aircraft cable or threaded rod. Supporting luminaires from any part of the ceiling system or using ceiling ties as fixture supports is not permitted.

### 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.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 RELATED SECTIONS

- .1 Section 26 50 00 - Lighting
- .2 Section 26 05 21 – Wires and Cables.

### 1.2 SUMMARY

- .1 The lighting control system specified in this section shall be capable of providing time-based, sensor-based (both occupancy/vacancy and daylight), and manual lighting control.
- .2 The system shall be capable of turning lighting loads on/off as well as dimming lights.
- .3 The system architecture shall be capable of enabling stand-alone groups of devices to function in some default capacity if network connectivity to the greater system is lost.
- .4 The system architecture shall facilitate remote operation via a computer connection.
- .5 The system shall not require any centrally hardwired switching equipment.
- .6 The system shall be of wired architecture.
- .7 The system shall include a PC based lighting control and monitoring software and graphics package installed on the building's BMS system computer.

### 1.3 SUBMITTALS

- .1 Product datasheets including general device descriptions, dimensions, wiring details and nomenclature.
- .2 Project specific detailed riser diagrams showing interconnectivity of devices.
- .3 Other Diagrams as needed for special operation or interaction with other system(s).
- .4 Hardware and Software Operation Manuals.
- .5 Other operational descriptions as needed.

### 1.4 QUALITY ASSURANCE

- .1 Products shall be manufactured by a company that is actively and primarily involved in the lighting controls industry with local representation and technical support.

## PART 2 - PRODUCTS

### 2.1 SYSTEM REQUIREMENTS

- .1 System shall have an architecture that is based upon three main concepts; 1) intelligent lighting control devices 2) standalone lighting control zones 3) network backbone for remote or time based operation.
- .2 Intelligent lighting control devices shall consist of one or more basic lighting control components; occupancy sensors, photocell sensors, relays, dimming outputs, manual switch stations, and manual dimming stations. Combining one or more of these components into a single device enclosure should be permissible so as to minimize overall device count of system.
- .3 Intelligent lighting control devices shall communicate digitally and possess RJ-45 style connectors.
- .4 Lighting control zones shall consist of one or more intelligent lighting control components, be capable of stand-alone operation, and be capable of being connected to a higher level network backbone.
- .5 Devices within a lighting control zone shall be connected with CAT-5e low voltage cabling in any order.
- .6 Lighting control zone shall be capable of automatically configuring itself for default operation without any start-up labor required.
- .7 Individual lighting zones must continue to provide a user defined default level of lighting control in the event of a system communication failure.
- .8 Power for devices within a lighting control zone shall come from either resident devices already present for switching (relay device) or dimming purposes, or from the network backbone. Standalone "bus power supplies" shall not be required in all cases.
- .9 All switching and dimming for a specific lighting zone shall take place within the devices located near the zone itself to facilitate system robustness and minimize wiring requirements.
- .10 Individual lighting zones shall be capable of being segmented into several "local" channels of occupancy, photocell, and switch functionality for more advanced configurations and sequences of operation.
- .11 Devices located in different lighting zones shall be able to communicate occupancy, photocell, and switch information.
- .12 System shall be capable of operating a lighting control zone according to several sequences of operation. System shall be able to change a spaces sequence of operation according to a time schedule so as to enable customized time-of-day, day-of-week utilization of a space.
- .13 System shall be capable of operating all controls schemes identified on the drawings.

### 2.2 CEILING MOUNTED OCCUPANCY/VACANCY SENSOR

- .1 Passive dual technology.
  - .1 Primary: Infrared
  - .2 Secondary: Acoustic Sensing or ultrasonic.
  - .3 Secondary sensing technology's sensitivity is to be adjustable or disabled via the lighting control software.
- .2 42m<sup>2</sup> sensing range.

- .3 360 degree coverage pattern.
- .4 Dual RJ-45 Jacks for networked lighting control system connectivity.
- .5 White in colour.

### 2.3 WALL MOUNTED VACANCY SENSOR SWITCH

- .1 Passive dual technology.
  - .1 Primary: Infrared
  - .2 Secondary: Acoustic Sensing or ultrasonic.
  - .3 Secondary sensing technology's sensitivity is to be adjustable or disabled via the lighting control software.
- .2 58m<sup>2</sup> sensing range.
- .3 180 degree coverage pattern.
- .4 Dual RJ-45 Jacks for networked lighting control system connectivity.
- .5 White in colour.
- .6 White nylon decora coverplate.

### 2.4 WALL MOUNTED SWITCHING/DIMMING STATION

- .1 "On/Off" momentary contact pushbutton.
- .2 "Raise"/"Lower" momentary contact pushbuttons.
- .3 Dual RJ-45 Jacks for networked lighting control system connectivity.
- .4 White in colour.
- .5 White nylon decora coverplate.

### 2.5 WALL MOUNTED SWITCHING STATION

- .1 "On" momentary contact pushbutton.
- .2 "Off" momentary contact pushbuttons.
- .3 Dual RJ-45 Jacks for networked lighting control system connectivity.
- .4 White in colour.
- .5 White nylon decora coverplate.

## 2.6 CONTROL RELAY POWER PACK C/W DIMMING

- .1 16A latching relay rating at 120V.
- .2 0-10V dimming output.
- .3 16mm threaded chase nipple for mounting on junction box.
- .4 Dual RJ-45 Jacks for networked lighting control system connectivity.

## 2.7 NETWORK BRIDGE

- .1 16mm threaded chase nipple for mounting on junction box.
- .2 120V power supply.
- .3 Port identification label.

## 2.8 CONTROL MODULE (GATEWAY)

- .1 Control module shall be a device that facilitates communication and time-based control of downstream network devices and linking into an Ethernet.
- .2 Devices shall have a user interface that is capable of wall mounting.
- .3 Control device shall have three RJ-45 ports for connection to other backbone devices (bridges) or directly to lighting control devices.
- .4 Device shall have a standard and astronomical internal time clock.
- .5 Device shall have one RJ-45 10/100 BaseT Ethernet connection.
- .6 Each control gateway device shall be capable of linking 1500 devices to the management software.
- .7 Device shall be capable of using a dedicated or DHCP assigned IP address.

## 2.9 MANAGEMENT SOFTWARE

- .1 Every device parameter (e.g. sensor time delay and photocell set-point) shall be available and configurable remotely from the software
- .2 The following status monitoring information shall be made available from the software for all devices for which it is applicable: current occupancy status, current PIR Status, current secondary sensing status, remaining occupancy time delay(s), current photocell reading, current photocell inhibiting state, photocell transitions time remaining, current dim level, device temperature, and device relay state(s).
- .3 The following device identification information shall be made available from the software: model number, model description, serial number, manufacturing date code, custom label(s), and parent network device.
- .4 A printable network inventory report shall be available via the software.
- .5 A printable report detailing all system profiles shall be available via the software.

- .6 Software shall require all users to login with a User Name and Password.
- .7 Software shall provide at least three permission levels for users.
- .8 All sensitive stored information and privileged communication by the software shall be encrypted.
- .9 All device firmware and system software updates must be available for automatic download and installation via the internet.
- .10 Software shall be capable of managing systems interconnected via a WAN (wide area network)
- .11 Software shall include a graphical building and device layout indicating the installed location of lighting control devices as well as lighting zone status

#### 2.10 BMS COMPATIBILITY

- .1 System shall provide a BACnet IP gateway as a downloadable software plug-in to its management software. No additional hardware shall be required.
- .2 BACnet IP gateway software shall communicate information gathered by networked system to other building management systems.
- .3 BACnet IP gateway software shall translate and forward lighting relay and other select control commands from BMS system to networked control devices.

### PART 3 - EXECUTION

#### 3.1 EQUIPMENT INSTALLATION

- .1 The lighting control system and associated components shall be installed and verified. This verification shall be completed by a Factory trained manufacturer's representative.
- .2 Install devices as per manufacturer's installation instructions.
- .3 Wiring.
  - .1 Do not mix low voltage and high voltage conductors in the same conduit. No exceptions.
  - .2 Ensure low voltage conduits or control wires do not run parallel to current carrying conduits.
  - .3 Do not exceed manufacturer's recommendations for wire length for the system bus.

#### 3.2 INSTALLATION AND SET UP

- .1 Coordinate all programming and operation requirements with the Departmental Representative prior to programming of the lighting control system functions.
- .2 Prior to substantial completion, arrange and provide a one-day instruction period to designated personnel, this shall be provided by a factory trained manufacturer's representative.
- .3 Set-up, commissioning of the lighting control system, and instruction includes:
  - .1 Confirmation of entire system operation and communication to each device.

- .2 Confirmation of operation of individual devices, switches and occupancy sensors.
  - .3 Confirmation of system programming including appropriate control zone functionality.
  - .4 Provide training to cover installation, maintenance, troubleshooting, programming, and repair and operation of the lighting control system.
- .4 Test all low voltage cable for integrity and proper operation prior to turn over. Verify with system manufacturer all wiring and testing requirements.
- .5 Equipment shall be located so that it is readily accessible and not exposed to physical damage.

### 3.3 TRAINING

- .1 Provide two separate training sessions with building users spaced 30 days apart.

### 3.4 DOCUMENTATION

- .1 Provide a point-to-point wiring diagram for the entire lighting control system. Diagram must indicate exact mounting location of each system device. This accurate "as built" shall indicate the loads controlled by each relay and the identification number for placement of switches and location of occupancy sensors. Original to be given to the Departmental Representative.

**END OF SECTION**

PART 1 - GENERAL

1.1 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00.
- .2 Data to indicate system components, mounting method, source of power and special attachments.

1.2 OPERATION AND MAINTENANCE DATA

- .1 Submit operation and maintenance data for incorporation in the Manual specified in Section 01 78 00.

PART 2 - PRODUCTS

2.1 BATTERY UNITS AND REMOTE HEADS

- .1 Refer to drawings for specifications.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install unit equipment and remote mounted fixtures as indicated.
- .2 Direct heads as indicated.
- .3 Make connections.
- .4 Test and verify operation of units upon loss and restoration of normal ac power. Verify 90 min. battery life upon loss of power.
- .5 Feed the emergency lighting system from the un-switched leg of the same circuit which feeds the normal lights in that area.

**END OF SECTION**

PART 1 - GENERAL

1.1 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00.

1.2 OPERATION AND MAINTENANCE DATA

- .1 Submit operation and maintenance data for incorporation in the Manual specified in Section 01 78 00.

1.3 REFERENCE

- .1 CAN/CSA-C860-2011, Performance of Internally Lighted Exit Signs.

PART 2 - PRODUCTS

2.1 STANDARD UNITS

- .1 Refer to drawings for specifications.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install exit lights.
- .2 Connect fixtures to exit light circuits as indicated on the drawings.
- .3 Confirm that exit light circuit breaker is locked in on position.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 REFERENCES

- .1 AASHTO specification for "Structural Supports for Highway Signs, Luminaires and Traffic Signals".

### 1.2 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00.
- .2 Provide a lighting standard design including pole, arm and foundation based on the specified lighting fixtures and pole and foundation criteria. The design is to be stamped by a structural engineer licensed to practice in the province of Nova Scotia.

## PART 2 - PRODUCTS

### 2.1 STEEL POLES

- .1 Steel poles design 1: AASHTO specification designed for underground wiring and:
  - .1 Mounting on concrete foundation.
  - .2 Style: square, straight, steel pole.
  - .3 Suitable for single or double luminaires as indicated on the drawings.
  - .4 Gasketed access handhole 450 mm above pole base for wiring connections, with welded-on reinforcing frame and bolted-on cover.
  - .5 Size: 7.0m x 125mm x 125mm
  - .6 Galvanized steel anchor bolts: as per manufacturer's recommendation with shims, nuts and covers.
  - .7 Finish: polyester powder coat, colour to match luminaire.
  - .8 Treatment: all poles to be hot dipped galvanized before application of finish. Painted only poles will not be accepted.
  - .9 Grounding lug.
  - .10 Provide 10 year warranty against rust.
  - .11 Rated for sustained wind loads in the installed area plus 1.3 gust factor as well as 1.5 EPA rating of luminaires mounted on the pole.

### 2.2 CONCRETE FOUNDATIONS

- .1 Concrete foundations are to be raised 600mm above finished grade, minimum 450mm diameter.

### 2.3 LUMINAIRE MOUNTING BRACKETS

- .1 Refer to Section 26 50 00 and the drawings for luminaire specification.
- .2 For single fixture poles, provide arm mount.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install poles true and plumb, complete with brackets in accordance with manufacturer's instructions.
- .2 Perform tests in accordance with Section 26 05 00.
- .3 Contractor shall provide anchor bolts, base cover plate and footing for the lighting standards.

**END OF SECTION**