

- 1 GENERAL
- .1 This Section covers items common to Sections of Division 26, 27, 28. This section supplements requirements of Division 1.
 - .2 Read this Section in conjunction with all other contract documents.
- 2 REFERENCES
- .1 CAN3-C235-83(R2010), Preferred Voltage Levels for AC Systems, 0 to 50,000V.
 - .2 CSA-C22.1-2015, Canadian Electrical Code, Part 1 (22nd edition), Safety Standard for Electrical Installations.
 - .3 CSA Z85-1983, Abbreviations for Electrical Terms.
 - .4 EEMAC Y1-2-1979, Standard for Performance Specification for Finishing Systems for Outdoor Electrical Equipment.
 - .5 EEMAC 2Y-1-1958, Standard for CEMA Light Grey Colour for Indoor Switchgear.
 - .6 CSA B44-10/ASME A17.1-2010, Safety Code for Elevators and Escalators.
- 3 CARE, OPERATION AND STARTUP
- .1 Instruct Departmental Representative and 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.
- 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.
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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.
- .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. Display permits 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 otherwise specified.
- .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 for permits, fees and inspection.

6 MATERIALS AND
EQUIPMENT

- .1 Provide materials and equipment in accordance with Section 01 61 00.
- .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.

- 6 MATERIALS AND EQUIPMENT
(Cont'd)
- .3 Factory assemble control panels and component assemblies.
- 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.
- 8 EQUIPMENT IDENTIFICATION
- .1 Identify electrical equipment with nameplates and labels as specified herein.
- .2 Identification:
.1 Provide all switchboards, panels, disconnect switches, receptacles, voice/data/CATV/Multimedia outlets/P.A. Speakers, MCC's, transformers, control panels, fire alarm devices, magnetic starters, TOL's, etc. with lamicaid nameplates as further described herein. Affix all plates 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 Lamicaid nameplates installed on distribution panelboards, motor control centres, splitter troughs and transformers to 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.
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8 EQUIPMENT
IDENTIFICATION
(Cont'd)

- .2 Identification:(Cont'd)
.6 (Cont'd)
.4 (Cont'd)

Example
PANEL A - 225 AMPS
120/208V - 3PH - 4W
FED FROM MAIN SWITCHBOARD 'SB-1'

.7 Lamicoid nameplates installed on combination starters, magnetic starters, manual starter and all various systems controls, control panels, disconnect switches, etc., to 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. 1 SUPPLY FAN NO. 1
PANEL A - CCT. NO. 10 M.C.C. NO. 1
120V - 1-Phase 600V - 3-Phase

.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 Lamicoid nameplates are to be installed 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:	Example:
MAIN BREAKER 400 AMPS	MAIN SWITCH 400 AMPS
600/347V, 3PH, 4W	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, Motor Control Centres. etc.), that contain overcurrent devices (i.e., circuit breakers and/or fuses), that have been designed for, and

8 EQUIPMENT
IDENTIFICATION
(Cont'd)

- .2 Identification:(Cont'd)
.12 (Cont'd)
incorporate interrupting capacity greater than 10 kA
I.C.

Example:

Min, interrupting capacity of breakers
installed in this panel to be not less
than 22 kA I.C.

Example:

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

.13 Install lamicoid nameplates above all types of
receptacles and abutted directly to tops of their
respective device plates. Identification 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 black
letters on white core, directly above all
receptacles. Plate to be identical width as
finish device plate.

Example: PANEL 'A' CCT.20

.14 Identify receptacles intended for computer,
electronic or other sensitive types of electronic
equipment etc., as per following:

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

Example: For computer use only
PANEL 'A' - CCT.24

.15 Identify lamicoid 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
black letters on white core above all
receptacles. Identical width as finish device
plate (EXAMPLE: GFCI Protected Panel 'A'
CCT.24).

.16 Apply lamicoid nameplate(s) for
power/voice/data/CATV/CCTV/multimedia outlets/P.A.
specific devices directly to face of finish plate.

- .1 1.5mm thick x 19mm wide complete with 6mm
black letter on white cove above all

8 EQUIPMENT
IDENTIFICATION
(Cont'd)

- .2 Identification:(Cont'd)
- .16 (Cont'd)
- .1 (Cont'd)
- receptacles. Identical width as finish device plate.
- .17 All addressable fire alarm devices are to be lamicaid identified.
- .1 Lamicaid identification is to be chain hung on mechanical items (pressure switches, supervisory switches, etc.).
- .2 Manual pull station lamicaid plate to be similar to typical receptacle lamicaid plate.
- .3 Lamicaid working to match physical location and annunciator display address.
- .18 Lamicaid 3mm thick plastic engraving sheet, white face, black core, for all electrical systems except Fire Alarm: Fire Alarm to have red face with white core.
- .1 1.5mm thick nameplates above receptacles as previously indicated, with top left and right corners to be rounded off.
- .2 Lettering on lamicaid nameplates shall not 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 Have the wording on nameplates and labels 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 and install lamicaid nameplates on, or adjacent to, all various systems' control panels, equipment racks and/or cabinets complete with information as indicated. Nameplates to reflect individual system's assigned name, and where

8 EQUIPMENT
IDENTIFICATION
(Cont'd)

- .6 (Cont'd)
applicable, indicate both designated panel name and associated branch circuit breaker number(s).
 - .1 Fire alarm panels
 - .2 Security (CCTV) units/panels
 - .3 Energy management racks/panels
 - .4 Television panels
 - .5 Communication racks/panels
 - .6 Low voltage lighting relay panels (EXAMPLE: LIGHTING RELAY PANEL #1 - LPA - 01).
 - .7 PA (Public Address) System.
- .7 Control Transformers:
 - .1 Concealed control transformers located within ceiling spaces 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 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 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. List to be neatly written using black indelible marker.
- .11 Colour code all electrical junction boxes, pull boxes, and conduit fittings as follows:
 - .1 Apply colour coding prior to pulling conductors into boxes.
 - .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.

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. Labels to be installed 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:
Phase A - Red
Phase B - Black
Phase C - Blue
Neutral - White
Bond - Green
Ground - Green
Isolated Ground - Green c/w yellow strip
- .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 e.g.: "Panel "P-1" - CCT.03". Identify all neutral conductors bonding and ground conductors to indicate the phase conductor with which they are associated.

10 CONDUIT AND
CABLE
IDENTIFICATION

- .1 Colour code conduits, boxes and metallic sheathed cables. Boxes are to be coloured inside and outside where one colour is required. Boxes are to be coloured 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.

10 CONDUIT AND
CABLE
IDENTIFICATION
(Cont'd)

.2 Code with plastic tape or 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.

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

.4 All various system junction and/or pull boxes etc., where located above ceiling grid system to have location identified 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. Intall 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>Outer</u> 19mm Discs	<u>Inner</u> 6mm Discs
Various Systems		
0 to 50 volts	VIOLET	
51 to 240 volts	YELLOW	
241 to 600 volts	ORANGE	
Fire Alarm	RED	
Telephone (voice only)	BLACK	

10 CONDUIT AND CABLE IDENTIFICATION (Cont'd)

	<u>Outer</u>	<u>Inner</u>
P.A. and Intercom	BLUE	
Security	BROWN	
Ground or Bond	GREEN	
Cable Television	YELLOW	WHITE
Energy Management	RED	WHITE
Computer (data only)	BLACK	WHITE
Voice and Data	BLUE	WHITE
CCTV	GREEN	WHITE
Other	BROWN	WHITE

- .5 Provide a legend of colour coding, mounted under plexiglass cover. Install in main electrical room.

11 WIRING TERMINATIONS

- .1 Lugs, terminals, screws used for termination of wiring to be suitable for copper conductors only.
- .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.

12 MANUFACTURERS AND CSA LABELS

- .1 Visible and legible after equipment is installed.

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.

14 SINGLE LINE ELECTRICAL DIAGRAMS

- .1 Provide single line electrical diagrams under plexiglass as follows:
- .1 Electrical distribution system: locate in main electrical room and local electrical room.
- .2 Include a legend of colour coding for the various systems identified in item 10-conduit and cable identification.

- 14 SINGLE LINE ELECTRICAL DIAGRAMS (Cont'd) .2 Drawings: Full drawing size from most recent drawing set, in main electrical room and 610mm x 610mm (minimum) size drawing in the penthouse.
- 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 wherever possible.
- .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 unless otherwise indicated. Locate disconnect devices in mechanical and elevator machine rooms on latch side of the door.
- 16 MOUNTING HEIGHTS .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or otherwise indicated.
- .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .3 Mounting heights for devices to conform with NBC 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: 460mm
- .2 Above top of continuous baseboard heater: 200mm, minimum 460mm AFF.
- .3 Above top of counters or counter backsplash: 150mm
- .4 In mechanical rooms: 1200mm
- .5 Exterior Receptacles: 1000mm
- .3 Panelboards: as required by Code or as indicated.
- .4 Wall mounted telephone, data and CATV outlets:
- .1 General: 460mm
- .2 Above top of continuous baseboard heater: 200mm, minimum 460mm 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
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- 16 MOUNTING HEIGHTS .4 (Cont'd)
(Cont'd)
- .7 Security keypads: 1200mm
 - .8 Pin/Prox readers: 1200mm
 - .9 Wall mounted motion sensors: 150mm below finished ceiling.
- 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 and motor control centres, operating under normal load. State hour and date on which each load was measured, and voltage at time of test.
- 18 CONDUIT AND CABLE INSTALLATION .1 Install conduit and sleeves prior to pouring of concrete. Sleeves through concrete: schedule 40 steel pipe or plastic, sized for free passage of conduit, and protruding 50 mm.
- .2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
- .3 Install cables, conduits and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.
- .4 Arrange and pay for holes through exterior walls and roof to be flashed and made weatherproof.
- 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.
- 20 FIELD QUALITY CONTROL .1 Conduct and pay for following tests:
- .1 Distribution system including phasing, voltage, grounding and load balancing.
 - .2 Circuits originating from branch distribution panels.
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- 20 FIELD QUALITY CONTROL
(Cont'd)
- .1 (Cont'd)
 - .3 Lighting and its control.
 - .4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
 - .5 Systems: fire alarm system and lighting control 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 Confirm circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.

PART 1 - GENERAL

- 1.1 REFERENCES .1 CSA C22.2 No. 65-2013, Wire Connectors, Tri-National Standard, with UL 486A-486B and NMX-J-543-ANCE-03.

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 Fixture type splicing connectors: with current carrying parts of copper and copper alloy sized to fit copper conductors #10 AWG or less.
- .3 Clamps or connectors for armoured cable, liquid tight flexible metal conduit.

PART 3 - EXECUTION

- 3.1 MATERIALS .1 Make connections and terminations electrically and mechanically secure. Sizes of connectors to be as per manufacturer's recommendations for various sizes and combinations of wire sizes.
- .2 Make joints required in branch wiring #10 and smaller utilizing "twist-on" type connectors as manufactured by "Ideal" (colour coded wirenut) of "Marrettes" #31, #33 or #35, or approved equivalents.
- .3 Make joints for all other wiring utilizing "Thomas & Betts" colour keyed compression type connectors #5400 series c/w TBM series compression tools. A first layer of compound type tape to be followed by an additional layer of "Scotch" #33 vinyl tape. Approved alternative for wire connections up to, and including #6 may be colour coded wing-nut as manufactured by "Ideal".
- .4 Plier tighten marrette type connectors.

PART 1 - GENERAL

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| <u>1.1 REFERENCES</u> | .1 | CSA C22.2 No. 0.3-09(R2014), Test Methods for Electrical Wires and Cables. |
| | .2 | CSA C22.2 No. 208-2014, Fire Alarm and Signal Cable. |
| | .3 | CSA C22.1-2015, Canadian Electrical Code (CEC). |
| <u>1.2 PRODUCT DATA</u> | .1 | Submit product data in accordance with Section 01 33 00. |
| <u>1.3 OPERATION AND MAINTENANCE DATA</u> | .1 | Submit operation and maintenance data for incorporation into manual specified in Section 01 78 00. |
| <u>1.4 RELATED WORK</u> | .1 | Electrical General Requirements: Section 26 05 00. |

PART 2 - PRODUCTS

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|---------------------------|----|--|
| <u>2.1 BUILDING WIRES</u> | .1 | Conductors: soft drawn stranded copper (of 98% conductivity). 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 | Copper conductors sized as indicated or as required by C.E.C., with 1000 V insulation of chemically cross-linked thermosetting polyethylene material rated RWU90-XLPE. |
| <u>2.2 TECK 90 CABLE</u> | .1 | Conductors:
.1 Grounding conductors: stranded copper.
.2 Circuit conductors: stranded copper, size as indicated. |
| | .2 | Insulation:
.1 Chemically cross-linked thermosetting polyethylene rated type RW90, 600V. |
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- 2.2 TECK 90 CABLE
(Cont'd)
- .3 Inner jacket: polyvinyl chloride material.
 - .4 Armour: interlocking aluminum.
 - .5 Overall covering: polyvinyl chloride (PVC), heat, flame and moisture resistant material.
 - .6 Connectors:
 - .1 Non-hazardous areas: Thomas & Betts Star Teck aluminum connectors or Crouse-Hinds or Appleton approved equivalent, complete with aluminum locknut.
 - .7 Multi-conductor TECK cable ampacity is to be de-rated in accordance with the Canadian Electrical Code (based on number of conductors in cable assembly, ambient temperature, etc.).
- 2.3 ARMOURED CABLES
- .1 Conductors: 600 V insulated (RW90 XLPE), copper (of 98% conductivity), size as indicated, minimum #12 AWG.
 - .2 Type: AC90.
 - .3 Armour: interlocking type fabricated from aluminum strip.
 - .4 Connectors: designed for cable.
- 2.4 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 (colour to suit system, see Section 26 05 00). FT6 rated when run in free-air.
- 2.5 FIRE ALARM CABLES
- .1 Type FAS 105 to CSA C22.2 No. 208, PVC insulation, size and quantity of conductors as indicated, 105°C flame retardant, Red PVC outer jacket. FT6 rated.
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PART 3 - EXECUTION

- 3.1 VOLTAGE DROP .1 Unless cable or wire sizes are indicated or noted on the electrical drawings, all 15A, 120VAC branch circuits size based on the following table. Length includes vertical drop. De-rated multi-conductor TECK cable sizes, if larger, will supersede the following table.

0-20m	#12 AWG
21-35m	#10 AWG
36-55m	#8 AWG
56-90m	#6 AWG
91-140m	#4 AWG
141-180m	#3 AWG
181-215m	#2 AWG

- 3.2 INSTALLATION OF BUILDING WIRES .1 Install wiring as follows:
.1 In conduit systems in accordance with Section 26 05 34.
.2 The feeder neutral for all new branch circuit panels must be rated to 200% of phase conductors.

- 3.3 INSTALLATION OF TECK 90 CABLE - 1000V .1 Install cables where indicated on drawings and herein. All mounting hardware will be galvanized steel.
.2 Group cables wherever possible on hanging assemblies, as specified in Section 26 05 29.
.3 Support cables independently of supports used for equipment of other trades; do not support from, or secure cables to any mechanical piping.
.4 Install cables in neat and professional manner, so as to conserve headroom.
.5 Cables to enter all wall mounted equipment from the top.
.6 Do not locate cables less than 300mm parallel to steam or hot water lines with minimum 100mm at crossovers.
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- 3.4 INSTALLATION OF FIRE ALARM CABLES
- .1 Install fire alarm cables in metallic conduit (EMT, unless otherwise indicated.
- 3.5 INSTALLATION OF ARMOURED CABLES
- .1 Group cables wherever possible.
- .2 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - 0 - 1000 V.
- .3 Install AC-90 cable as per the following guidelines:
- .1 AC90 will only be permitted for branch circuit wiring drops from ceiling junction boxes to light fixtures, within the same room requiring electrical power. The installation of AC90 cable for branch circuit wiring home runs or runs between rooms is not acceptable.
- .2 The grouping together of AC-90 cables to form a bundle for securing purposes is acceptable providing the following procedures are adhered to:
- .1 In addition to securing type AC-90 cables at 1.5m intervals to structure, multiple or bundled groups of armoured cables must be tye-wrapped together at mid-point between each structure support, or every 760mm and secured to structure at 1.5m intervals, and also secured together (between each structure point) at 1.5m intervals.
- .2 Limit grouping of AC-90 cables to a maximum of eight (8) current carrying conductors, including associated oversized neutral conductors where phase sharing occurs.
- .3 The following examples incorporate uses of both, common and dedicated (separate) branch circuit neutral conductors:
- .1 Maximum of two (2) runs of #12/4 conductor cables, including common (oversized) branch circuit neutral in each.
- .2 Maximum of two (2) runs of #12/3 conductor cables, including (oversized) branch circuit neutrals (if not 3 phase, 3 wire), plus one 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.
- .4 Where dedicated or separate branch circuit neutral conductors are non phase sharing, they need not be sized larger than phase conductors they accompany unless specifically indicated otherwise.
- .5 Originate 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 119mm² square.
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3.5 INSTALLATION
OF ARMOURED CABLES
(Cont'd)

- .3 (Cont'd)
- .6 A 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 ceiling space (above T-Bar ceiling only) and its respective light fixture.
- .1 Fixture drops are not to exceed 4.5m in total length unless specifically indicated otherwise.
- .2 There will be not more than four (4) drops permitted to be fed from any one box regardless of its size. Secure AC-90 cables used for fixture drops within 300mm of the junction box. Each light fixture is to be complete with its own separate fixture drop originating from a junction box located within same ceiling of room as fixture. An exception will be 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 or greater in diameter.
- .3 Wire light fixtures with a separate whip emanating from an overhead junction box within a T-bar ceiling space.
- .4 #12 AWG type AC-90 armoured cables may be used where total fixture drop loads do not exceed the following:
- .1 Maximum of 5000 watts @ 347 volts using #12 AWG drop.
- .2 Maximum of 1800 watts @ 120 volts using #12 AWG drop.
- .7 Provide separate pig-tail type leads in each light fixture junction/outlet box for final connections to fixture drops. Connect pig-tail leads to light fixture line and associated neutral conductors.

3.6 INSTALLATION
OF CONTROL CABLES

- .1 Install control cables in conduit.
- .2 Ground control cable shield where required.
- .3 Install insulated bonding conductor (minimum #12AWG Stranded Copper, green RW90 insulation) in conduit for control systems less than 50V.

3.7 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.
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- 3.7 INSTALLATION
OF CABLES: GENERAL
(Cont'd)
- .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. Inspection will be by the Departmental Representative. Correct any unacceptable Work at no cost to PWGSC.
 - .4 Install cables parallel and perpendicular to building lines.
 - .5 Secure cables to underside of metal decking wherever practicable.
 - .6 Exposed wiring at panels to be neatly marshalled from panel to finished ceiling space using suitably sized (minimum 450mm wide) ladder type cable tray.
 - .7 Ty-rap branch circuit phase conductors and neutral (where applicable) at the closest point of entry within all panelboards, pull boxes, junction boxes, MCC's and switchboards.
 - .8 Twist together stranded conductors at each termination.
 - .9 Do not notch or cut structural members of wood frame construction to accommodate wiring installation.
 - .10 Provide mechanical protection as required to protect wiring from damage from mechanical fasteners (nails, screws etc).
 - .11 Drill individual holes for wiring and cables penetrating wood frame floor joists. Locate holes in centre third of joist depth. Space holes a minimum of 25 mm and not less than one diameter apart.
 - .12 Obtain permission of Departmental Representative prior to drilling where more than four (4) holes must be clustered or adjacent to structural connections.

PART 1 - GENERAL

- 1.1 REFERENCES .1 CSA C22.2 No. 41-2013, Grounding and Bonding Equipment (Bi-National Standard with UL 467).

PART 2 - PRODUCTS

- 2.1 EQUIPMENT
- .1 Clamps for grounding of conductor: size as required and suitable for application.
 - .2 Rod electrodes: galvanized 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 9 - Wiring Identification).
 - .5 Ground bus: copper, minimum size 6mm x 75mm x 600mm size and as indicated, complete with insulated supports, fastenings, connectors.
 - .6 Ground connections to take place on the ground bus are 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 Bonding jumpers, straps.
 - .5 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 conductors from mechanical injury.
 - .4 Make buried connections, and connections to electrodes using copper welding by thermit process or inspectable copper crimp type compression connectors.
 - .5 Use mechanical connectors for grounding connections to equipment provided with lugs except grounding terminations in 600V switchboards, 600V CDP panels, 600V MCC's to be copper, compression type, long barrel, two hole connectors.
 - .6 Soldered joints not permitted.
 - .7 Install insulated bonding conductor in all conduits.
 - .8 Make grounding connections in radial configuration only, with connections terminating at single grounding point as indicated. Avoid loop connections.
 - .9 Secure 'feed' bonding conductor (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.
 - .10 Twist together all ground/bond wires with a screw-on type wire connector, and then place in the rear of the outlet box.
 - .11 Bond EMT wall stubs or sleeves to ground as per the latest CEC requirements.

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|---|---|
| <u>3.2 ELECTRODES</u> | <ul style="list-style-type: none">.1 Install rod electrodes and make grounding connections..2 Bond separate, multiple electrodes together..3 Use size #2/0 AWG copper conductors for connections to electrodes unless otherwise indicated..4 Make special provision for installing electrodes that will give acceptable resistance to ground value where rock or sand terrain prevails. Ground as indicated. |
|
 | |
| <u>3.3 SYSTEM AND CIRCUIT GROUNDING</u> | <ul style="list-style-type: none">.1 Install system and circuit grounding connections to neutral of secondary systems. |
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 | |
| <u>3.4 EQUIPMENT GROUNDING</u> | <ul style="list-style-type: none">.1 Install grounding connections to typical equipment included in, but not necessarily limited to following list: service equipment, transformers, switchgear, duct systems, frames of motors, motor control centres, starters, control panels, building steel work, generators, cellular floor headers and cells and fittings, distribution panels, outdoor lighting, metallic waste water piping systems, metallic rain water leader systems, metallic gas fuel piping systems. |
|
 | |
| <u>3.5 GROUNDING BUS</u> | <ul style="list-style-type: none">.1 Where existing electrical rooms and telecommunications rooms are provided with a ground bus, make ground connections to that bus..2 Ground items of electrical equipment to ground bus as indicated herein and on the Drawings. |
|
 | |
| <u>3.6 COMMUNICATION SYSTEMS</u> | <ul style="list-style-type: none">.1 Telecommunications: provide grounding and bonding in accordance with BICSI Telecommunications Distribution Methods Manual (TDMM), 12th Edition. |
|
 | |
| <u>3.7 FIELD QUALITY CONTROL</u> | <ul style="list-style-type: none">.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. |
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3.7 FIELD QUALITY	.3	Perform tests before energizing electrical system.
CONTROL		
(Cont'd)	.4	Where applicable, disconnect ground fault indicator during tests.

PART 1 - GENERAL

Not Applicable

PART 2 - PRODUCTS

2.1 SUPPORT
CHANNELS

- .1 U shape, size 40mm x 40mm, 2.7mm thick galvanized steel, surface mounted, suspended or set in poured concrete walls and ceilings unless otherwise indicated.
- .2 Standard rolled structural steel shapes, plates and pre-fabricated components to form a complete assembly.

2.2 CABLE TIES

- .1 The use of cable ties for supporting purposes is not permitted. Cable ties can only be used to hold various system cables in place.
- .2 Nylon flame retardent, low smoke cable tie. Size as required.
- .3 Nylon flame retardant, low smoke cable tie mounting bracket. Mechanical fastening type only; adhesive mounts not acceptable.

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 Do not support equipment from T-bar ceiling support. Provide independent 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 a maximum of 1m of each outlet box, junction box, pull box, cabinet or conduit fittings with spacing between

3.1 INSTALLATION
(Cont'd)

- .6 (Cont'd)
supports as per CEC to building construction, conduit type and support system using straps.
 - .1 One-hole straps to secure surface conduits and cables smaller than 41mm.
 - .2 Two-hole straps for conduits and cables 41mm and larger.
 - .3 Conduit straps to be zinc plated steel.
- .7 Suspended support systems for conduits:
 - .1 Support individual conduit runs with minimum 12mm dia. continuously threaded rods and spring clips.
 - .2 Support two (2) or more conduits on u-shaped support channels supported by minimum 12mm dia. threaded rod hangers (trapeze style) where direct fastening to building construction is impractical.
 - .3 Continuously threaded rods to be zinc plated steel.
 - .4 Space channels in accordance with the CEC for the smallest conduit installed (maximum 1.5m spacing).
 - .5 Install washer and nut on both upper and underside of channel.
- .8 For surface mounting of two (2) or more conduits, use channels spaced at 1.5m (center-to-center) spacing (maximum).
- .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 Confirm adequate support for raceways and cables, drop vertically to equipment where there is no wall support.
- .11 Do not use wire lashing or cable ties to support or secure raceways or cables.
- .12 Do not use non-electrical equipment 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 using cable ties as permitted in 26 05 21 - Wire and Cables 0-1000 Volts.

3.1 INSTALLATION
(Cont'd)

- .15 Support various suspended types of junction, pull and/or outlet boxes as well as conduits, with minimum size 9 mm threaded rod, nuts and flat washers. Secure threaded rods to boxes with one (1) 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 (22,500mm² and smaller).
 - .2 Two (2) rods required for boxes sized 22,500mm² and larger, up to and including those sized 300mm x 300mm (90,000mm²).
 - .3 Minimum of four (4) rods required for all boxes sized larger than 90,000mm²
 - .4 All excess rod is to be cut-off within 13mm of channel bottom.
- .16 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 from mid point of all 90° bends.
- .17 Maximum spacings between conduit support channels shall be as dictated by smallest size conduit(s) being supported and/or secured to same.
- .18 Touch up all field cut galvanized steel supports with galvanizing paint.

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.
- .2 Main and branch lugs or connection bars to match required size and number of incoming and outgoing conductors as indicated.
- .3 Provide at least three (3) spare terminals on each set of lugs in splitters less than 400 A.
- 2.2 JUNCTION AND PULL BOXES .1 Type C: welded steel construction, hinged cover, catch with hasp. Provision for locking. Surface or flush mounting as indicated.
- .2 Type D: welded steel construction with screw-on flat covers for surface mounting. Size cover a minimum of 25mm larger than the actual box dimensions. Surface or flush mounting as indicated.
- .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 shall be complete with screw cover.
- .4 Covers with 25mm minimum extension all around, for flush-mounted pull and junction boxes.
- .5 Single gang sectional type devices boxes being used in steel stud walls for the installation of both metallic and non-metallic type cables, shall not be sized smaller than 250cm², complete with wrap around type bracket.
- .6 Two (2) or more flush installed sectional boxes ganged together, or boxes sized 100mm² and larger (intended for devices) are to have an additional support bracket installed on opposite side of box not presently secured to metal stud.

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

2.4 EXTERIOR CABINETS .1 NEMA 4X, hinged screw-to-lock door 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 760mm 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. Refer to Section 26 05 29 for number of threaded rods.

.6 Junction or outlet boxes feeding a maximum of two fixture drops must not be sized smaller than 100mm square.

.7 Concealed boxes located in the ceiling spaces above suspended type ceilings are not to be installed greater than 762mm above the finished ceiling elevation.

.8 Junction boxes larger than 150mm x 150mm used in branch circuit wiring are to be complete with bonding terminal stripes.

.9 Bond all metallic pull boxes with bonding conductor.

3.3 IDENTIFICATION .1 Provide equipment identification in accordance with
Section 26 05 00.

PART 1 - GENERAL

- 1.1 REFERENCES .1 CSA C22.1-2015, 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 100mm 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.
.5 Combination boxes with barriers where outlets for more than one system are grouped.

- 2.2 SHEET STEEL OUTLET BOXES .1 Electro-galvanized steel single and multi gang flush device boxes for flush installation, minimum size 76mm x 50mm x 38mm or as indicated. 100mm square outlet boxes when more than one conduit enters one side with extension and tile rings as required.
.2 Electro-galvanized steel utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 100mm x 54mm x 47mm.
.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 single and multi gang boxes for devices flush mounted in exposed block walls.

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

2.5 FIRE RATED .1 Fire rated poke throughs are specified on drawings.
POKE THROUGHS

2.6 CONDUIT BOXES .1 Cast FS or FD feraloy boxes with factory-threaded hubs and mounting feet for all surface wiring of switches, receptacle, thermostats and similar devices mounted.

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

PART 3 - EXECUTION

3.1 INSTALLATION .1 Support boxes independently of connecting conduits.
.2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of Work.
.3 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 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.
.9 Install concealed boxes in accessible locations.

- 3.1 INSTALLATION
(Cont'd)
- .10 Flush installed 100mm or 120mm square box being used as a pull box or junction box to 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 Connect boxes to AC-90 cables specifically made for only AC-90 cables.
 - .13 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.

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), Electrical Rigid Metal Conduit - Steel (Tri-National Standard, with UL 6 and NMJ-J-534-ANCE-2007).

.2 CSA C22.2 No. 56-2013, 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(R2011), 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

- | | | |
|-------------------------------|----|---|
| <u>2.1 CONDUITS</u> | .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. |
| <u>2.2 CONDUIT FASTENINGS</u> | .1 | Use one (1) hole straps to secure surface conduits smaller than 41mm. Use two (2) hole straps for conduits 41mm and larger. Use straps that are zinc plated (galvanized) steel. |
| | .2 | Beam clamps to secure conduits to exposed steel work. |
| | .3 | Channel type supports for two (2) or more conduits at 1.5m oc. |
| | .4 | 12mm dia threaded rods to support suspended channels. |
| <u>2.3 CONDUIT FITTINGS</u> | .1 | Fittings: manufactured for use with conduit specified. Coating: same as conduit. |
| | .2 | Conduit fittings (LB, LL and LR) are to be used for 90° bends. "Ells" or corner pulling "Elbows" are prohibited. |
| | .3 | Connectors, fittings and couplings for EMT: use steel set-screw type. |
| | .4 | Rain-tight or waterproof type connectors shall be used on all vertical conduit runs to connecting equipment in areas with sprinkler heads. |
| | .5 | Screw on plastic or metal (malleable) type bushings for conduit ends. |
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- 2.4 EXPANSION
FITTINGS FOR RIGID
CONDUIT
- .1 Weatherproof expansion fittings with internal bonding assembly suitable for 200mm linear expansion.
 - .2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 21mm deflection in all directions.
 - .3 Weatherproof expansion fittings for linear expansion at entry to panel.

- 2.5 FISH CORD
- .1 Polypropylene: minimum 3mm diameter.

PART 3 - EXECUTION

- 3.1 INSTALLATION
- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass. Install as high as possible to underside of structure.
 - .2 Conceal conduits except in mechanical and electrical service rooms and in unfinished areas.
 - .3 Use electrical metallic tubing (EMT) in dry areas and where not subjected to damage. Do not use EMT in cast concrete.
 - .4 Use rigid hot dipped galvanized steel threaded conduit outdoors, in wet/damp areas (water entry and pilot plant rooms) and where subjected to damage.
 - .5 Use rigid PVC conduit underground and below concrete floor slabs: minimum size 27mm dia.
 - .6 Use liquid tight flexible metal conduit for connection to motors and other vibrating and/or mechanical equipment including but not limited to the following: dry type transformers, valves, motorized dampers, unit heaters, chillers, HVAC equipment, sprinkler system controls, etc.
 - .7 Minimum conduit size for lighting, power and control circuits: 21mm.
 - .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.

3.1 INSTALLATION
(Cont'd)

- .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.
- .16 Install bushings in all EMT and rigid galvanized steel conduits sized 21mm and larger before pulling in conductors.
- .17 Raintight EMT connectors and couplings are to be used on the vertical portion of conduit runs where terminating into tops of electrical equipment in areas with sprinkler heads and in wet areas.
- .18 Rigid PVC conduit shall be FT6 rated.
- .19 Install a conduit drop to each flush installed device box in all walls. For cables to be run in free air (telecommunications, etc), stub the conduit out of the wall into the accessible ceiling space of the room containing the flush installed device box.
- .20 For EMT wall stubs, install steel EMT connectors complete with plastic or grounding type bushings screwed on same. CSA approved EMT plastic end cap bushings may also be used.
- .21 Adequately bond conduit wall stubs and associated boxes to ground per CEC requirements.

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 Group conduits wherever possible on suspended or surface channels.
 - .4 Do not pass conduits through structural members except as indicated.
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|-------------------------------------|----|---|
| 3.2 SURFACE
CONDUITS
(Cont'd) | .5 | Do not locate conduits less than 76mm parallel to steam or hot water lines with minimum of 25mm at crossovers. |
| 3.3 CONCEALED
CONDUITS | .1 | Run parallel or perpendicular to building lines. |
| | .2 | Conduits to be installed above the bottom of the concrete ceiling drop panel. |
| 3.4 CONDUITS
UNDERGROUND | .1 | Slope conduits to provide drainage. |
| | .2 | Waterproof joints (pvc excepted) with heavy coat of bituminous paint. |
| | .3 | Where RPVC conduits emerge above floors, provide mechanical protection as required but not less than to a minimum of 150 mm above the slab. |
| | .4 | Install below slab conduits in trenches not less than 300mm from underside of concrete floor slab to bottom of trench. Provide minimum 50mm of freshwater sand all around conduits. |

PART 1 - GENERAL

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| 1.1 RELATED
SECTIONS | .1 | Electrical General Requirements: Section 26 05 00. |
|-------------------------|----|--|

PART 2 - PRODUCTS

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| 2.1 CABLE
PROTECTION | .1 | Protection materials and methods as indicated on drawings. |
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PART 3 - EXECUTION

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|---------------------------------------|----|---|
| 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. Ensure resistance to ground of circuits is not less than 50 megohms. |
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- 3.2 FIELD QUALITY CONTROL
(Cont'd)
- .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.

PART 1 - GENERAL

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| <u>1.1 REFERENCES</u> | .1 | CAN/CSA-C802.2-2012, Minimum Efficiency Values for Dry-Type Transformers. |
| <u>1.2 SHOP DRAWINGS AND PRODUCT DATA</u> | .1 | Submit shop drawings and product data in accordance with Section 01 33 00. |
| <u>1.3 OPERATIONS & MAINTENANCE DATA</u> | .1 | Provide operations and maintenance data for transformers for incorporation into manual in accordance with Section 01 78 00. |

PART 2 - PRODUCTS

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|-------------------------|----|---|
| <u>2.1 TRANSFORMERS</u> | .1 | Use transformers of one (1) manufacturer throughout project. |
| | .2 | Transformers must meet or exceed energy efficiencies as outlined in CAN/CSA-C802.2. |
| | .3 | Design 1: <ul style="list-style-type: none">.1 Type: dry..2 3 phase, kVA as indicated, 600 V input, 120/208 V output, 60 Hz..3 Voltage taps: 2.5% - 2FCAN, 2 FCBN (95%, 97.5%, 100%, 102.5% and 105%)..4 Insulation: Class H, 115°C temperature rise..5 Basic Impulse Level (BIL): standard..6 Hipot: standard..7 Average sound level: standard..8 Impedance at 170°C: standard..9 Enclosure: NEMA Type 2, ventilated removable metal front panel and hood, drip proof..10 Mounting: as indicated..11 Finish: in accordance with Section 26 05 00..12 Winding configuration: Delta primary, grounded Y secondary. All windings copper..13 Mandatory Accessories:<ul style="list-style-type: none">.1 Vibration isolators..2 Dual rated spade type transformer lug for ground/bonding of transformers..14 Acceptable material:<ul style="list-style-type: none">.1 Hammond Power.2 Schneider Canada.3 Delta.4 Siemens |
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|-------------------------------------|-----|------------------------------|
| <u>2.1 TRANSFORMERS</u>
(Cont'd) | .3 | Design 1:(Cont'd) |
| | .14 | Acceptable material:(Cont'd) |
| | .5 | Pex Manufacturing |

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|-------------------------------------|----|---|
| <u>2.2 EQUIPMENT IDENTIFICATION</u> | .1 | Provide equipment identification in accordance with Section 26 05 00. |
| | .2 | Label size: 9. |

PART 3 - EXECUTION

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|-------------------------|----|---|
| <u>3.1 INSTALLATION</u> | .1 | Securely mount dry type transformer on concrete housekeeping pad or on wall as indicated. Refer to drawings for mounting details. Provide external vibration isolators on transformer support channels at each of the four corners and between the transformer enclosure legs and floor or support structure.
.1 Acceptable material: Vibro-Acoustics RM Series, size as required. |
| | .2 | Transformers containing electrical termination points located on both front and rear sides of same are not acceptable. |
| | .3 | Install with adequate clearance around transformer for ventilation in accordance with the Canadian Electrical Code and Electrical Inspection department. |
| | .4 | Install transformers in level upright position. |
| | .5 | Remove shipping supports only after transformer is installed and just before putting into service. |
| | .6 | Loosen isolation pad bolts until no compression is visible. |
| | .7 | Megger both primary and secondary windings with 1000 V and 500 V megger as recommended by the manufacturer and report immediately any reading below 100 megohms. Submit test results for the Departmental Representative's review and approval and include in O&M Manual. |
| | .8 | Confirm the transformer is on the correct tap. Record tap settings and include in O&M Manual. |
| | .9 | Add lugs for copper conductors when double neutrals are used. |
-

- 3.1 INSTALLATION
(Cont'd)
- .10 Provide all dry type transformers complete with a Dual Rated Spade Type Transformer Lug, sized as required to facilitate both grounding and bonding conductor requirements.
- .1 To be bolted directly to transformer enclosure (chassis) with a minimum of two 12 mm bolts, flat and lock washers and accompanying nuts etc.
- .2 To contain number of termination openings as necessary to ensure individual terminations of "each" ground and "each" bond conductor(s) is achieved.
- .11 Make primary and secondary connections in accordance with wiring diagram.
- .12 Energize transformers after installation and testing is complete.

PART 1 - GENERAL

- | | | |
|---|----|---|
| <u>1.1 SOURCE QUALITY CONTROL</u> | .1 | Provide manufacturer's factory test certificates. |
| | .2 | Submit written test results to Departmental Representative. |
| | | |
| <u>1.2 SHOP DRAWINGS AND PRODUCT DATA</u> | .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. |
| | .3 | Submit shop drawings for surge protection device and digital metering. |
| | | |
| <u>1.3 OPERATION AND MAINTENANCE DATA</u> | .1 | Provide operation and maintenance data for panelboards, surge protection device and digital metering for incorporation into manual specified in Section 01 78 00. |
| | .2 | Include panel schedules. |

PART 2 - PRODUCTS

- | | | |
|------------------------|----|--|
| <u>2.1 PANELBOARDS</u> | .1 | Panelboards: use the product of one (1) manufacturer. |
| | .2 | 250 and 600 V panelboards: bus and breakers rated as indicated, short circuit current rating (RMS momentary symmetrical) 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 | Two (2) keys for each panelboard and key panelboards alike. |
-

2.1 PANELBOARDS
(Cont'd)

- .6 Tin-plated copper bus. Neutral to be 200% rated of mains.
- .7 Mains: suitable for bolt-on breakers.
- .8 Trim with concealed front bolts and hinges.
- .9 Trim and door finish: baked grey enamel.
- .10 Minimum of one terminal screw on factory installed neutral bar for each circuit breaker position.
- .11 Panelboards rated 225A and less will not be less than 508mm in width. Panelboards rated more than 225A shall not be less than 914mm wide x 280mm deep.
- .12 Suitably sized neutral lug(s) for 200% rated conductors.

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 Owner.

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.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install panels secure and plumb to walls or floors with appropriate fasteners and anchors.
- .2 Install floor mounted panels on concrete housekeeping pad. Pad to be nominal 100mm high and extend 25mm (minimum) beyond the equipment enclosure.
- .3 Connect neutral conductors to common neutral bus with respective neutral identified.
- .4 Bond panel to ground.
- .5 Enter and connect panel feeder and branch circuit wiring.
- .6 Perform tests and record results.
- .7 Install panel identification.

PART 1 - GENERAL

- 1.1 REFERENCES .1 CAN/CSA C22.2 No. 42-10, General Use Receptacles, Attachment Plugs and Similar Wiring Devices.
- .2 CAN/CSA C22.2 No. 55-M1986(R2012), Special Use Switches.
- .3 CAN/CSA C22.2 No. 111-10, Standard-use Snap Switches (Bi-National Standard with UL 20).
- 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 20A, 120V, specification grade single pole or two way switches as indicated.
- .2 Manually-operated general purpose AC switches with following features:
- .1 Terminal holes approved for #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 manufacturer throughout project.
- 2.2 RECEPTACLES .1 Design R1:
- .1 General purpose duplex receptacles, specification grade CSA type 5-15R, 125V, 15A, U-ground, with following features:
- .1 White urea molded housing.

2.2 RECEPTACLES
(Cont'd)

- .1 Design R1:(Cont'd)
 - .1 (Cont'd)
 - .2 Suitable for #10 AWG for back and side wiring.
 - .3 Break-off links for use as split receptacles.
 - .4 Eight (8) back wired entrances, four (4) side wiring screws.
 - .5 Triple wipe contacts and rivetted grounding contacts.
 - .6 Isolated ground receptacles where indicated.
 - .7 White nylon face.
- .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 #10 AWG for back and side wiring.
 - .3 Break-off links for use as split receptacles.
 - .4 Eight (8) back wired entrances, four (4) side wiring screws.
 - .5 Triple wipe contacts and rivetted grounding contacts.
 - .6 Isolated ground receptacles where indicated.
 - .7 White nylon face.
- .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 #10 AWG for back and side wiring.
 - .3 Eight (8) back wired entrances, four (4) side wiring screws.
 - .4 Triple wipe contacts and riveted grounding contacts.
 - .5 White nylon face.
 - .6 GFI test and reset buttons.
 - .7 Leakage current: Class A, 5mA.
- .4 Design R4:
 - .1 GFI duplex receptacles: Specification grade, CSA type 5-20R(T-Slot), 125V, 15/20A, U-ground with the following features:
 - .1 White urea moulded housing.
 - .2 Suitable for #10 AWG for back and side wiring.
 - .3 Eight (8) back wired entrances, four side wiring screws.

-
- 2.2 RECEPTACLES (Cont'd)
- .4 Design R4:(Cont'd)
 - .1 GFI duplex receptacles:(Cont'd)
 - .4 Triple wipе contacts and riveted grounding contacts.
 - .5 White nylon face.
 - .6 GFI test and reset buttons.
 - .7 Leakage current: Class A, 5mA.
 - .5 Other receptacles with ampacity and voltage as indicated.
 - .6 Use the receptacles of one (1) manufacturer throughout project.
- 2.3 COVER PLATES
- .1 Cover plates for wiring devices.
 - .2 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.
 - .3 Brushed stainless steel plates for wiring devices mounted in flush-mounted outlet box.
 - .4 Sheet metal cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.
 - .5 Lockable UV resistant polycarbonate while-in-use weather-proof cover plates.
- PART 3 - EXECUTION
- 3.1 INSTALLATION
- .1 Switches:
 - .1 Install single throw switches with handle in "UP" position when switch closed.
 - .2 Install switches in gang type outlet box when more than one (1) switch is required in one location.
 - .3 Mount toggle switches at height specified in Section 26 05 00 - Electrical General Requirements or as indicated.
 - .4 Recess switches in finished areas.
 - .2 Receptacles:
 - .1 Install receptacles in gang type outlet box when more than one (1) receptacle is required in one location.
 - .2 Mount receptacles at height specified in Section 26 05 00 - Electrical General Requirements or as indicated.
 - .3 Where split receptacle has one portion switched, mount vertically and switch upper portion.
-

3.1 INSTALLATION
(Cont'd)

- .2 Receptacles:(Cont'd)
 - .4 Mount receptacles with "U" ground up for vertically mounted and neutral slot at top for horizontally mounted receptacle.
 - .5 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.
 - .6 Use recessed receptacles in finished areas.
- .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 Demonstrate successful operation of all devices and record results and set points at time of completion.

PART 1 - GENERAL

- | | | |
|---|----|--|
| <u>1.1 REFERENCES</u> | .1 | CAN/CSA C22.2 No. 248, SET, 2000, Low Voltage Fuses Complete Set. |
| <u>1.2 SHOP DRAWINGS AND PRODUCT DATA</u> | .1 | Submit shop drawings and product data in accordance with Section 01 33 00. |
| <u>1.3 MAINTENANCE MATERIALS</u> | .1 | Provide three (3) spare fuses of each type and size. |
| <u>1.4 DELIVERY AND STORAGE</u> | .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

- | | | |
|--------------------------|----|--|
| <u>2.1 FUSES GENERAL</u> | .1 | Fuses: product of one manufacturer. |
| | .2 | Low voltage fuses, types as specified, shall be CSA certified in accordance with CSA Standard C22.2 No. 248. |
| <u>2.2 FUSE TYPES</u> | .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. 248.8.
.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 CC: |

- 2.2 FUSE TYPES (Cont'd) .3 Class CC:(Cont'd)
- .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.

PART 3 - EXECUTION

- 3.1 INSTALLATION .1 Install fuses in mounting devices immediately before energizing circuit.
- .2 Confirm correct fuses are fitted to physically matched mounting devices.
 - .3 Confirm correct fuses are fitted to assigned electrical circuit.
 - .4 Ensure fuse size is correctly identified on equipment.
 - .5 For feeder circuit fuses, use fast acting Class J 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 solid state, reduced voltage motor soft starters, use Class HSJ time delay fuses (15A and above) and fast acting Class J fuses (less than 15A).
 - .8 For 600Vac control circuits, use Class CC type fuses. Use time delay Class CC fuses upstream of control transformers and solenoids.

PART 1 - GENERAL

- | | | |
|---|----|--|
| <u>1.1 PRODUCT DATA</u> | .1 | Submit product data in accordance with Section 01 33 00. |
| | .2 | Include circuit breaker types, ratings, magnetic adjustment ranges and time-current characteristic curves for breakers with ampacity of 225 A and over. LSIG adjustment ranges to be included for LSIG breakers. |
| <u>1.2 OPERATION AND MAINTENANCE DATA</u> | .1 | Provide operation and maintenance data for circuit breakers for incorporation into Manual specified in Section 01 78 00. |
| | .2 | Include matrix for individual circuit breaker settings for all breakers with adjustable settings. |

PART 2 - PRODUCTS

- | | | |
|-----------------------------|----|---|
| <u>2.1 BREAKERS GENERAL</u> | .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 pole breakers to have single handle. |
| | .3 | Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting. Trip settings on breakers with adjustable trips to range from 3-8 times current rating. |
| | .4 | Circuit breakers with interchangeable trips as indicated. |
| | .5 | Circuit breakers to have interrupting capacity as indicated on the Drawings. |
| | .6 | GFI branch breakers to be ground fault interrupter type (5mA maximum) for circuits as indicated on the Drawings. |
| | .7 | Circuit breakers for all lighting circuits must be minimum 20A, unless otherwise indicated. |
-

- 2.2 THERMAL
MAGNETIC BREAKERS .1 Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.
- 2.3 MAGNETIC
BREAKERS .1 Moulded case circuit breaker to operate automatically by means of magnetic tripping devices to provide instantaneous tripping for short circuit protection.
- 2.4 SOLID STATE
TRIP BREAKERS .1 Moulded case circuit breaker to operate by means of a solid-state trip unit with associated current monitors and self- powered shunt trip to provide inverse time current trip under overload condition, long time, short time, and instantaneous tripping for phase and ground fault short circuit protection. Settings to be individually adjustable.
- 2.5 OPTIONAL
FEATURES .1 Include:
.1 On-off locking device for 10% of branch breakers and for all breakers supplying emergency lighting battery units and fire alarm devices.

PART 3 - EXECUTION

- 3.1 INSTALLATION .1 Install circuit breakers as required.
- .2 Adjust circuit breaker settings to the values indicated on the manufacturer's supplied Coordination Study.

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 driphood) electrical ratings as indicated.
- .2 Provision for padlocking in both the 'on' and '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 Auxiliary contacts for units supplying elevator equipment.
- .9 Viewing window to view open/close status of disconnect switch blades.
-

- 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.

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 Mounting method and dimensions.
 - .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.

PART 1 - GENERAL

- 1.1 RELATED WORK .1 Power Generation Natural Gas: Section 26 32 12.
- 1.2 REFERENCES .1 CSA-C13-M83(R2003), Instrument Transformers.
.2 CSA-C22.2 No. 178-1978(R2006), Automatic Transfer Switches.
- 1.3 SYSTEM DESCRIPTION .1 Automatic load transfer equipment to:
.1 Monitor voltage on all phases of normal power supply.
.2 Initiate cranking of standby generator unit on normal power failure or abnormal voltage on any one phase below preset adjustable limits for adjustable period of time.
.3 Transfer load from normal supply to standby unit when standby unit reaches rated frequency and voltage pre-set adjustable limits.
.4 Transfer load from standby unit to normal power supply when normal power restored, confirmed by sensing of voltage on all phases above adjustable pre-set limit for adjustable time period.
.5 Shut down standby unit after running unloaded to cool down using adjustable time delay relay.
- 1.4 SHOP DRAWINGS .1 Submit shop drawings in accordance with Section 01 33 00.
.2 Include:
.1 Make, model and type.
.2 Single line diagram showing controls and relays.
.3 Description of equipment operation including:
.1 Automatic starting and transfer to standby unit and back to normal power.
.2 Test control.
.3 Manual control.
.4 Automatic shutdown.
- 1.5 CLOSEOUT SUBMITTALS .1 Provide operation and maintenance data for automatic load transfer equipment for incorporation into manual specified in Section 01 78 00.
-

- 1.5 CLOSEOUT SUBMITTALS
(Cont'd)
- .2 Detailed instructions to permit effective operation, maintenance and repair.
 - .3 Technical data:
 - .1 Schematic diagram of components, controls and relays.
 - .2 Illustrated parts lists with parts catalogue numbers.
 - .3 Certified copy of factory test results.

PART 2 - PRODUCTS

- 2.1 MATERIALS
- .1 Instrument transformers: to CSA-C13.
 - .2 Transfer switch must meet or exceed the requirements of CSA C22.2 No. 178.
 - .3 Transfer switch to be mechanically interlocked to ensure only two possible positions, normal or emergency.
 - .4 All transfer switches and controllers shall be products of the same manufacturer.
 - .5 Busbars and main connections: 99.3% copper, tinplated.
 - .6 Main operators that include overcurrent disconnect devices, linear motors and gears shall not be accepted.
 - .7 Designs utilizing components of moulded case circuit breakers or switches will not be accepted.

- 2.2 CONTACTOR TYPE
TRANSFER EQUIPMENT
- .1 Two 3 phase contactors mounted on common frame, in double throw arrangement, mechanically and electrically interlocked, solenoid operated. Include a microprocessor controller to provide automatic operation. The operating time must not exceed 8 cycles including the power failure sensing.
 - .2 Open transition type switch with a fully rated solid neutral.
 - .3 Rated: continuous ampere rating as noted on the drawings, 600 V, 60 Hz, 3 phase, 3 pole, solid neutral.
 - .4 Switch and relay contacts, coils, spring and control elements accessible for inspection and maintenance

2.2 CONTACTOR TYPE
TRANSFER EQUIPMENT
(Cont'd)

- .4 (Cont'd)
from front of panel without removal of switch panel
or disconnection of drive linkages and power
conductors.
- .5 Minimum 35kA momentary (rms symmetrical) fault
withstand rating. Transfer switch to be suitable for
connection to standby generator as indicated.
- .6 Lever to operate switch manually when switch is
isolated.

2.3 MICROPROCESSOR
CONTROLLER

- .1 Provide the controller's sensing and logic by a
built-in microprocessor for maximum reliability.
- .2 Connect the controller to the transfer switch by an
interconnecting wiring harness. The harness includes
a keyed disconnect plug to enable the controller to
be disconnected from the transfer switch for routine
maintenance.
- .3 An LCD display and keypad will be an integral part
of the controller for viewing all available data and
setting desired operational parameters.
- .4 Controller LCD display to include a "System Status"
screen. The screen shall display a clear description
of the active operating sequence and switch position.
- .5 Controller to contain a diagnostic screen for the
purpose of detecting system errors. The screen will
provide information on the status input signals to
the controller which may be preventing load transfer
commands from being completed.
- .6 Controller to have the ability to log data and to
maintain the last 99 events, even in the event of a
total loss of power. The following events must be
time and date stamped and maintained in a non
volatile memory.
 - .1 Event Logging:
 - .1 Date, time, and reason for transfer normal
to emergency.
 - .2 Date, time, and reason for transfer
emergency to normal.
 - .3 Date, time, and reason for engine start.
 - .4 Date, time, engine stopped.
 - .5 Date, time, emergency source available.
 - .6 Date, time, emergency source not
available.
 - .2 Statistical Logging:
 - .1 Total number of transfers.

- 2.3 MICROPROCESSOR .6 (Cont'd)
CONTROLLER
(Cont'd)
- .2 Statistical Logging:(Cont'd)
.2 Total number of transfers due to source failure.
.3 Total number of days controller is energized.
.4 Total number of hours both normal and emergency are available.

- 2.4 VOLTAGE, .1 Voltage and frequency on both the normal and
FREQUENCY AND
PHASE ROTATION
SENSING

Parameter	Sources	Dropout	Pickup
Undervoltage	N & E, 3Ø	70-98%	85-100%
Over voltage	N & E, 3Ø	102-115%	2% below trip
Under frequency	N & E	85-98%	90-100%
Over frequency	N & E	102-110%	2% below trip
Voltage unbalance	N & E	5-20%	1% below DO

- .2 Voltage and frequency settings must be field adjustable in 1% increments either locally with the display and keypad or remotely via serial communications port access.
- .3 Controller to be capable (when activated by the keypad or through the serial port) of sensing the phase rotation of both the normal and emergency sources. The source will be considered unacceptable if the phase rotation is not the preferred rotation selected.
- .4 Provide source status screens for both normal and emergency to provide digital readout of voltage on all 3 phases, frequency, and phase rotation.

- 2.5 TIME DELAYS
- .1 Provide an adjustable time delay of 0 to 6 seconds to override momentary normal outages and delay all transfer and engine starting signals.
- .2 Provide a time delay on transfer to emergency, adjustable from 0 to 60 minutes, for controlled timing of transfer of loads to emergency.

2.5 TIME DELAYS
(Cont'd)

- .3 Provide two time delay modes (which are independently adjustable) on re-transfer to normal. One delay will be for actual normal power failures and the other for the test mode function. Time delays to be adjustable from 0 to 60 minutes. Time delay will be automatically bypassed if the emergency source fails and the normal source is acceptable.
- .4 Provide a time delay on shutdown of engine generator for cool down, adjustable from 0 to 60 minutes.
- .5 All time delays must be adjustable in one second increments.
- .6 All time delays will be adjustable by using the LCD display and keypad or through serial communications port.

2.6 ACCESSORIES

- .1 Provide an inphase monitor in the controller. The inphase monitor will compare both the normal and emergency sources and shall signal the transfer switch to operate at an advance angle as determined by the frequency difference between the two sources at the time of transfer. It must automatically adjust the phase advance angle at which the transfer operation is initiated to permit the load to be reconnected, so that inrush currents are limited to no more than normal starting current.
- .2 Provide a set of DPDT gold-flashed contacts rated 10 amps, 32 Vdc for a low-voltage engine start signal.
- .3 Provide LED indicating lights (16 mm industrial grade type 12): one to indicate when the ATS is connected to the norm source (green) and one to indicate when the ATS is connected to the emergency source (red).
- .4 Provide LED indicating lights (16 mm industrial grade type 12) and energize by controller outputs. The lights will provide true source availability of the normal and emergency sources, as determined by the voltage sensing trip and reset settings for each source.
- .5 Provide four (4) auxiliary contacts (rated 10A, 250 VAC), closed when the transfer switch is in normal position.
- .6 Provide four (4) auxiliary contacts (rated 10A, 250 VAC), closed when the transfer switch is in emergency position.

2.6 ACCESSORIES
(Cont'd)

- .7 Provide a pre-transfer signal prior to transfer occurring in either direction. The contact will close for an adjustable period of 0 to 15 seconds prior to transfer. The circuit will reset immediately after transfer.
- .8 Provide the ability to select "commit/no commit to transfer" to determine whether the load should be transferred to the emergency generator if normal source restores before the generator is ready to accept the load.
- .9 Provide terminals for a remote contact which opens to signal the ATS to transfer to emergency and for remote contacts which open to inhibit transfer to emergency and/or re-transfer to normal. Both inhibit signals will be activated through the keypad or serial port.
- .10 Wire all customer connections to a common terminal block to simplify field wiring connections.
- .11 Provide a three position momentary type test switch for the Test/Automatic/Reset modes. The test position will simulate a normal source failure. The reset position will bypass the time delays on either transfer to emergency or re-transfer to normal.
- .12 Engine exerciser: Controller to provide an internal engine exerciser. It shall be possible to program up to seven different exercise routines. For each routine, it must be possible to:
 - .1 Enable or disable the routine
 - .2 Enable or disable transfer of the load during routine.
 - .3 Set the start time: time of day, day of week, week of month (1st, 2nd, 3rd, 4th, alternate or every).
 - .4 Set the duration of the exercise. At the end of the specified duration the switch will transfer the load back to normal and run the generator for the specified cool down period.
- .13 Provide transfer equipment complete with a 100% rated bypass.

2.7 EQUIPMENT
IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00.
- .2 Control panel:
 - .1 For selector switch and manual switch: size 5 nameplates.

- | | | |
|--|----|--|
| <u>2.7 EQUIPMENT IDENTIFICATION (Cont'd)</u> | .2 | Control panel:(Cont'd)
.2 For meters, indicating lights, minor controls: size 3 nameplates. |
| <u>2.8 SOURCE QUALITY CONTROL</u> | .1 | Complete equipment, including transfer mechanism, controls, relays and accessories factory assembled and tested to applicable standards. |
| | .2 | Provide two (2) copies of written factory tests to the Departmental Representative for review. |
| | .3 | Tests:
.1 Operate equipment both mechanically and electrically to ensure proper performance.
.2 Check selector switch, in all modes of operation Test, Auto, Manual, Engine Start and record results.
.3 Check voltage sensing and time delay relay settings.
.4 Check:
.1 Automatic starting and transfer of load on failure of normal power.
.2 Retransfer of load when normal power supply resumed.
.3 Automatic shutdown.
.4 In-phase monitor operation. |

PART 3 - EXECUTION

- | | | |
|----------------------------------|----|---|
| <u>3.1 INSTALLATION</u> | .1 | Locate, install and connect transfer switch in the main switchboard as indicated on the drawings. |
| | .2 | Check controller and adjust as required. |
| | .3 | Connect auxiliary contacts to PLC/RTU as indicated. |
| | .4 | Mount control switches and annunciation lights in door of automatic transfer switch. |
| | .5 | Connect transfer switch to generator control panel as per manufacturer's recommendations, with 2-#14 AWG RW90 in conduit. |
| <u>3.2 FIELD QUALITY CONTROL</u> | .1 | Perform tests in accordance with Section 26 05 00. |
| | .2 | Energize transfer equipment from normal power supply. |

3.2 FIELD QUALITY
CONTROL
(Cont'd)

- .3 Set selector switch in "Test" position to ensure proper standby start, running, transfer, retransfer. Return selector switch to "Auto" position to ensure standby shuts down.
- .4 Set selector switch in "Manual" position and check to ensure proper performance.
- .5 Set selector switch in "Engine start" position and check to ensure proper performance. Return switch to "Auto" to stop engine.
- .6 Set selector switch in "Auto" position and open normal power supply disconnect. Standby genset should start, come up to rated voltage and frequency, and then load should transfer to standby. Allow to operate for 10 min, then close main power supply disconnect. Load should transfer back to normal power supply and standby should shutdown.
- .7 Repeat, at 15 minute intervals, four (4) times, complete test with selector switch in each position, for each test.
- .8 After completion of tests above, and a five minute cooling period, load test engine for a minimum of four (4) hours using the building load. Co-ordinate testing with the Departmental Representative to ensure representative plant load is available for load test. Record the following at 5 minute intervals for the first 15 minutes and at 15 minute intervals there after. - voltage, frequency, amperes - engine oil pressure and temperature Tabulate results and submit to the Departmental Representative for review and approval.
- .9 Arrange and pay for a factory certified representative to set up and commission transfer switch for proper operation to the satisfaction of the the Departmental Representative. Document all testing and set up and submit to the Departmental Representative. Assume that two (2) days (not including travel) for commissioning equipment will be required. Assume two (2) trips to the site will be required.
- .10 The factory certified representative will fully instruct the plant operators in the proper operation and maintenance of the automatic transfer switch and controls.

PART 1 - GENERAL

<u>1.1 DESCRIPTION OF WORK</u>	.1	This section specifies requirements for the supply and installation of surge protection devices.
	.2	Unless otherwise indicated, integrally mount SPDs in switchboards, panel boards or other distribution equipment.
<u>1.2 RELATED WORK</u>	.1	Service Entrance Switchboard: Section 26 24 02
	.2	Panelboards-Breaker Type: Section 26 24 17
<u>1.3 REFERENCES</u>	.1	IEEE C62.41.1-2002 and C62.41.2-2002, Surge Voltages in Low-Voltage AC Power Circuits.
	.2	IEEE C62.45-2002, Surge Testing for Equipment Connected to Low-Voltage (1000V and Less) AC Power Circuits.
	.3	IEEE 1100-2005, Powering and Grounding Electronic Equipment.
	.4	NEMA LS1-1992, Low Voltage Surge Protection Devices.
	.5	OSHA, Occupational Safety and Health Association, Compliance Handbook 1992.
	.6	UL 1283-2015, Standard for Safety for Electromagnetic Interference Filters.
	.7	ANSI/UL 1449-2014, 3rd Edition, Surge Protection Devices.
<u>1.4 SHOP DRAWINGS</u>	.1	Submit shop drawings in accordance with Section 01 33 00.
	.2	Provide Shop Drawings with wiring diagrams, installation information, testing and maintenance procedures, and operational information for the transient protection system.
	.3	Indicate: .1 Dimensional Drawing of each SPD type, Indicating proposed mounting arrangements. .2 Written functional description of the transient protection circuit in terms of components,

- 1.4 SHOP DRAWINGS (Cont'd)
- .3 Indicate:(Cont'd)
- .2 (Cont'd)
- configuration, design approach, and performance capability per NEMA LS1.
- .3 The means of connection of the SPD to the electrical distribution system per NEMA LS1.
- .4 Manufacturer will provide ANSI/UL1449 data card showing the Voltage Protection Rating (VPR), system voltage, phases, modes of protection and nominal discharge current (In) for the specific catalog number submitted.
- .5 Mark the devices with the short circuit current rating. This rating must meet or exceed the available fault current. Provide test data from an independent testing laboratory to demonstrate the short circuit current rating has been tested on a complete device.
- .6 Submit test report data clearly demonstrating the maximum surge current rating has been tested on a complete SPD unit including all necessary fusing/overcurrent protection, thermal disconnects, integral disconnects and monitoring systems. Manufacturers who cannot provide this data will not be considered.
- .7 Submit data demonstrating the complete SPD unit, including all overcurrent protection, is fully capable of a minimum repetitive surge current rating of 12,000 ANSI/IEEE C62.41, Category C3 (20kA) impulses without failure or a change in performance characteristics of more than 10%.
- .8 Written detailed response to each paragraph of the specification indicating that the proposed product meets or exceeds this specification. If specific paragraphs are not met, provide written explanation as to why not.
- 1.5 EXTENDED WARRANTY
- .1 Manufacturer to provide an extended product warranty for a period of not less than ten (10) years from the Date of Substantial Completion. Warranty must cover unlimited replacement of system protection modules during warranty period. The first five (5) years of this warranty must include any field labor required to perform repair or replacement work.
- 1.6 OPERATION AND MAINTENANCE DATA
- .1 Provide maintenance data for SPDs for incorporation into manual specified in Section 01 78 00.
-

PART 2 - PRODUCTS

- 2.1 ENVIRONMENTAL
- .1 General requirements:
 - .1 No audible noise must be generated.
 - .2 Operating Conditions:
 - .1 30 - 130 Degrees F
 - .2 15 - 85 Percent Humidity Non-Condensing
 - .2 Integral Mount: the unit enclosure within the equipment must meet the requirements of the equipment in which it is installed and shall not degrade the equipment ratings. SPDs integral to equipment must be designed to mitigate the migration of faults within the SPD to the switchboard or panel.
 - .3 Side mount enclosure: Unit to have a heavy duty NEMA 12 dust-tight, drip-tight enclosure.
- 2.2 SURGE SUPPRESSORS
- .1 General requirements:
 - .1 Rated for a 600Y/347 volt, 60 Hertz, 3-phase, 4-wire or 208Y/120Volt 60 Hertz, 3 phase 4-wire systems as indicated.
 - .2 Provide surge suppressors in accordance with the following requirements:
 - .1 Unit to be parallel in design and connect in parallel to main switchboard. Each surge suppression element (MOV) must be individually fused so that a failure of one element and/or fuse will not affect other surge suppression elements.
 - .2 Unit to be ANSI/UL 1449, 3rd Edition recognized.
 - .3 Unit to provide maximum UL 1449 3rd Edition Voltage Protection Rating (VPR) for 600Y/347 Volt systems as follows:
 - .1 N-G; L-N; L-G = 1500V
 - .2 L-L = 3000V

2.2 SURGE
SUPPRESSORS
(Cont'd)

- .1 (Cont'd)
- .2 (Cont'd)
- .4 For 208Y/120V systems as follows:
- .1 N-G; L-N; L-G = 700V
- .2 L-L = 1200V
- .5 Unit to provide maximum surge current rating of amperes per mode (L-L, L-G) and amperes per phase based on ANSI/IEEE C62.41 standard 8 by 20 microsecond current waveform as indicated below:
- Location
Category
- | | |
|---|---------------------------------|
| C | 250kA per phase: 125kA per mode |
| B | 160kA per phase: 80 kA per mode |
| A | 120kA per phase: 60kA per mode |
- .6 Unit to have a short circuit current rating of 50,000 amperes at rated voltage or greater.
- .7 Unit to be UL 1283 listed as an electromagnetic interference filter and provide 50 Ohm noise attenuation of at least 40 dB at 100 kHz, 30 dB at 1 MHz, 35 dB at 10 MHz, and 50 dB at 100 MHz.
- .8 Unit to include solid-state, long-life externally mounted LED visual status indicators that indicate the on- line status and operational integrity of each phase of the unit.
- .9 Unit to have a Form C summary alarm output contact rated for at least 1 amp at 120VAC for remote annunciation of TVSS status.
- .10 Unit to include a built-in, push-to-test feature that tests the integrity of all modules, MOVs and fuses in the system. Manufacturers that require an external test device to perform this feature will include the test set in this quotation.
- .11 Unit to have an audible alarm with an alarm on/off switch to silence the alarm and a push to test switch to test the alarm function.
- .12 An adjustable (resetable) counter will be provided to totalize transient voltage surges in both the normal and common mode. The counter will come complete with a 10-year battery back-up to maintain counts in the event of power loss.
- .2 SPDs must not require any routine maintenance or parts replacement during their published lifetime.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 General requirements:
 - .1 All SPDs must be factory installed integral with electrical assemblies unless otherwise indicated.
 - .2 Install Category C location SPDs in service entrance equipment.
 - .3 Install Category B location SPDs in distribution panels.
 - .4 Install Category A location SPDs in branch circuit panels.
 - .5 For side mounted SPDs conductors between suppressor and point of attachment to equipment shall be as short as possible, and not exceeding 600 mm.
 - .6 Grounding: Suppressor ground shall be bonded to the equipment grounding conductor and service entrance ground.
- .2 Arrange and pay for a factory certified representative to set up and commission the TVSS at site for proper operation to the satisfaction of the Departmental Representative. Document all testing and set up and submit to Departmental Representative. Assume that a minimum of one (1) day (not including travel) will be required.
- .3 Provide training to the Owner's forces in the operation and maintenance of the device.

PART 1 - GENERAL

- 1.1 REFERENCES
- .1 ANSI C82.1-2011, Line Frequency Fluorescent Lamp Ballasts.
 - .2 IEEE C62.41.2-2002, IEEE Recommended Practice on Characterization of Surges in Voltages in Low-Voltage (1000V and less) AC Power Circuits.
 - .3 IEEE C62.45-2002, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000V and less) AC Power Circuits.
 - .4 CAN/CSA C654-10, Fluorescent Lamp Ballast Efficacy Measurements.
 - .5 NECA/ESNA 500-2006, Recommended Practice for Installing Indoor Commercial Lighting Systems (ANSI).
 - .6 ANSI/IESNA RP1-2004; American National Standard Practice for Office lighting.
 - .7 ASTM F1137-11, Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners.
 - .8 FCC CFR47; USA Federal Communications Commission Frequency Allocations and Radio Treaty Matters; General Rules and Regulations.
- 1.2 RELATED SECTIONS
- .1 Submittal Procedures: Section 01 33 00
 - .2 Environmental and Waste Management Plans: Section 01 74 21
 - .3 Closeout Submittals: Section 01 78 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 or light source for each luminaire type.
 - .3 Ballast for each luminaire type.
 - .3 Shop Drawings:
 - .1 Shop drawings to clearly indicate the following:
 - .1 Luminaire ID number as identified in contract documents.
-

- | | | |
|---|--|--|
| 1.3 SHOP DRAWINGS
AND PRODUCT DATA
(Cont'd) | .3 Shop Drawings:(Cont'd) | |
| | .1 (Cont'd) | |
| | .2 Fixture specification as identified in Part 2. | |
| | .3 Solid State Light Sources or Lamp specification as identified in Part 2. | |
| | .4 Solid State Drivers or Ballast specification as identified in Part 2. | |
| | .5 Photometric data for each luminaire type. | |
| | .6 Energy data for light source and driver/ballast. | |
| | .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;and | |
| | .7 Summary in accordance with IES procedures. | |
| 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 21. | |
| | .2 Place materials defined as hazardous or toxic waste in designated containers. | |
| | .3 Confirm emptied containers are sealed and stored safely for disposal away from children. | |
| | .4 Disposal of fluorescent lamps. | |

1.6 HIGH
PERFORMANCE T8
LIGHTING SYSTEM

- .1 Use 32W T8 lamps listed as approved products in Efficiency Nova Scotia's "Smart Lighting Choices" program.
- .2 Provide fluorescent lamps that are within the TCLP criteria for classification as non-hazardous waste.

PART 2 - PRODUCTS

2.1 DRIVERS

- .1 Dimmable as indicated on drawings.
- .2 Total THD <10%.

2.2 LUMINAIRES

- .1 Refer to luminaire schedule on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Locate and install luminaires as indicated.
- .2 Coordinate installation with all other services.
- .3 Each "lay-in" type fixture must be capable of being raised upwards and moved laterally in any direction a minimum of not less than 610mm.

3.2 WIRING

- .1 Connect luminaires to lighting circuits as indicated.
- .2 Each light fixture installed in acoustic (drop ceiling systems) ceiling 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 light fixtures (drop ceiling systems) ceiling 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.
- .4 A maximum of four (4) drops is permitted from any single box, regardless of box size.
- .5 AC-90 fixture drops may only be supported from T-Bar ceiling grid support wires with metal type clips,

3.2 WIRING
(Cont'd)

- .5 (Cont'd)
approved for this particular application. The use of
tye-wraps is prohibited.
- .6 If the luminaire opening in a non accessible ceiling
is less than 150mm in diameter, provide a separate
fixture drop.
- .7 Run fixture drops to an accessible junction box
above an accessible ceiling or an access panel.
- .8 Fixture drops are not to exceed 5m in length.

3.3 LUMINAIRE
SUPPORTS

- .1 For suspended ceiling installations, support
luminaires independently of ceiling with threaded
rods and metal channel or aircraft cable.

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.

PART 1 - GENERAL

- | | |
|------------------------------------|--|
| <u>1.1 DESCRIPTION OF WORK</u> | <ul style="list-style-type: none">.1 Supply, install and commission complete system for the control of lighting and other equipment as indicated on the lighting and lighting control system drawings and as further defined herein..2 The Contractor is solely responsible to verify quantity of specific devices and equipment required for this project. The Contractor is responsible for providing all components and accessories necessary to ensure a fully functional lighting control system..3 The system must include but not be limited by the following list: Pre-wired, microprocessor-controlled relay panels with electrically- or magnetically-held, electronically- or magnetically-latched relays controlled via a complete list of communication based accessories including digital switches, dual-technology occupancy sensors, Digital Time Clock (DTC) and interface cards to building automation systems, fire alarm system, security/intrusion alarm system, access control system, and other devices as indicated herein or as necessary for the proper operation of the lighting control system. |
| <u>1.2 CONSTRUCTION SUBMITTALS</u> | <ul style="list-style-type: none">.1 Shop Drawings: submit dimensioned drawings of lighting control system and accessories including, but not necessarily limited to, relay panels, switches, DTC, occupancy sensors, and other interfaces. Shop drawings must indicate locations of each device..2 One-line Diagram: submit a one-line diagram of the system configuration indicating the type, size and number of conductors between each component. The one-line diagram must also indicate all auxiliary system interface components. Submittals that show typical riser diagrams are not acceptable..3 Separate Price List: submit with the shop drawings separate pricing for individual components (and associated auxiliaries) identified below. The Vendor must also submit pricing for any other components which may be deemed necessary not included in the below list. The pricing must include for the supply, delivery as well as any associated programming of such components. The submitted pricing must be valid until the Substantial Completion of the project.<ul style="list-style-type: none">.1 Digital Switch.2 Relay (on/off control zone) |

1.2 CONSTRUCTION
SUBMITTALS
(Cont'd)

- .3 Separate Price List:(Cont'd)
 - .3 Dimming control zone (0- 10Vdc)
 - .4 Occupancy Sensor
 - .5 I/O Interface Card
- .4 Provide information on the Manufacturer including head office location, Canadian office locations, local sales representative and local service representative.

1.3 MAINTENANCE
MATERIALS

- .1 Provide the following information for submission as per Section 01 78 00.
- .2 Provide, at the completion of the project, Operation and Maintenance materials for inclusion in the Operation and Maintenance Manual. These materials must, at a minimum, include product data, shop drawings, updated single line diagram (indicating any modifications, additions or subtractions made from the time of Tender to the completion of construction), CD version of the operating software including graphical interface software, letter verifying installation, letter verifying start-up and commissioning. Provide quantity of Operation and Maintenance materials as required.
- .3 Provide, at the completion of the project, separate pricing for individual components (and associated auxiliaries) identified below. The Vendor must also submit pricing for any other components or services which may be deemed necessary not included in the below list. The pricing must include for the supply, delivery as well as any associated programming of such components. The submitted pricing must be valid for one (1) year from the date of Substantial Completion and must be specifically identified by the Vendor.
 - .1 Digital Switch
 - .2 Relay (on/off control zone)
 - .3 Dimming control zone (0- 10Vdc)
 - .4 Occupancy Sensor
 - .5 I/O Interface Card
- .4 Provide, at the completion of the project, a listing of recommended spare components with which may be deemed necessary under normal operation of:
 - .1 1000 hours
 - .2 One (1) year
 - .3 Three (3) years
 - .4 Five (5) years

1.4 QUALITY
ASSURANCE

- .1 Products must be manufactured by a firm regularly engaged in manufacture of lighting control equipment and ancillary equipment, of types and capacities required, whose products have been in successfully used in similar service for not less than five (5) years.

1.5 SUBSTITUTIONS

- .1 Submit pricing based on the specification and drawings provided however alternate lighting control systems and associated products may be proposed by the Contractor with separate pricing for such systems provided, in addition to the specified system, with the Tender. If alternate systems and/or products are proposed, a complete description of the system and operation is to be included as well as a description of variances from the specified system.
- .2 Any discrepancies between the specifications and proposed products and system must be identified, with full description of the variance from the specifications as well as reference to the specification item.
- .3 Alternate system pricing must include all associated modifications and additions related to materials, labour, wiring, etc., necessary for a fully installed, functional and commissioned system.

1.6 SYSTEM
DESCRIPTION

- .1 The lighting control system is to be a networked system that communicates via low voltage serial communication. The system must be able to communicate with fully digital centralized relay panels, micro relay panels, digital switches, photocells, occupancy sensors, and various interfaces, and must include all operational software. Distributed lighting control for perimeter spaces identified with daylight harvesting utilizing continual dimming; areas identified with manual dimming control as well as meeting areas must be provided using a networked micro dimming/switching panel. A centralized relay panel will control switched lighting loads located on each floor level. Centralized relay panels are to be located in the electrical rooms or accessible service chases. The lighting control system must include all hardware and software required for complete system functionality. Software to be resident within the lighting control system. System must provide local

1.6 SYSTEM
DESCRIPTION
(Cont'd)

- .1 (Cont'd)
access to all programming functions at the master lighting control panel (LCP) and remote access to all programming functions via dial up modem and through any standard computer workstation running an industry standard internet browser. Lighting control system must have server built into the master LCP that serves HTML-formatted pages to any authorized workstation. Desktop and laptop computers are not part of this work and will be provided by others. Non-networked, non-digital, non-server capable systems not acceptable.
- .2 System software must provide real time status of each relay, each zone and each group.
- .3 The lighting control system dimming modules must operate with industry standard fluorescent dimming ballasts which require a control signal ranging from 0 - 10Vdc. The use of a lighting control system which requires proprietary ballasts must not be acceptable.
- .4 Lighting control system must be able to be monitored by and take commands from a remote PC. At any time, should the remote PC go off-line all system programming uploaded to the lighting control system must continue to operate as intended. Systems requiring an on line PC or server for normal operation are not acceptable
- .5 All devices must be pre-addressed at the factory. Field addressing is not acceptable.
- .6 All programs, schedules, time of day, etc., must be held in non-volatile memory for a minimum of ten (10) years at power failure. At restoration of power, lighting control system must implement programs required by current time and date without external support from PC or servers.
- .7 System must be capable of flashing lights Off/On any relay or any zone prior to the lights being turned Off. The warning interval time between the flash and the final lights off signal must be definable for each zone. Occupant must be able to override any scheduled Off sweep using local wall switches within the occupied space. Occupant override time must be locally and remotely programmable and not exceed two (2) hours.
- .8 The system must be capable of implementing On commands, Off commands, Raise (dimming) commands, Lower (dimming) commands for any relay, group or zone by means of digital wall switches, specification grade line voltage type wall switches, photocell,

1.6 SYSTEM
DESCRIPTION
(Cont'd)

- .8 (Cont'd)
occupancy sensor, web based software or other devices connected to programmable inputs in a lighting control panel.
- .9 The lighting control system must provide the ability to control each relay and each relay group per this specifications requirement. All programming and scheduling must be able to be done locally at the master LCP and remotely via dial up modem and via the Internet. Remote connection to the lighting control system must provide real time control and real time feedback.
- .10 System to consist of centralized relay panels, micro dimming/relay panels, digital switches, photocells, occupancy sensors and various digital interfaces. The Vendor is responsible to verify exact type and quantity of system components which are required based on the lighting controls design and the proposed lighting control system. Micro dimming/relay panels, centralized relay panels and digital switches must communicate as one network via RS485 (CAT 6 cabling with RJ45 connectors). Micro dimming/relay panels, mounted in each local area, must control lighting fixtures in that space, provide power to occupancy sensors and take input from daylight sensor and occupancy sensors. Micro dimming/relay panels must be capable of taking inputs from standard, line voltage type switches and outputting up to eight (8) independent 0V to 10V dimming signals. All micro relay panels and all devices connected to micro relay panels (switches, photocells and occupancy sensors, etc.) must be wired per lighting control manufacturer's instructions.
- .11 Equip centralized relay panels with a minimum of 10% spare capacity for addition of future relays and 10% spare relays to a minimum of two (2).
- .12 The following section describes the general system operation and control requirements for the majority of the building spaces, specifics regarding controls and control schemes are indicated on the drawings. Note that it is intended that all lighting control zones must have the ability to be controlled from the time clock for both on and off functions:
.1 Meeting Rooms: Occupancy sensor for automatic off; manual switch for on/off control.
.2 All other rooms containing occupancy sensors are to be configured for automatic-on, automatic-off operation, with a time-delay of fifteen (15) minutes. Wall-mounted occupancy sensors must contain an override switch to allow lights to be switched on or off manually. If lights are switched off manually,

1.6 SYSTEM
DESCRIPTION
(Cont'd)

- .12 (Cont'd)
- .2 (Cont'd)
the system is to default back to automatic-on,
automatic-off operation.
- .3 Service Rooms: In general equip the service
spaces such as electrical, mechanical, and
telecommunications rooms with switched luminaires.
Line-voltage switch(es) will provide manual control
to turn the lighting on or off; no automated control
(time clock or occupancy sensor) for these spaces is
required unless specifically identified otherwise on
the drawings.
- .4 Integration with Building Systems: Incorporate
separate control signal inputs from the various
building systems into the lighting control system.
The building systems include: fire alarm,
security/intrusion alarm and access control. The
inputs are to be N/O contacts and will be provided to
the centralized relay panel located in the main
electrical room. Each input is to act as a master
switch turning on or off various lighting control
circuits throughout the building. Include a total of
twenty (20) inputs (and associated control outputs).
- .5 Fire alarm integration: Provide all relays,
wiring, programming, etc. as required to integrate
the lighting control system with the existing fire
alarm system. Upon activation of a fire alarm, all
lights within the public washrooms are to default to
100% light output for the duration of the alarm. Once
the fire alarm has been reset, the system is to
return to normal operation.

PART 2 - PRODUCTS

2.1 MATERIALS AND
COMPONENTS

- .1 Relay Panels:
- .1 CSA Type 1 rated enclosure with screw cover or
hinged door.
- .2 16-gauge steel barriers must separate the high
voltage and low voltage compartments of the panel.
- .3 LCP input power must be capable of accepting
120V.
- .4 Control electronics in the low voltage section
must be capable of driving 2 to 48, 30A, 18,000 SCCR
rated latching relays, control any individual or
group of relays, provide individual relay overrides,
provide a master override for each panel, store all
programming in non-volatile memory, after power is
restored return system to current state, provide
programmable blink warn timers for each relay and
every zone, and be able to control relays that
default to Open, Normally Open Latching (NOL) or

2.1 MATERIALS AND
COMPONENTS
(Cont'd)

- .1 Relay Panels:(Cont'd)
- .4 (Cont'd)
relays that default to Closed, Normally Closed Latching (NCL).
- .5 Lighting control system must be digital and consist of a Master LCP, Slave LCPs, Micro LCPs with up to eight (8) individual relays or dimming outputs, digital switches, digital interface cards. Master and slave relay panels must include a maximum of twelve (12) relays (spaces) and contain both 10% spare relays and 10% free space for the addition of future relays with a minimum of two (2) spare relays. All system components must connect and be controlled via a single Category 6, 4 twisted pair cable with RJ45 connectors, providing real time two-way communication with each system component. Analog systems are not acceptable.
- .6 The lighting control system is a networked system that communicates via RS485 and includes centralized relay panels, micro dimming/relay panels, digital switches, photocells, occupancy sensors, various interfaces and operational software. The intent of the specification is to integrate all lighting control into one system. Lighting control system must include all hardware and software. Software to be resident within the lighting control system. System must provide local access to all programming functions at the DTC and remote access to all programming functions via dial up modem and through any standard computer workstation running an industry standard internet browser. Lighting control system must have server built into the master LCP that serves HTML-formatted pages to any authorized workstation. Desktop computers are not part of this section and will be provided by others. Non-networked, non- digital system not acceptable.
- .7 Provide control transformers, voltage barriers and factory installed bonding and neutral termination strips.
- .2 Micro Dimming/Relay Panels:
- .1 Micro relay panels must have up to 8-30A, 18,000 SCCR rated lighting relays and must control all lighting in the designated area indicated on the plans and be networked to centralized relay panels, micro dimming/relay panels, digital switches, photocells, and various interfaces. Each micro dimming/relay panel must provide minimum 300mA at 12/24Vdc for powering occupancy sensors. Micro dimming/relay panels that require a separate occupancy sensor power pack are not acceptable.
- .2 Micro relay panel must provide a minimum 4-programmable photocell inputs, a minimum

2.1 MATERIALS AND
COMPONENTS
(Cont'd)

- .2 Micro Dimming/Relay Panels:(Cont'd)
- .2 (Cont'd)
- 4-programmable occupancy sensor inputs and matrixed contact closure inputs. This requirement is to ensure integration of entire lighting system into one networked, lighting control system.
- .3 Micro relay panels must be capable of outputting minimum four (4) and up to eight (8) independent 0V to 10V dimming signals, one independent dimming signal at each of 8 relays. In order to maximize daylight harvesting and minimize disruption to occupants, each dimming output must provide adjustment for baseline, start point, mid-point, end point, trim, fade up rate, fade down rate, time delay and enable/disable masking. All photocell setting must be remotely accessible. Systems providing On, Off with Time Delay only and system that do not provide remote access are not acceptable.
- .4 Provide control transformers, voltage barriers and factory installed bonding and neutral termination strips.
- .3 Standard Output relays:
- .1 UL Listed 30A, Latching, 18,000 SCCR, 277VAC. Ballast and HID: 20A at 347VAC, and Tungsten: 20 A at 120 Vac, electrically operated by momentary pulse, mechanically latched.
- .2 Relays must be individually replaceable. Relay terminal blocks must be capable of accepting two (2) #8 AWG wires on both the line and the load side. Systems that do not allow for individual relay replacement or additions are not acceptable.
- .3 Relays to be rated for 250,000 operations minimum at a full 30A lighting load, default to closed at normal power loss, Normally Closed Latching (NCL).
- .4 Optional relay types available must include: Normally Open Latching (NOL) relay rated for 250,000 operations, a 600V 2-pole NO and NC and a Single Pole, Double Throw (SPDT) relay.
- .4 Low Voltage Switches:
- .1 All switches must be digital and communicate via RS 485. Contact closure style switches, except as specified for connection to the micro dimming/relay panel matrixed contact closure inputs, must not be acceptable. The programming for a digital switch will reside in the switch itself, via double EPROM memory. Any digital switch button function must be able to be changed locally (at the DTC or a PC) or remotely, via modem, Internet or Ethernet.

2.1 MATERIALS AND
COMPONENTS
(Cont'd)

- .4 Low Voltage Switches:(Cont'd)
- .2 Digital low voltage switch must be a device that sits on the lighting control system bus. Digital switch must connect to the system bus using the same cable and connection method required for relay panels. System must provide capability to locally and remotely program each individual switch button, monitor and change function of each button locally and remotely. Each button must be capable of being programmed for On only, Off only, On/Off (toggle), Raise (Dim up) and Lower (Dim down). Moving switches requiring low voltage control wires from one input terminal to another to accomplish these functions are not acceptable.
- .5 DTC - Digital Electronic Time Clock:
- .1 A Digital Time Clock (DTC) must control and program the entire lighting control system and supply all time functions and accept interface inputs.
- .2 DTC must be capable of up to 32 schedules. Each schedule consists of one (1) set of On and Off times per day for each day of the week and for each of two (2) holiday lists. The schedules must apply to any individual relay or group of relays.
- .3 The DTC must be capable of controlling up to 126 digital devices on a single bus and capable of interfacing digitally with other individual busses using manufacturer supplied interface cards.
- .4 The DTC must accept control locally using built in button prompts and use of an 8 line 21-letter display or from a computer or modem via an on-board RS 232 port. All commands must be in plain English. Help pages must display on the DTC screen.
- .5 The DTC must be run from non- volatile memory so that all system programming and real time clock functions are maintained for a minimum of fifteen (15) years with loss of power.
- .6 Pre-installed lighting control software must provide via local or remote PC a visual representation of each device on the bus, show real time status and the ability to change the status of any individual device, relay or zone. System must be capable of running lighting control software, which must provide for directly importing vector based graphics.
- .7 Pre-Installed modem for remote programming from any location using a PC. Modem to include all necessary software for local or remote control.
- .8 DTC must provide system wide timed overrides. Any relay, group or zone that is overridden On, before or after hours, must automatically be swept Off by the DTC a maximum of 2 hours later.

2.1 MATERIALS AND
COMPONENTS
(Cont'd)

- .6 Occupancy Sensors: Ceiling or wall mount occupancy sensors in location indicated on the drawings. Occupancy sensors must be dual technology: passive infrared (PIR) and acoustic sensing technologies. Standard sensing area of 185 m². Sensors to be operated at 12- 24Vac or dc. Occupancy sensors must be powered through the lighting control system, occupancy sensors requiring separate power packs must not be accepted. Connect occupancy sensors to the centralized or micro dimming/relay panels, or networked via CAT 6 cabling. Programming for control must be via the lighting control software, occupancy sensors requiring manual adjustment are not acceptable.
- .7 Interfaces: Verify and install those interfaces required for a fully operational lighting control system and those specifically indicated on the plans.
- .1 A dry contact input interface card that provides 14 programmable dry contact closure inputs. Use shielded cable to connect input devices to interface card.
- .2 Interface card providing digital communication from one system bus to another system bus, allowing up to 12,000 devices to communicate.
- .3 A voice prompted telephone override interface module. Interface module must accept up to three (3) phone lines and allow up to three (3) simultaneous phone calls. Voice prompted menu and up to 999 unique pass codes must be standard with each interface module.
- .4 Software pre-installed to run graphical interface software. Software must provide via local or remote PC a visual representation of a specific area or the total area of the project. Full graphic pages must be designed to the Owner's specifications. The Owner must provide to Vendor all necessary files and criteria. Preparation and creation of a total of three (3) graphic pages must be included.

PART 3 - EXECUTION

3.1 EQUIPMENT
INSTALLATION

- .1 Install and verify the lighting control system and associated components. Have verification completed by a factory-trained manufacturer's representative.
- .2 Mount relay control cabinets as required. Cabinets must be wall mounted in service spaces or accessible chases; mounting above ceilings will not be accepted. Neatly lace and rack wiring in cabinets. During construction process, protect all interior components of each relay panel and each digital switch from dust and debris. Any damage done to electronic components due to non-protection is the sole responsibility of the Contractor.
- .3 Switches: Provide outlet boxes, single or multi-gang, as shown on the plans for the low voltage digital switches. Mount switches as per plans. Supply faceplates per plans and specifications. Supply and install the required low voltage cable, Category 6, 4 twisted pair, with RJ45 connectors and snagless boots (commonly referred to as Cat 6 patch cable) between all switches and panels. Field-test all Cat 6 patch cable with a recognized cable tester. All low voltage wire to be run in conduit.
- .4 Wiring:
 - .1 Do not mix low voltage and high voltage conductors in the same conduit. No exceptions.
 - .2 Confirm low voltage conduits or control wires do not run parallel to current carrying conduits.
 - .3 Place manufacturer supplied terminators at each end of the system bus per manufacturers' instructions.
 - .4 Neatly lace and rack wiring in cabinets.
 - .5 Plug in Category 6 patch cable that has been field-tested with a recognized cable tester, at the indicated RJ45 connector provided at each lighting control device, per manufacturer's instructions.
 - .6 Use Category 6 patch cable for all system low voltage connections. Additional conductors may be required to compensate for voltage drop with specific system designs. Manufacturer to recommend cabling type if different. Use shielded cable for dry contact inputs to lighting control system.
 - .7 Do not exceed 1,200 m (4,000 ft) wire length for the system bus.
 - .8 All items on the bus must be connected in sequence (daisy chained). Star and spur topologies are not acceptable.
 - .9 Install the specified lighting control system and make all necessary wiring connections to external

3.1 EQUIPMENT
INSTALLATION
(Cont'd)

- .4 Wiring:(Cont'd)
 - .9 (Cont'd)
devices and equipment, to include photocell. Wire per manufacturer instructions.
 - .10 Install all low-voltage wiring in accordance with specification section 27 05 13 - Telecommunications System.

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. A meeting with the Manufacturer's representative and the Departmental's Representative may be arranged by the Contractor at a location determined by the Departmental Representative coordinate these requirements.
- .2 Before Substantial Completion, arrange and provide a one (1) day instruction period to designated PWGSC personnel. This must be provided by a factory-trained manufacturer's representative.
- .3 Set-up, commissioning of the lighting control system, and operating personnel instruction includes:
 - .1 Confirmation of entire system operation and communication to each device.
 - .2 Confirmation of operation of individual relays, switches, occupancy sensors and daylight sensors
 - .3 Confirmation of system Programming, photocell settings, override settings, etc.
 - .4 Provide training to cover installation, maintenance, troubleshooting, programming, and repair and operation of the lighting control system.
- .4 Request PWGSC representation at the training by means of a project Request for Information (RFI) and suggest at least four (4) dates with at least ten (10) working days' notice prior to the training.
- .5 Provide a written record of the training, including a copy of the sign-in sheet, in the Operations Manuals.
- .6 Service and Operation Manuals:
 - .1 Submit operation and service manuals. Include complete manuals with the O&M Manual submission; data must be typewritten or drafted. Refer to other sections of the project specifications for numbers of required copies of the service and operation manuals. Provide at least one electronic copy of the Service and Operations Manuals and submit it to the Owner.
 - .2 Manuals must include instructions necessary for proper operation and servicing of system and must

3.2 INSTALLATION
AND SET-UP
(Cont'd)

- .6 Service and Operation Manuals:(Cont'd)
 - .2 (Cont'd)
include complete wiring circuit diagrams of system, wiring destination schedules for circuits and replacement part numbers. Manuals must include as-built cable Project site plot plans and floor plans indicating cables, both underground and in each building with conduit, and as-built coding used on cables. Programming forms of systems must be submitted with complete information.
- .7 Verify conduit for line-voltage wires enters panel in line-voltage areas and conduit for low-voltage control wires enters panel on low-voltage areas. Refer to manufacturer's plans and approved shop drawings for location of line and low-voltage areas. It is the responsibility of the contractor to verify with lighting control manufacturer all catalogue information and specific product acceptability.
- .8 For approved line voltage type micro relay panel switches connected to matrixed inputs of the micro relay panel, furnish #18 AWG solid conductors. For all other digital switches, provide wiring required by system manufacturer.
- .9 Test all low voltage cable for integrity and proper operation prior to turn over. Verify with system manufacturer all wiring and testing requirements.
- .10 Locate panels so that they are readily accessible and not exposed to physical damage.
- .11 Panel locations must be furnished with sufficient working space around panels to comply with the Canadian Electrical Code.
- .12 Securely fasten panels to the mounting surface by at least four (4) points.
- .13 Close any unused openings in the cabinet.
- .14 Ground cabinets as specified in the Canadian Electrical Code.
- .15 Lugs must be suitable and listed for installation with the conductor being connected.
- .16 Maintain conductor lengths to a minimum within the wiring gutter space. Conductors must be long enough to reach the terminal location in a manner that avoids strain on the connecting lugs.
- .17 Maintain the required bending radius of conductors inside cabinets.

3.2 INSTALLATION
AND SET-UP
(Cont'd)

- .18 Clean cabinets of foreign material such as cement, plaster and paint.
- .19 Distribute and arrange conductors neatly in the wiring gutters.
- .20 Follow the manufacturer's torque values to tighten lugs.
- .21 Before energizing the panelboard, the following steps must be taken:
 - .1 Retighten connections to the manufacturer's torque specifications. Verify required connections have been furnished.
 - .2 Remove shipping blocks from component devices and the panel interior.
 - .3 Remove debris from panelboard interior.
- .22 Follow manufacturers' instructions for installation and all low voltage wiring.

3.3 DOCUMENTATION

- .1 Each relay must have an identification label indicating the originating branch circuit number and panelboard name as indicated on the drawings. Each line side branch circuit conductor must have an identification tag indicating the branch circuit number.
- .2 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 drawing must indicate the loads controlled by each relay and the identification number for that relay, placement of switches and location of photocell. Give original to the Departmental Representative and place copies inside the door of each LCP.

3.4 SERVICE AND
SUPPORT

- .1 Start up: At least seven (7) days before turnover of project the Vendor will run diagnostics and confirm system programming, this can be done on site or remotely via telephone or data connection.
- .2 Telephone factory support must be available at no additional cost to the Contract both during and after the warranty period. Factory to pre-program the lighting control system per plans and approved submittal, to the extent data is available. The specified manufacturer, at no added cost, must provide additional remote programming via modem as required by the Electrical contractor or Departmental

- 3.4 SERVICE AND SUPPORT
(Cont'd)
- .2 (Cont'd)
Representative for the operation life of the system. Upon request manufacturer to provide remote dial up software at no added cost to system owner. No exceptions.
- .3 Provide a factory trained representative for on-site training of the operating and maintenance personnel. Coordinate timing with the Owner a minimum of three (3) weeks in advance. Provide a minimum of two (2) days of factory on-site training.
- 3.5 WARRANTY
- .1 Provide a minimum of two (2) year warranty on the entire lighting control system including components, software and hardware. The warranty must begin on the date of substantial completion as agreed by PWGSC and the Departmental Representative.

PART 1 - GENERAL

- 1.1 PRODUCT DATA .1 Submit product data in accordance with Section 01 33 00.
- .2 Data to indicate unit specifications and 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 WARRANTY .1 All emergency lighting units to have a minimum ten (10) year life warranty.
- 2.2 BATTERY UNIT - TYPE EM-1 .1 Supply voltage: 120VAC.
- .2 Output voltage: 12Vdc.
- .3 Operating time: four (4) hours continuous operation, based on full DC load.
- .4 Battery: sealed, maintenance free, ten (10) year life warranty.
- .5 Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01 V for plus or minus 10% input variations.
- .6 Solid state transfer circuit.
- .7 Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.
- .8 Signal lights: L.E.D. solid state, for 'AC Power ON' and 'High Charge'.
- .9 Lamp heads: integral on unit, 345 horizontal and 180 vertical adjustment.

- 2.2 BATTERY UNIT - .10 Lamp type: LED Type 4W (MR-16).
TYPE EM-1
(Cont'd)
- .1 Cabinet: suitable for direct mounting to wall and complete with knockouts for conduit. Removable or hinged front panel for easy access to batteries.
 - .2 Finish: white.
 - .3 Auxiliary equipment:
 - .1 Test switch.
 - .2 Self Diagnostic circuitry.

- 2.3 REMOTE HEAD .1 Supply voltage: 12 V dc from the battery pack as
TYPE EM-2 indicated on the Drawings.
- .2 Lamp heads: Lamp heads and stem shall be injection molded, impact resistant, flame retardant thermoplastic. Lampheads shall be fully adjustable for aiming lamps. Lamp type: two (2) LED Type 4W lamps (MR-16).
 - .3 Mounting: mounts directly onto standard octagon Junction box.
 - .4 Housing: 125mm round canopy with two (2) lamp heads. Colour is to be white.

- 2.4 WIRING OF .1 Conduit: As specified in Section 26 05 34 -
REMOTE HEADS conduits, conduit fastenings and fittings.
- .2 Conductors: minimum #12 AWG RW90 in conduit.

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 30 min. battery life upon loss of power.

PART 1 - GENERAL

- 1.1 PRODUCT DATA .1 Submit product data in accordance with Section 01 33 00.
- .2 Data to include unit specifications and 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.
- 1.3 REFERENCE .1 CAN/CSA-C860-2011, Performance of Internally Lighted Exit Signs.

PART 2 - PRODUCTS

- 2.1 EXIT LIGHT TYPE EXL-1 .1 Housing: die cast aluminum, brushed aluminum finish.
- .2 Face and back plates: die cast aluminum.
- .3 Lamps: One LED-2W panel 120VAC, 219,000 h.
- .4 Face plate: number of faces as indicated. Universal faces indicating "running man" pictogram only or "running man" pictogram with directional arrows.
- .5 Face plate pictogram to illustrate image and direction specific to application and installation eg: exist straight form here; progress down to right; progrss left; etc.
- .6 Face plate to remain captive for relamping.
- .7 Finish: white finish.
- .8 Options: Unit complete with integral 90 minute battery backup.
- .9 Mounting: Unit to have universal mounting position and single or double face with knock out arrows as indicated.
- .10 Minimum ten (10) year life warranty.

PART 3 - EXECUTION

- 3.1 INSTALLATION
- .1 Install exit lights.
 - .2 Install correct pictogram(s).
 - .3 Connect fixtures to exit light circuits as indicated on the drawings.
 - .4 Confirm that exit light circuit breaker is locked in on position.