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## **PART 1 - GENERAL**

### **1.1 GENERAL**

- . 1 This Section covers items common to Sections of Division 26, 27, 28 and portions of 33. This section supplements requirements of Division 1.
- . 2 Refer to Section 01 91 01 for commissioning requirements.
- . 3 Install and wire the following electrical equipment shipped loose with equipment specified in other sections: VFD's, hand dryers, door control devices, motorized door control buttons, control panels for air curtains.
- . 4 All overhead and underground medium voltage work is to be included in this project. Contractor to supply, install, wire, and test all hardware, including but not limited to pressure treated utility poles, guying, ACSR cable, group operated disconnect, fused cutouts, pad mounted transformer, concrete pad, grounding (both primary and secondary), all connections, etc to have a completely tested and operational service feed to the new facility. Some of specifications of this equipment is contained within this document and some is specified on the construction drawings.

### **1.2 CODES AND STANDARDS**

- . 1 Do complete installation in accordance with CSA C22.1-2012, and local regulations, except where specified otherwise.
- . 2 Do overhead systems in accordance with CAN/CSA-C22.3 No. 1 and underground systems in accordance with CAN/CSA C22.3 No. 7, except where specified otherwise.
- . 3 Abbreviations for electrical terms: to CSA Z85-1983.
- . 4 Comply with the requirements of the "Model National Energy Code of Canada for Buildings 2010."
- . 5 CAN3 C235-83(R2010).

### **1.3 CARE, OPERATION AND START-UP**

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

### **1.4 VOLTAGE RATINGS**

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

### **1.5 PERMITS, FEES AND INSPECTION**

- . 1 Submit to the Electrical Inspection Department, Municipal Authority and supply authority the necessary number of drawings and specifications, for examination and approval prior to commencement of work. This information shall be submitted within twenty (20) working days of the award of Tender and

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the Departmental Representative is to be provided with written notice at the time this has been submitted.

. 2 Obtain all necessary permits including an Electrical Wiring Permit for electrical work and Communications Cabling Permit for communications cabling work from the authority having jurisdiction, prior to commencement of work. Provide a copy of each permit to the Departmental Representative upon receipt. The permits are to be properly displayed on the work site.

. 3 Upon specific request, the Departmental Representative will provide, to the Contractor, up to a maximum of three (3) copies of the drawings and specifications required for submittal to the Electrical Inspection Department and Supply Authority. These drawings and specifications will be provided to the Contractor at no cost, unless specified otherwise.

. 4 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.

. 5 Furnish Certificates of Acceptance from authorities having jurisdiction upon completion of work. Include a copy in the Operation and Maintenance Manual.

. 6 Pay all associated fees, including necessary inspections and inspection department representation occurring outside normal working hours.

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## **1.6 MATERIALS AND EQUIPMENT**

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

## **1.7 FINISHES**

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

## **1.8 EQUIPMENT IDENTIFICATION**

- . 1 Identify electrical equipment with nameplates and labels as specified herein.
- . 2 Identification:
  - . 1 All switchboards, panels, disconnect switches, receptacles, voice/data, transformers, control panels, fire alarm devices, magnetic starters, TOL's, etc. are to be provided with "lamicoid" nameplates as further described herein. Care is to be taken to ensure that all plates are affixed true and level, and plumb in all instances.
  - . 2 Affix nameplates to all "metal" surfaces with steel type "pop-rivets".
  - . 3 Affix nameplates to other types of surfaces with contact type cement.
  - . 4 Affix nameplates to building "exterior" surfaces with nylon inserts and self tapping screws unless specifically indicated otherwise.
  - . 5 Apply contact type cement to complete rear side of plate, as opposed to several locations or areas on same.
  - . 6 Lamicoid nameplates installed on distribution panelboards, motor control centres, splitter troughs and transformers must indicate the following:
    - . 1 Designated name of equipment.
    - . 2 Amperage of overcurrent protection device.

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- . 3 Voltages, number of phases and wires.
- . 4 Designation of power source.

Example  
PANEL H - 150 AMPS  
120/208V - 3PH - 4W  
FED FROM MAIN SWITCHBOARD #QMS-1

- . 7 Lamicoid nameplates installed on combination starters, magnetic starters, manual starter and all various systems controls, control panels, disconnect switches, etc., must contain the following information:
  - . 1 Designated name of equipment.
  - . 2 Designated name of power source.
  - . 3 Branch circuit breaker number(s) where possible.
  - . 4 Voltage(s).

EXHAUST FAN NO. 5                      SUPPLY FAN NO. 3  
PANEL H - CCT. NO. 17              M.C.C. NO. 1  
120V - PH                                  600V - 3 PH

- . 8 Lamicoid nameplates installed on fusible type disconnect switches are to also indicate maximum designated/designated fuse size.
- . 9 Install lamicoïd nameplates on all junction and/or pull boxes sized 150 mm x 150 mm and larger indicating name of system, designated panel name and electrical characteristics where applicable.
- . 10 Install lamicoïd nameplates adjacent to each overcurrent devices located in switchboards, CDP panels, etc. They need only indicate designated name and/or number of equipment they feed. Unused O.C. devices are to be identified as spare(s).
- . 11 Lamicoïd 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 800 AMPS              MAIN SWITCH 200 AMPS  
346/600V, 3PH, 4W                      120/208V, 3PH, 4W

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

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

Example:  
Min. interrupting capacity of fuses  
installed in this MCC to be not less

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than 100 KAIC

- . 13 Install lamicoïd nameplates above all types of receptacles and abutted directly to tops of their respective device plates. Identification is to indicate respective panel source complete with associated circuit breaker number(s) as per the following:
  - . 1 1.5mm x 13mm high complete with 6 mm black letters on white core, directly above all receptacles. Plate to be identical width as finish device plate.

Example: PANEL H - 20

- . 14 Lamicoïd nameplates above 120V receptacles protected by GFCI circuit breakers, or GFCI type receptacles are to be identified 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 H-26).
- . 15 Apply lamicoïd nameplate(s) for power/voice/data outlets above face of finish plate, complete with information as specified in section 27 05 13.
  - . 1 1.5mm thick x 19mm wide complete with 6mm black letters on white cove above all receptacles. Identical width as finish device plate.
- . 16 All addressable fire alarm devices are to be lamicoïd identified.
  - . 1 Lamicoïd identification is to be chain hung on mechanical items (pressure switches, supervisory switches, etc.).
  - . 2 Manual pull station lamicoïd plate to be similar to typical receptacle lamicoïd plate.
  - . 3 Lamicoïd wording to match physical location and annunciator display address.
- . 17 Lamicoïd 3mm thick plastic engraving sheet, white face, black core, for all electrical systems except fire alarm which shall 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 lamicoïd nameplates are not to "start", nor "end" nearer than 13mm from either, or both ends of said plates. Size of lettering, including overall lengths of various plates shall be as indicated in the following chart.

**NAMEPLATE SIZES**

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

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

**1.9 WIRING  
 IDENTIFICATION**

- . 1 Identify wiring with self laminating, permanently mechanically imprinted labels on both ends of each conductor and cable utilized. Identify conductors and cables in each junction or pull box through which they pass. Install labels in a "flagged" manner around individual conductors.
- . 2 Maintain phase sequence and colour coding throughout.
- . 3 All conductors are to have their insulation colors identified as follows:
  - . 1 Phase A - Red
  - . 2 Phase B - Black
  - . 3 Phase C - Blue
  - . 4 Neutral - White
  - . 5 Bond - Green
  - . 6 Ground - Green
- . 4 Color coded "Conductor Insulation" as per the following:
  - . 1 All sizes of phase conductors up to and including #2AWG.
  - . 2 All sizes of neutral, bond and/or ground conductors up to and including #3/0AWG.
  - . 3 Approved colored tapes in lieu of insulation coloring may be used to identify conductors that exceed sizes as previously indicated. Labelling is to take place at both ends of all runs at a minimum of 300mm from terminations, in addition to within all boxes between both ends of the run.
- . 5 Use colour coded wires in communication cables, matched throughout system.
- . 6 Indicate panel and circuit number of all phase conductors i.e.: "Panel "A" - cct 3". Identify all neutral conductors bonding and ground conductors to indicate the phase conductor with which they are associated.

**1.10 CONDUIT  
 AND CABLE  
 IDENTIFICATION**

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

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

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Computer (data only)	BLACK	WHITE
Voice and Data	BLUE	WHITE

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

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

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

. 6 Where boxes are not concealed, disks are to be fastened directly to outside of boxes after architectural painting is complete. Coverplates for such boxes are to have each branch circuit number neatly identified inside of the coverplate.

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**1.11 WIRING  
TERMINATIONS**

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

**1.12 MANUFACTURERS  
AND CSA LABELS**

- .1 Visible and legible after equipment is installed.

**1.13 WARNING SIGNS**

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

**1.14 SINGLE LINE  
ELECTRICAL DIAGRAMS**

- .1 Provide single line electrical diagrams under plexiglass as follows:
  - .1 Electrical distribution system: locate in main electrical room.
  - .2 Include a legend of colour coding for the various systems identified in item 10-conduit and cable identification.
- .2 Provide 610 x 610mm size drawings indicating riser diagrams for the following systems:
  - .1 Communications
  - .2 Fire Alarm
  - .3 Security
  - .4 Public Address

**1.15 LOCATION  
OF EQUIPMENT**

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

**1.16 MOUNTING  
HEIGHTS**

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .3 Mounting heights for devices to conform with NBCC and NB Building Code Act for Barrier Free design.
- .4 Install electrical equipment at following heights unless otherwise indicated.
  - .1 Local switches: 1200mm
  - .2 Wall receptacles:
    - .1 General: 450mm
    - .2 Above top of continuous baseboard heater: 200mm, minimum 450mm AFF.
    - .3 Above top of counters or counter backsplash: 150mm

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- . 4 In mechanical rooms: 1200mm
- . 3 Panelboards: as required by Code or as indicated.
- . 4 Wall mounted telephone and data outlets:
  - . 1 General: 450mm
  - . 2 Above top of continuous baseboard heater: 200mm, minimum 450mm AFF.
  - . 3 Above top of counters or counter backsplash: 200mm
  - . 4 In mechanical rooms: 1200mm
- . 5 Fire alarm stations: 1200mm
- . 6 Fire alarm signals: 2300mm

### **1.17 LOAD BALANCE**

- . 1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance. Adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
- . 2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
- . 3 Submit, at completion of Work, report listing phase and neutral currents on panelboards, dry-core transformers, operating under normal load. State hour and date on which each load was measured, and voltage at time of test.

### **1.18 CONDUIT AND CABLE INSTALLATION**

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

### **1.19 FIRESTOPPING**

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

### **1.20 FIELD QUALITY CONTROL**

- . 1 Conduct and pay for following tests:
  - . 2 Circuits originating from branch distribution panels.
  - . 3 Lighting and its control.
  - . 4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
  - . 5 Systems: fire alarm system, intrusion alarm system, and public address 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.

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.5 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

.6 Submit typed test results for Departmental Representative's review and inclusion in the Operation and Maintenance Manual.

**1.21 COORDINATION  
OF PROTECTIVE  
DEVICES**

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

**1.22 DEMONSTRATION,  
OPERATING AND  
MAINTENANCE  
INSTRUCTIONS**

.1 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, troubleshooting and servicing all systems and equipment, during regular work hours, prior to acceptance.

.2 Use as-built drawings, operation and maintenance manual, audio visual aids, etc. as part of instruction materials.

**1.23 WASTE  
MANAGEMENT AND  
DISPOSAL**

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

END OF SECTION

## **PART 1- GENERAL**

### **1.1 RELATED SECTIONS**

- .1 Section 26 05 22 – Load Break Elbows
- .2 Section 26 05 44 - Installation of Cables in Trenches and in Ducts

### **1.2 REFERENCES**

- .1 Canadian Standards Association (CSA)
  - .1 CAN/CSA-C68.3-1997 (R2006), Shielded and Concentric Neutral Power Cables Rated 5-45kV.
  - .2 National Electrical Manufacturers' Association (NEMA)/Insulated Cable Engineers Association (ICEA)
    - .1 NEMA WC7-2009, Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.

### **1.3 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials in accordance with Section 01 74 22.
- .2 Place materials defined as hazardous or toxic waste in designated containers.

## **PART 2 - PRODUCTS**

### **2.1 CONCENTRIC NEUTRAL POWER CABLE 15,000 V**

- .1 To CSA C68.3.
- .2 Single conductor copper #2/0 conductor.
- .3 Semi-conducting XLPE conductor shield.
- .4 Class 2 compact round.
- .5 Insulation of cross-linked thermosetting polyethylene rated 90°C and 28 kV for 100% voltage level.
- .6 Semi-conducting insulation shielding of thermosetting XLPE.
- .7 20 #12 copper neutral wires applied helically over insulation shield equivalent to full capacity.
- .8 Separator tape over neutral wires.
- .9 Extruded PVC jacket rated for direct earth buried applications to -40°C.

### **2.2 SUPPORTED HIGH VOLTAGE POWER CABLE**

- .1 To CSA C61089.
- .2 Bare overhead aluminum #2/0AWG conductor.
- .3 Aluminum alloy 1350 wires wrapped helically around centre wire.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- . 1 Install primary cables in ducts as indicated on drawings.
- . 2 Install overhead lines as indicated on drawings.
- . 3 Refer to NB Power standards for further details.
- . 4 This 12,470V overhead service is owned and maintained by the institution and therefore in addition to NB Power standards, the Canadian Electrical Code applies to the installation. Contractor is responsible to provide an installation in compliance with the CEC.

END OF SECTION

**PART 1 - GENERAL**

**1.1 REFERENCES**

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

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

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

**PART 3 - EXECUTION**

**3.1 MATERIALS**

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

END OF SECTION

**PART 1 - GENERAL**

**1.1 REFERENCES**

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

**1.2 PRODUCT DATA**

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

**1.3 OPERATION AND MAINTENANCE DATA**

- .1 Submit operation and maintenance data for incorporation into manual specified in Section 01 33 00.

**1.4 RELATED WORK**

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

**PART 2 - PRODUCTS**

**2.1 BUILDING WIRES**

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

**2.2 ARMoured CABLES**

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

**2.3 CONTROL CABLES**

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

**2.4 SECURITY AND AUXILIARY SYSTEM CABLING**

- .1 FT6 rated.
- .2 Insulated copper conductors, size and type as indicated or required by manufacturer.
- .3 Black coloured PVC outer jacket.
- .4 Other cables as specified on the drawings.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION OF BUILDING WIRES**

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

### **3.2 INSTALLATION OF FIRE ALARM CABLES**

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

### **3.3 INSTALLATION OF ARMoured CABLES**

- . 1 AC-90 will only be permitted for branch circuit wiring drops from ceiling junction boxes to light fixtures installed in fully exposed or concealed ceiling spaces, within the same room requiring electrical power. The installation of AC-90 cable for branch circuit wiring home runs or runs between rooms or in areas with linear metal panel ceilings is not acceptable.
- . 2 Always install and secure surface cables directly to the underside of ceiling slabs or metal decking where located in concealed ceiling spaces.
- . 3 Originate all AC-90 fixture feeds from the sides of outlet boxes and not from the box cover. Where three (3) and/or four (4) fixture drops extend from any one outlet box, the box must not be sized smaller than 4-11/16" square.
- . 4 Fixture drop is defined as that portion of AC-90 cable or flexible conduit being used to make final connection between accessible type junction or outlet box located in concealed or exposed ceiling space and its respective light fixture.
  - . 1 Fixture drops are not to exceed 5m (15') in total length unless specifically indicated otherwise.
  - . 2 There shall be not more than four (4) drops permitted to be fed from any one box regardless of its size. All AC-90 cables used for fixture drops are to be secured within 300mm (12") of the junction box. Each light fixture is to be complete with its own separate fixture drop originating from junction box located in the same room as the fixture. An exception shall be made for recessed down lights which may be wired from one fixture to another if they have integral junction boxes and the luminaire access opening is 150mm (6") or greater in diameter.
  - . 3 Wire each light fixture with a separate "whip" emanating from an overhead junction box.
  - . 4 Both #12 AWG and #14 AWG type AC-90 armoured cables may be used where the total fixture drop loads do not exceed the following:

- . 1 5000W @347V, #12AWG
- . 2 3500W @347V, #14AWG
- . 3 1800W @120V, #12AWG
- . 4 1300W @120V, #14AWG

. 5 Separate pig-tail type leads shall be provided in each light fixture junction/outlet box for final connection to fixture drops. These pig-tails are to be only connected to light fixture returns and associated neutral conductors.

### **3.4 INSTALLATION OF CONTROL CABLES**

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

### **3.5 INSTALLATION OF CABLES: GENERAL**

- . 1 Cables to be installed in EMT.
- . 2 Do not lay AC90 cables on top of suspended ceiling grids and tiles.
- . 3 Twist together all stranded conductors prior to any types of terminations taking place, but not necessarily limited to: receptacles, light switches, neutral terminal strips, bonding terminal strips, circuit breakers, disconnect switches, starters, contactors, relays, all types of termination lugs, panelboards, etc.

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

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

END OF SECTION

## **PART 1- GENERAL**

- 1.1 SECTION INCLUDES** .1 Materials and installation for connectors and terminations.
- 1.2 RELATED SECTIONS** .1 Section 01 33 00 - Submittal Procedures  
.2 Section 01 74 22 - Waste Management and Disposal
- 1.3 REFERENCES** .1 CAN/CSA C22.2 No. 41-2007, Grounding and Bonding Equipment.
- 1.4 PRODUCT DATA** .1 Submit product data in accordance with Section 01 33 00.
- 1.5 WASTE MANAGEMENT AND DISPOSAL** .1 Separate and recycle waste materials in accordance with Section 01 74 22.  
.2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.  
.3 Collect and separate for disposal packaging material for recycling in accordance with Waste Management Plan.

## **PART 2 - PRODUCTS**

- 2.1 LOADBREAK ELBOW CONNECTORS** .1 Rated 200A, 15kV BIL, to match existing loadbreak junction and transformer bushings as follows:  
.1 Probe: tinned copper with washers and arc follower.  
.2 Elbow connector housing of moulded EPDM.  
.3 Conductor contact: copper crimp type.  
.4 Operating eye.  
.5 Voltage test point.  
.6 Grounding eye.  
.7 Moulded stress control.  
.8 Moulded shield of conductive EPDM.  
.9 Conductive insert and compression lug.  
.10 Dead end receptacles: by Cooper Power Systems, Cat #2606591A02M, or equivalent.

## **PART 3 - EXECUTION**

- 3.1 INSTALLATION** .1 Install loadbreak elbow in accordance with manufacturer's instructions.  
.2 Bond and ground as required to CSA C22.2 No.41.

END OF SECTION

## **PART 1 - GENERAL**

### **1.1 RELATED WORK**

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

### **1.2 REFERENCES**

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

## **PART 2 - PRODUCTS**

### **2.1 EQUIPMENT**

- . 1 Clamps for grounding of conductor: size as required and suitable for application.
- . 2 Rod electrodes: copper clad steel 19mm dia by 3m long.
- . 3 Direct buried grounding conductors: bare stranded copper of 98% conductivity, soft annealed, size as indicated.
- . 4 Insulated grounding and bonding conductors: soft drawn stranded copper of 98% conductivity, type RW90 (green coloured insulation as indicated in 26 05 00, item 10 - Wiring Identification).
- . 5 Ground bus: copper, minimum size 6mm x 75mm x 600m size and as indicated, complete with insulated supports, fastenings, connectors.
- . 6 Ground connections to take place on the ground bus to be as follows:
  - . 1 For wire sizes 6 AWG and smaller: copper, one-hole, short barrel (single crimp) lugs.
  - . 2 Wire larger than 6 AWG to be two-hole, long barrel (dual crimp) lugs.
- . 7 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
  - . 1 Grounding and bonding bushings.
  - . 2 Protective type clamps.
  - . 3 Bolted type conductor connectors.
  - . 4 Thermit welded type conductor connectors.
  - . 5 Bonding jumpers, straps.
  - . 6 Pressure wire connectors.
- . 8 Copper compression type, long barrel, two hole type lugs unless specified otherwise.
- . 9 Copper compression type connectors (cable to cable, cable to ground rod, etc.).

### **2.2 MANUFACTURERS**

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

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION GENERAL**

- . 1 Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories. Conform to the requirements of the Departmental Representative, applicable codes and the local electrical inspection authority having jurisdiction.

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

### **3.2 ELECTRODES**

- . 1 Install rod electrodes and make grounding connections.
- . 2 Bond separate, multiple electrodes together.
- . 3 Use size #4/0 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.

### **3.3 SYSTEM AND CIRCUIT GROUNDING**

- . 1 Install system and circuit grounding connections to neutral of secondary systems.

. 2 The main incoming ground conductor is to run unbroken to the main electrical service entrance overcurrent device ground bus and then to the wall mounted ground bus.

**3.4 EQUIPMENT  
GROUNDING**

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

**3.5 GROUNDING BUS**

. 1 Install copper grounding bus mounted on insulated supports on each wall of electrical and telecommunications rooms.

. 2 Ground items of electrical equipment to ground bus as indicated herein and on the Drawings.

**3.6 COMMUNICATION  
SYSTEMS**

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

**3.7 FIELD QUALITY  
CONTROL**

. 1 Perform tests in accordance with Section 26 05 00 - Electrical General Requirements.

. 2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Departmental Representative and local authority having jurisdiction over installation.

. 3 Perform tests before energizing electrical system.

. 4 Where applicable, disconnect ground fault indicator during tests.

END OF SECTION

**PART 1 - GENERAL**

- .1 Not used.

**PART 2 - PRODUCTS**

**2.1 SUPPORT CHANNELS SYS**

- .1 U shape, size 40mm x 40mm, galvanized steel, surface mounted, suspended or set in poured concrete walls and ceilings unless otherwise indicated.
- .2 Threaded rod minimum 9mm, galvanized steel.
- .3 Washers and nuts to be galvanized.

**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 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .5 Fasten exposed conduit or cables within 1m of each outlet box, junction box, pull box, cabinet or conduit fittings with spacing between supports as per CEC to building construction or support system using straps.
  - .1 One-hole zinc plated steel straps to secure surface conduits and cables smaller than 41mm.
  - .2 Two-hole zinc plated steel straps for conduits and cables 41mm and larger.
  - .3 Beam clamps to secure conduit to exposed steel work.
- .6 Suspended support systems.
  - .1 Support individual cable or conduit runs with 9mm dia threaded rods and spring clips.
  - .2 Support two (2) or more cables or conduits on channels supported by 9mm dia threaded rod hangers where direct fastening to building construction is impractical.
- .7 For surface mounting of two or more conduits use channels at 1.5m oc spacing.
- .8 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .9 Verify there is adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .10 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .11 Do not use supports or equipment installed for other trades for conduit or cable support.

.12 Install fastenings and supports as required for each type of equipment, cables and conduits, and in accordance with manufacturer's installation recommendations.

.13 Fasten individual and multiple runs of armoured cables to structure and in bundles as permitted in 26 05 21 - Wire and Cables 0-1000 Volts.

.14 Various suspended types of junction, pull and/or outlet boxes as well as conduits, are to be supported with minimum size 9mm threaded rod, nuts and flat washers. Threaded rods to be secured to boxes with one flat washer and nut installed on both sides of box.

- .1 One (1) rod required for all type boxes sized 150mm x 150mm and smaller (22,500mm<sup>2</sup> and smaller).
- .2 Two (2) rods required for boxes sized 22,500mm<sup>2</sup> and larger, up to and including those sized 300mm x 300mm (90,000mm<sup>2</sup>).
- .3 Minimum of four (4) rods required for all boxes sized larger than 90,000mm<sup>2</sup>.

.15 Cut off all excess rod within 13mm of channel bottom. In addition to C.E.C. minimum conduit spacing requirements, all suspended conduit runs containing horizontal or vertical elbows are to have one additional support rod installed not greater than 300mm and mid point of "all" 90 bends. Maximum spacings between conduit support channels will be as dictated by smallest size conduit(s) being supported and/or secured to same.

.16 In addition to the CEC minimum conduit spacing requirements, all suspended conduit runs containing horizontal or vertical elbows are to have one (1) additional support rod installed not greater than 300mm from midpoint of all 90 bends. Maximum spacings between conduit support channels will be dictated by smallest size conduit(s) being supported and/or secured to same.

END OF SECTION

## **PART 1 - GENERAL**

### **1.1 SHOP DRAWINGS AND PRODUCT DATA**

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

## **PART 2 - PRODUCTS**

### **2.1 SPLITTERS**

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

### **2.2 JUNCTION AND PULL BOXES**

- . 1 Type C: welded steel construction, hinged cover, catch with hasp. Provision for locking. Surface mounting.
- . 2 Type D: welded steel construction with screw-on flat covers for surface mounting. Surface or flush mounting as indicated. Covers with 25mm minimum extension all around, for flush-mounted pull and junction boxes.
- . 3 Junction and pull boxes larger than 125mm x 125mm shall be Type "E", complete with continuously hinged door. Junction and pull boxes 125mm x 125mm and smaller to be complete with screw cover.
- . 4 Single gang "sectional" type devices boxes being used in steel stud walls for the installation of both metallic and non-metallic type cables, not to be sized smaller than 250cm, complete with wrap around type bracket.
- . 5 Two (2) or more flush installed sectional boxes, ganged together on boxes sized 100mm<sup>2</sup> and larger (intended for devices), are to have an additional support bracket installed on opposite side of box, not presently secured to metal stud.
- . 6 Where larger sized devices or other types of "flush" outlet or junction boxes may be required, use suitably sized 100mm x 100mm (4x4") deep or 118 mm (4-11/16") square boxes complete with appropriate sized extension tile rings. The use of plaster rings in lieu of tile type extension rings is not acceptable.
- . 7 Junction boxes 150mm x 150mm (6"x6") used in branch circuit wiring are to be complete with bonding terminal strips.

### **2.3 CABINETS**

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

### **PART 3 - EXECUTION**

#### **3.1 SPLITTER INSTALLATION**

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

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

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

#### **3.3 IDENTIFICATION**

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

END OF SECTION

## **PART 1 - GENERAL**

### **1.1 REFERENCES**

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

## **PART 2 - PRODUCTS**

### **2.1 OUTLET AND CONDUIT BOXES GENERAL**

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

### **2.2 SHEET STEEL OUTLET BOXES**

- . 1 Electro-galvanized steel 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 CONDUIT BOXES**

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

### **2.6 FITTINGS- GENERAL**

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

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- . 1 Support boxes independently of connecting conduits.
- . 2 Fill boxes with paper, sponges or foam or similar approved material to

prevent entry of debris during construction. Remove upon completion of work.

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

END OF SECTION

**PART 1 - GENERAL**

**1.1 LOCATION  
OF CONDUIT**

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

**1.2 REFERENCES**

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

**1.3 TRADE SIZE**

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

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

**1.4 RELATED WORK**

- .1 Section 26 05 29: Fastenings and Supports

**PART 2 - PRODUCTS**

**2.1 OUTLET AND  
CONDUIT BOXES -  
GENERAL**

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

**2.2 CONDUITS**

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

**2.3 CONDUIT  
FASTENINGS**

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

**2.4 CONDUIT  
FITTINGS**

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

**2.5 GENERAL  
FITTINGS**

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

**2.6 EXPANSION  
FITTINGS FOR**

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

## **EXPANSION. RIGID COND**

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

## **2.7 FISH CORD**

- . 1 Polypropylene: minimum 3mm diameter.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- . 1 Install conduits as high as possible to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass but too high as to render boxes inaccessible from access panels.
- . 2 Conceal conduits except in mechanical and electrical service rooms and in unfinished areas. Install conduits as high as possible and secured to building structure with approved supports.
- . 3 Use EMT for all interior wiring.
- . 4 Use Rigid galvanized steel conduit where subject to mechanical damage.
- . 5 Use rigid PVC conduit underground: minimum size 21mm dia.
- . 6 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment.
- . 7 Minimum conduit size for lighting and power 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.
- . 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. whichever is larger.
- . 15 Non-connected PVC or steel raceways protruding up through open bottoms of free-standing equipment require PVC bell ends and steel type "ground bushings" installed on ends of respective types of conduits. Extend conduits a minimum of 50mm (2") above housekeeping pad or concrete trough.
- . 16 Install plastic bushings in all EMT sized 35mm and larger before pulling in conductors.

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

### **3.2 SURFACE CONDUITS**

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5m clearance.
- .3 Run conduits in flanged portion of structural steel.
- .4 Group conduits wherever possible on suspended or surface channels.
- .5 Do not pass conduits through structural members except as indicated.
- .6 Do not locate conduits less than 76mm parallel to steam or hot water lines with minimum of 25mm at crossovers.

### **3.3 CONDUITS UNDERGROUND**

- .1 Slope conduits to provide drainage.
- .2 Waterproof joints (pvc excepted) with heavy coat of bituminous paint.
- .3 Conduits are only permitted to be installed below floors and are not to be installed in concrete floors unless specifically indicated otherwise.
- .4 Install PVC conduits sized 35mm (1½") and larger in trenches not less than 300mm in depth from underside of concrete floor slab to bottom of

trench. Place conduits on a 50mm bed of sand and are to have a second 50mm bed of sand placed on top. Conduits to be completely surrounded by sand prior to backfilling taking place.

. 5 Wiring for all various systems devices and/or outlets installed below ground floor concrete floor slabs may be performed utilizing minimum 21m PVC rigid conduit. Transition from PVC rigid thick wall conduit to rigid steel threaded conduit is to take place below the floor slab.

. 6 All underground conduit to be up sized one (1) trade size above the minimum code requirement.

. 7 Rigid PVC (thick wall) conduit will be permitted to be direct buried.

. 8 Underground and underslab conduits are only permitted to be installed where specifically indicated.

. 9 Install PVC conduits sized 32mm in diameter and larger in trenches not less than 300mm in depth from underside of concrete floor slab to bottom of trench. Place conduits on a 50mm bed of sand and have a second 50mm of sand placed on top. Conduits to be "completely surrounded" by sand prior to backfilling taking place.

. 10 Conduit installation is not to influence the thickness of the floor slab.

. 11 Do not run conduits along concrete walls installed to reinforce wall installations.

. 12 PVC conduits of all sizes prior to turning-up through floor slabs, unless specifically indicated otherwise, are to have transition to rigid steel threaded conduit take place as previously indicated.

. 13 The installation of PVC type conduits above ground is prohibited.

. 14 Up-size all underground conduits at least one trade size above the minimum code requirement for ease of pulling.

. 15 Only use rigid Types EB1 and DB2/ES2 PVC (thinwall) Conduit (CSA C22.2 211.1) where embedded in concrete.

. 16 Rigid PVC (thick wall) Conduit (CSA C22.2 211.2) will be permitted to be direct buried.

END OF SECTION

**PART 1 - GENERAL**

- 1.1 RELATED WORK** . 1 Electrical general requirements: Section 26 05 00.

**PART 2 - PRODUCTS**

- 2.1 CABLE PROTECTION** . 1 Protection materials and methods as indicated on drawings.

**PART 3 - EXECUTION**

- 3.1 CABLE INSTALLATION IN DUCTS**
- . 1 Install cables as indicated in ducts.
  - . 2 Do not pull spliced cables inside ducts.
  - . 3 Install multiple cables in duct simultaneously.
  - . 4 Use CSA approved lubricants of type compatible with cable jacket to reduce pulling tension.
  - . 5 To facilitate matching of colour coded multi-conductor control cables reel off in same direction during installation.
  - . 6 Before pulling cable into ducts and until cable ends are properly terminated, seal ends of lead covered cables with wiping solder, seal ends of non- leaded cables with moisture seal tape.
  - . 7 After installation of cables, seal duct ends with duct sealing compound.
- 3.2 FIELD QUALITY CONTROL**
- . 1 Perform tests in accordance with Section 26 05 00 - Electrical General Requirements.
  - . 2 Perform tests using qualified personnel. Provide necessary instruments and equipment.
  - . 3 Check phase rotation and identify each phase conductor of each feeder.
  - . 4 Check each feeder for continuity, short circuits and grounds. Confirm resistance to ground of circuits is not less than 50 megohms.
  - . 5 Pre-acceptance tests.
    - . 1 After installing cable but before terminating, perform insulation resistance test with 1000 V megger on each phase conductor.
    - . 2 Check insulation resistance after each termination to ensure that cable system is ready for acceptance testing.
  - . 6 Provide Departmental Representative with list of test results showing

location at which each test was made, circuit tested and result of each test.

. 7 Remove and replace entire length of cable if cable fails to meet any of test criteria.

END OF SECTION

**PART 1 GENERAL**

1.1 This work shall be governed by all the conditions of labour and material incorporated in the General Contract documents, of which these specifications form a part and shall be subject to all clauses contained in the General Conditions of Division 01.

1.2 RELATED WORK SPECIFIED ELSEWHERE

.1	Commissioning	Section 01 91 00
.2	General Commissioning Requirements	Section 01 91 01
.3	Commissioning: Training	Section 01 91 41
.4	Mechanical Systems Commissioning	Section 23 05 02
.5	Mechanical Testing Requirements	Section 23 05 03
.6	EMCS: Startup, Verification and Commissioning	Section 25 01 11
.7	EMCS: Training	Section 25 01 12
.8	Electrical Testing Requirements	Section 26 10 02
.9	Commissioning Plan	

1.3 SCOPE / WORK INCLUDED

.1 Provide labour tools and supervision to commission systems specified in Division 26 in accordance with this section and those referenced in subsection 1.2 Related Work Specified Elsewhere.

1.4 RESPONSIBILITIES

.1 General and Electrical Contractors. The commissioning responsibilities applicable to the electrical contractor(s) of Division 26 are as follows:

- .1 Attend a commissioning information meeting and other necessary meetings scheduled by the CxA to facilitate the commissioning process.
- .2 Provide normal cut sheets and shop drawing submittals to the CxA of commissioned equipment.
- .3 Provide additional requested documentation, prior to normal O&M manual submittals, to the CxA for development of start-up and functional testing procedures.
  - .1 This will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, fan and pump curves, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Agent.

1.4 RESPONSIBILITIES – (Cont'd)

.1.3 – (Cont'd)

- .2 The Commissioning Agent may request further documentation necessary for the commissioning process. This data request may be made prior to normal submittals.
- .4 Provide a copy of the O&M manuals and submittals of commissioned equipment, through normal channels, to the CxA for review and approval.
- .5 Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
- .6 Provide limited assistance to the CxA in preparing the specific functional performance test procedures as specified in Section 26 10 02. Subs shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
- .7 Address current A/E punch list items before functional testing.
- .8 Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.
- .9 Perform functional performance testing under the direction of the CxA for specified equipment in Section 01 91 01 and the Commissioning Plan. Assist the CxA in interpreting the monitoring data, as necessary.
- .10 Correct deficiencies (differences between specified and observed performance) as interpreted by the CxA, CM and A/E and retest the equipment.
- .11 Execute seasonal or deferred functional performance testing, witnessed by the CxA, according to the specifications.

1.5 TEST EQUIPMENT

- .1 All test equipment necessary to fulfill the testing requirements of this section and/or as required in Division 26 specifications including the Commissioning Plan shall be provided as part of the work of this section.

**PART 2 PRODUCTS - Not Used.**

**PART 3 EXECUTION**

3.1 SUBMITTALS

- .1 Division 26 shall provide submittal documentation relative to commissioning as requested by the CxA.

3.2 STARTUP

- .1 The electrical contractors shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in 01 91 01. Division 26 has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the Commissioning Agent or Owner.

3.2 STARTUP - (*Cont'd*)

- .2 Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the CxA and CM. Beginning system testing before full completion does not relieve the Contractor from fully completing the system, including all pre-functional checklists as soon as possible.

3.3 FUNCTIONAL PERFORMANCE TESTS

- .1 Refer to Section 01 91 01 subsection 1.5 for a list of systems to be commissioned and to section 01 91 01 Part 3 Commissioning Process for a description of the process and to Section 26 10 02 for specific details on the required functional performance tests.

3.4 TESTING DOCUMENTATION NONCONFORMANCE AND APPROVALS

- .1 Refer to Section 01 91 01 for specific details on non-conformance issues relating to pre-functional checklists and tests.

3.5 OPERATION AND MAINTENANCE (O&M) MANUALS

- .1 Division 26 shall compile and prepare documentation for all equipment and systems covered in Division 26 and deliver to the GC for inclusion in the O&M manuals, according to Section 01 91 01.

3.6 TRAINING OF OWNER PERSONNEL

- .1 Refer to Section 01 91 41.

3.7 DEFERRED TESTING

- .1 Refer to Section 01 91 01, subsection 3.10.4 for requirements of deferred testing.

3.8 WRITTEN WORK PRODUCTS

- .1 Written work products of Contractors shall consist of the start-up and initial checkout plan described in Section 01 91 01 and the filled out start-up, initial checkout and pre-functional checklists.

END OF SECTION

**PART 1 GENERAL**

1.1 GENERAL

- .1 This work shall be governed by all the conditions of labour and material incorporated in the General Contract documents, of which these specifications form a part and shall be subject to all clauses contained in the General Conditions of Division 01.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- |    |   |                  |
|----|---|------------------|
| .1 | Commissioning                                 | Section 01 91 00 |
| .2 | General Commissioning Requirements            | Section 01 91 01 |
| .3 | Commissioning: Training                       | Section 01 91 41 |
| .4 | Mechanical Systems Commissioning              | Section 23 05 02 |
| .5 | Mechanical Testing Requirements               | Section 23 05 03 |
| .6 | EMCS: Startup, Verification and Commissioning | Section 25 01 11 |
| .7 | EMCS: Training                                | Section 25 01 12 |
| .8 | Electrical Systems Requirements               | Section 26 10 01 |
| .9 | Commissioning Plan                            |                  |

1.3 SCOPE/ WORK INCLUDED

- .1 Provide labour tools and supervision to conduct functional testing as described/specified herein and in Section 01 91 01 for the following equipment and systems:
- Interior and Exterior Lighting and Lighting Controls
  - Main Service Entrance Board
  - Panelboards
  - Emergency lighting
  - Feeders
  - Exit signs
  - Wiring Devices

Note: Final equipment list will be identified in Commissioning Plan

1.4 FUNCTIONAL TESTING

- .1 This section specifies the functional testing requirements for Division 16 systems and equipment. The functional testing process, requirements and test method definitions are described in Sections 01 91 01 and the Commissioning Plan.

1.4 FUNCTIONAL TESTING – (Cont'd)

.2 Prerequisites for functional testing are as follows:

- .1 All equipment, components and devices applicable to the test must be started and this start up must be documented. This includes completion of the checklists, testing of equipment, switchgear, main distribution panels, generators, sub-panels, etc., completed labeling and identification, etc.
- .2 The subcontractor of this section shall determine and CxA shall review the optimal sequence of testing.
- .3 All A/E punch list items for this equipment corrected.
- .4 These functional test procedures reviewed and approved by installing contractor.
- .5 Safeties and operating ranges reviewed by the CxA.
- .6 Test requirements and sequences of operation attached.
- .7 Functional tests for systems outlined in Section 1.3 Scope/Work included are outlined in the Commissioning Plan.

1.5 TEST EQUIPMENT

- .1 All test equipment necessary to fulfill the testing requirements of this section and/or as required in Division 26 specifications including the Commissioning Plan shall be provided as part of the work of this section.

**PART 2 PRODUCTS – NOT USED**

**PART 3 EXECUTION – NOT USED**

END OF SECTION

## **PART 1 - GENERAL**

### **1.1 PRODUCT DATA**

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

### **1.2 OPERATION AND MAINTENANCE DATA**

- . 1 Provide operation and maintenance data for dry type transformers for incorporation into Manual specified in Section 01 33 00.
- . 2 Include matrix of installed transformers tap settings for each transformer.
- . 3 Include matrix of primary and secondary winding megger results.

### **1.3 REFERENCES**

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

## **PART 2 - PRODUCTS**

### **2.1 TRANSFORMERS**

- . 1 Use transformers of one manufacturer throughout project.
- . 2 Design 1.
  - . 1 Type: dry, epoxy vacuum impregnation.
  - . 2 Odd harmonic mitigating with 30deg phase shift
  - . 3 K-13 rated
  - . 4 3 phase, kVA as indicated, 600 V input, 120/208 V output, 60 Hz.
  - . 5 Voltage taps: -5.0%, -2.5%, 0%, +2.5% and 5.0% of rated voltage.
  - . 6 Insulation: Class H (220°C), 150°C temperature rise.
  - . 7 Basic Impulse Level (BIL): to NEMA ST-20.
  - . 8 Hipot: standard.
  - . 9 Average sound level: standard.
  - . 10 Impedance at 170 C: standard.

- .11 Enclosure: EEMAC 2, ventilated removable metal front panel and hood, drip proof.
- .12 Mounting: Floor mounting only.
- .13 Finish: in accordance with Section 26 05 00 - Electrical General Requirements.
- .14 Winding configuration: Delta primary, grounded Y secondary. All windings copper.
- .15 Options:
  - .1 Vibration isolators.
  - .2 Dual rated spade type transformer lug for ground/bonding of transformers.
- .16 Electrostatically shielded.
- .17 Acceptable Manufacturers:
  - .1 Delta e-silver
  - .2 Siemens equivalent
  - .3 Hammond equivalent
  - .4 Schneider equivalent
  - .5 Eaton equivalent

## **2.2 EQUIPMENT IDENTIFICATION**

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

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- .1 Securely mount dry type transformer on concrete housekeeping pad or steel mounting frame. External vibration isolators to be provided on transformer support channels on each four corners and between transformer enclosure legs and mounting surface.
- .2 Transformers containing electrical termination points located on both front and rear sides of same are not acceptable.
- .3 Confirm adequate clearance around transformer for ventilation.
- .4 Install transformers in level upright position.
- .5 Remove shipping supports only after transformer is installed and just before putting into service.
- .6 Loosen isolation pad bolts until no compression is visible on vibration isolators.
- .7 Megger both primary and secondary windings with 1000 V and 500 V megger and report immediately and reading below 100 megohms. Include results in O&M Manual.
- .8 Ensure transformer is on the correct tap, measure voltages on secondary of transformer under normal building loading. Adjust voltage taps to obtain rated secondary voltages. Record tap settings and include in O&M Manual.
- .9 Add lugs for copper conductors when double neutrals are used.

- .10 All dry type transformers are to be 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 3mm (1/2") 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 Connect electrostatic shield and transformer neutral and case solidly to ground.
- .12 Make primary and secondary connections in accordance with wiring diagram.
- .13 Energize transformers after installation end testing is complete.

END OF SECTION

## **PART 1 - GENERAL**

### **1.1 RELATED WORK**

- .1 Section 03 Concrete

### **1.2 REFERENCES**

- .1 ANSI/IEEE 386-2006, Separable Insulated Connector Systems for Power Distribution Systems above 600V.
- .2 CAN/CSA-C2.1-2007, Single-Phase and Three-Phase Distribution Transformers.
- .3 CSA C227.4-2007, Three-Phase Front Pad-Mounted Distribution Transformers with Separable Insulated High Voltage Connectors.
- .4 CSA-C802.3-01, Maximum Losses for Distribution, Power and Dry Type Transformers.

### **1.3 SOURCE QUALITY CONTROL**

- .1 Submit to Departmental Representative standard factory test certificates of each transformer and type test of each transformer with high voltage accessories in accordance with CSA C2.

### **1.4 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate:
  - .1 Anchoring method and dimensioned foundation template.
  - .2 Dimensioned cable entry locations.
  - .3 Dimensioned cable termination and pothead height.
- .3 Identified internal and external component layout on assembly drawing.
- .4 Insulating liquid capacity.
- .5 Submit primary fuse time-current characteristics.

### **1.5 OPERATION AND MAINTENANCE DATA**

- .1 Provide operation and maintenance data for pad mounted distribution transformers for incorporation into manual specified in Section 01 33 00 - Submittals.
- .2 Include insulating liquid maintenance data.

### **1.6 MAINTENANCE MATERIALS**

- .1 Include six (6) spare fuses.

## **PART 2 - PRODUCTS**

### **2.1 OIL FILLED PAD MOUNTED TRANSFORMER**

- .1 Three phase dead front pad mounted distribution transformer: to CSA C227.4.
- .2 Oil Filled pad mounted distribution transformer complete with primary and secondary cable compartments, primary fused to form complete factory assembly, self contained, steel fabricated for mounting on precast concrete vault.
- .3 Three high voltage bushing wells for connection to distribution system through separable insulated connectors for dead front operation for a radial

primary feed system.

- . 4 Separable insulated connectors.
- . 5 Four hole spade type low voltage terminals.
- . 6 Primary protection: externally removable Bay-O-Net fuse link with oil immersed current limiting back-up fuse contained in transformer with fuses sized by transformer vendor.
- . 7 Oil drip plate.
- . 8 Tamper proof compartment doors with 90 and 110 degree hold open device.
- . 9 Provision for separate padlocking.
- . 10 Removable load break bushing well inserts for elbow connectors.
- . 11 Barrier separating high and low voltage compartments.
- . 12 Primary voltage: delta connected 12,470 V, 60 Hz, 3 phase, for use on a 12,470V system.
- . 13 Secondary voltage: 347/600 V, wye connected, 3 phase, 4 wire, grounded neutral.
- . 14 Capacity: 500 kVA.
- . 15 Basic impulse level: 125 kV.
- . 16 Impedance: not less than 4.0% not more than 5.0%.
- . 17 Copper coil construction.
- . 18 Four - 2.5% taps, 2-FCAN, 2-FCBN, tap changer with padlocking facilities for highest voltage only.
- . 19 External dual voltage switch: Position One: 12,470 V; Position Two 4160 V. 16 Self-actuating pressure relief device.
- . 20 Compartment door ground straps.
- . 21 Transformer lift lugs.
- . 22 Tank filled with insulating oil.
- . 23 Copper grounding bus 40 wide x 6 mm thick to extend between primary and secondary compartments.
- . 24 Finish exterior and interior with equipment grey.
- . 25 Pole mounted load-break group operated switch: 15 kV, 300 A, 3 ph, two-position off-on load-break,
- . 26 Switch handle with eye for hot stick operation. Refer to drawings for additional information.

- 2.2 ACCESSORIES**
- . 1 Liquid temperature thermometer.
  - . 2 Liquid level gauge.
  - . 3 Pressure relief device.
  - . 4 21 mm drain valve.
  - . 5 21 mm filler plug.
  - . 6 Tap switch.
  - . 7 Non-PCB label.
- 2.3 GROUNDING**
- . 1 Copper grounding bus size 21 mm x 6 mm.
  - . 2 Connectors for grounding conductors size #3/0 AWG.
- 2.4 FINISH**
- . 1 Finish exterior of unit shall be finished with Equipment Green, Munsell No. 7 GY3.29/1.5.
- 2.5 EQUIPMENT IDENTIFICATION**
- . 1 Provide equipment identification in accordance with Section 26 05 00-Electrical General Requirements.
  - . 2 Nameplate showing information in accordance with CSA C2.
- 2.6 WARNING SIGNS**
- . 1 Provide warning signs in accordance with Section 26 05 00.
- 2.7 RECOMMENDED PRODUCTS**
- . 1 Cooper Power Systems.
  - . 2 Carte International.
- PART 3 - EXECUTION**
- 3.1 INSPECTION**
- . 1 Check factory made connections of transformer unit for mechanical security and electrical continuity.
  - . 2 Check transformer insulating liquid for correct quantity and specification according to manufacturer's instructions.
- 3.2 INSTALLATION**
- . 1 Ensure concrete vault is fully cured before transformer is installed.
  - . 2 Set and secure transformer unit in place, rigid, plumb and square.
  - . 3 Make connections.
  - . 4 Connect transformer unit ground bus to system ground.
  - . 5 Set taps to produce rated secondary voltage at no-load.
  - . 6 Provide and install 15 kV Elastimold load break elbows on 15 kV cable and connect to transformer.
- 3.3 TESTING**
- . 1 Perform tests in accordance with Section 26 05 00.

- . 2 Carry out DC High Potential Stop Voltage Test.
- . 3 Inspect primary and secondary connections for tightness and for signs of overheating.
- . 4 Inspect and clean bushings and insulators.
- . 5 Check oil level and temperature indicators.
- . 6 Set transformer taps to rated voltage as specified.
- . 7 Inspect for oil leaks and excessive rusting.
- . 8 Inspect oil level.
- . 9 Check fuses for correctness of type and size.
- . 10 Insulation test (High voltage windings to low voltage windings and windings to ground.
- . 11 Power factor and capacitance dissipation test.
- . 12 Transformer turns ratio test for all taps.
- . 13 Verify proper core ground in accessible.
- . 14 Polarity and phase rotation relation test.
- . 15 Positive sequence Impedance test.
- . 16 Magnetizing current test.
- . 17 Oil testing from independent laboratory. Submit results to Departmental Representative for review.

END OF SECTION

**PART 1 - GENERAL**

**1.1 SHOP DRAWINGS  
AND PRODUCT DATA**

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

**1.2 REFERENCES**

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

**1.3 MAINTENANCE  
DATA**

- . 1 Provide maintenance data for service entrance board for incorporation into manual specified in Section 01 77 00.

**1.4 MAINTENANCE  
MATERIALS**

- . 1 Include manufacturer recommended maintenance materials.

**PART 2 - PRODUCTS**

**2.1 SERVICE  
ENTRANCE BOARD**

- . 1 Rating: 600 V, 3 phase, 4 wire, amperage as indicated, short circuit current as indicated.
- . 2 Cubicles: free standing, dead front, front access only, minimum 915mm deep, maximum 1200mm deep, provision for addition of future distribution sections, NEMA 1 with dripshield.
- . 3 Main breaker and metering section shall be bussed.
- . 4 Main breaker, solid- state type overcurrent protective trip unit with independently adjustable LSIG settings.
- . 5 Barrier metering sections from adjoining sections.
- . 6 Owners digital metering.
- . 7 Distribution breaker sections as indicated.
- . 8 Hinged access panels with captive knurled thumb screws.
- . 9 Bus bars and main connections: tin-plated or silver flashed 99.3% copper.
- . 10 Bus bars to be identified with phase color coding.
- . 11 Incoming wireway, minimum 965mm wide, suitable for back entry of conduit.

**2.2 MOULDED CASE  
CIRCUIT BREAKERS**

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

**2.3 OWNER'S  
METERING**

- . 1 Digital Metering System.
- . 2 Current transformers for each meter. Current transformers shall be wired to shorting-type terminal blocks.
- . 3 Modbus TCP communication
- . 4 watts, watt demand, watt-hours, voltage-amperes
- . 5 (VA), VA-hours, VARS,
- . 6 VAR Hours and power factor
- . 7 Acceptable manufacturers:
  - . 1 Eaton IQ 150
  - . 2 Siemens equivalent
  - . 3 Schneider equivalent

**2.4 SURGE  
PROTECTION DEVICE**

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

- . 4 The SPD clamping components shall have a response time rated less than 1 nanosecond. Filter components shall respond instantaneously.
- . 3 Filtering:
  - . 1 Noise Attenuation. The SPD unit shall be listed under UL 1283 and contain a high-frequency extended range tracking filter. The filter shall reduce fast rise-time, high-frequency, error-producing transients and electrical line noise to harmless levels thus eliminating disturbances which may lead to system upset. Noise attenuation shall be a minimum of 45 dB at 100 kHz based on standardized insertion loss data obtained utilizing the MIL-STD-220A, 50 ohm insertion loss methodology. Only manufacturers providing a documented attenuation value at 100 kHz will be considered. Spectrum analysis data may be required for support.
  - . 2 Bandwidth. The SPD unit(s) for main entrance panel application shall have an effective filtering bandwidth of 180 Hz to 50 MHz.
- . 4 General Features:
  - . 1 Connectors. Terminals shall be provided for all of the necessary input and output power and ground connections on the SPD.
  - . 2 Internal Connections. All surge current diversion connections shall be by way of low impedance wiring. Surge current diversion components shall be wired for reliable low impedance connections. No printed circuit boards shall be used for surge suppression paths.
  - . 3 Enclosure. The specified system shall be provided in a heavy duty NEMA 12 dust tight, enclosure with no ventilation openings. Indication of surge current module status shall be visible without opening the door.
  - . 4 Unit Status Indicators. Red status indicators shall be provided on the hinged front cover to indicate unit phase status. The absence of the red light shall reliably indicate that one or more surge current diversion phases have failed and that service is needed to restore full operation.
  - . 5 Fuses. The unit shall utilize internal fuses rated 600 VAC or greater and with a minimum interrupting capability of 200,000A or greater.
  - . 6 Identification. The unit shall include manufacturer's nameplate, UL rating, and a CSA approval on the exterior of the enclosure.
  - . 7 Warranty. The manufacturer shall provide a Five-Year Warranty from date of shipment.
  - . 8 Quality. Testing of each unit shall include but shall not be limited to quality assurance checks, a "Hi-Pot" test at two times rated voltage plus 1000 volts per UL requirements, and operational and calibration tests. Test results will be made available to the Departmental Representative upon request.

**2.5 GROUNDING**

- .1 Copper ground bus extending full width of cubicles and located at bottom.
- .2 Lugs at each end for size #4/0 grounding cable.

**2.6 FINISHES**

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

**2.7 EQUIPMENT IDENTIFICATION**

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

**2.8 ACCEPTABLE MANUFACTURERS**

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

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

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

**3.2 SOURCE QUALITY CONTROL**

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

END OF SECTION

## **PART 1 - GENERAL**

### **1.1 REFERENCES**

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

### **1.2 SHOP DRAWINGS**

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

### **1.3 OPERATION AND MAINTENANCE DATA**

- . 1 Provide operation and maintenance data for panelboards for incorporation into manual specified in Section 01 77 00.
- . 2 Include panel schedules.

## **PART 2 - PRODUCTS**

### **2.1 PANELBOARDS**

- . 1 Panelboards: product of one manufacturer.
- . 2 250 and 600 V panelboards: bus and breakers rated as indicated.
- . 3 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.
- . 4 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.
- . 5 Two (2) keys for each panelboard and key panelboards alike.
- . 6 Tin-plated copper bus. Neutral to be 100% 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 Panel boards rated above 400A shall be 300mm deep and 900mm wide minimum.

### **2.2 BREAKERS**

- . 1 Breakers: to Section 26 28 21 - Moulded Case Circuit Breakers.

. 2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.

. 3 Main breaker: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.

. 4 Lock-on devices for 10 % of 15 to 30 A breakers installed as indicated. Turn over unused lock-on devices to the Owner.

### 2.3 SURGE PROTECTION DEVICE

. 1 Provide SPD in panelboards indicated.

. 2 Operation and environment:

. 1 Voltage: TVSS devices to be suitable for the voltage and systems configuration as indicated on the single line diagram(s).

. 2 Maximum Continuous Operating Voltage (MCOV): maximum continuous operating voltage of the suppressor unit to be greater than 125% for 208Y/120V systems and 115% for 480V and 600V systems.

. 3 Protection Modes: provide transient voltage surge suppression paths for all possible common and normal modes (between each line and ground, neutral and ground, line to line, and each line and neutral).

. 3 Suppression Component:

. 1 Surge Current: unit's maximum peak surge current capacity per phase based on the standard 8 x 20us waveform (described in ANSI/IEEE C62.41, to be not less than 120,000 Amps. Total device peak surge current rating shall be not less than 3000,000 Amps.

. 2 Let-Through Voltage: Integrated Filtering Panelboard shall demonstrate the following peak let through voltage when measured at the panelboard bus bar. Test points at the panelboard bus bar demonstrate actual distribution system transient let-through voltages. UL1449 ratings established at test points other than the bus bar, will not be considered. Perform testing utilizing Category B3 and C1 test wave forms as described in ANSI/IEEE C62.41. Conduct the test procedure in accordance with ANSI/IEEE C62.45 and be conducted on the device as a finished product complete with integral fusing.

IEEE C62.41 Let Through  
Voltages (208Y/120V Units)

Category B3/C1 Impulse  
(Combination Waveform)

L-L 680 Volts

L-N 430 Volts

L-G 430 Volts

N-G 380 Volts

(For Delta configurations, IEEE let through is measured L-L and L-G).

- . 3 Each unit must be capable of withstanding 3,000 sequential, Category C1, 8 x 20 us impulses as described and conducted in ANSI/IEEE C62.42 and C62.45. The interval between impulses must not exceed 30 seconds. The resultant let through voltage of the last impulse must not vary from the first impulse by more than  $\pm 5\%$ .
- . 4 Suppression System: TVSS filtering unit to include an engineered solid-state high-performance suppression system, utilizing non-linear voltage dependant metal oxide varistors or selenium cells. The suppression system's components must not utilize gas tubes, spark gaps, silicon avalanche diodes or other components which might short or crowbar the line, thus leading to interruption of normal power flow or cause system upset of connected loads.
- . 5 TVSS clamping components to have a response time rated less than 1 nanosecond. Filter components shall respond instantaneously.
- . 4 Filtering:
  - . 1 Noise Attenuation: TVSS unit to be listed under UL1283 and contain a high-frequency extended range tracking filter. Filter to reduce fast rinse-time, high-frequency, error-producing transients and electrical line noise to harmless levels thus eliminating disturbances which may lead to system upset. Noise attenuation to be a minimum of -46db at 100kHz based on standard insertion loss data obtained utilizing the MIL-STD-220A, 50 ohm insertion loss methodology. Only manufacturers providing a documented value at 100 kHz will be considered. Spectrum analysis may be required for support.
  - . 2 Bandwidth: TVSS filter to have an effective filtering bandwidth of 10kHz to 50 MHz.
- . 5 General Features:
  - . 1 The Integrated TVSS Panel shall be fully integrated. The TVSS unit to be factory installed and connected to the bus bar. Field installed TVSS component products will not be considered. The integrated panelboard must be factory tested as a complete unit to ensure completed product integrity.
  - . 2 Suppression/Filter System Connections: Do not use plug-in component modules, quick-disconnect terminals or printed circuit boards in surge current-carrying paths.
  - . 3 The unit will have visual indicator lights for each phase of operation. The system will continuously monitor the operating status of each phase of suppression protection. If the unit is in proper working order, the indicator lights will be illuminated. If unit performance is degraded, the lamps will no longer be illuminated. These indicators must be visible without removal of the panel trim.
  - . 4 Fuses: TVSS/filter system to utilize internal fuses rated with a minimum interrupting rating of 200,000 AIC.
  - . 5 Identification: unit to include manufacturer's nameplate and

- . 6 CSA approval on the exterior of the enclosure.  
Warranty: provide a limited five (5) year warranty on the TVSS filter. This warranty shall commence from date of shipment.
- . 7 Testing: testing of each unit to include quality assurance checks, "Hi-Pot" test at two times rated voltage plus 1000 volts per UL requirements, and operational and calibration tests.

**2.4 EQUIPMENT IDENTIFICATION**

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

**2.5 ACCEPTABLE MANUFACTURERS**

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

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- . 1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.
- . 2 Mount panelboards to height specified in Section 26 05 00 - Electrical General Requirements or as indicated.
- . 3 Connect loads to circuits.
- . 4 Connect neutral conductors to common neutral bus with respective neutral identified.
- . 5 Where more than one bonding terminal strip is present in one panel, hardwire both together using same size bonding conductor as the one that accompanies the panel feeder conductors.

END OF SECTION

**PART 1 - GENERAL**

**1.1 REFERENCES**

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

**1.2 SHOP DRAWINGS**

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

**1.3 OPERATIONAL AND MAINTENANCE DATA**

- .1 Provide operation and maintenance data for wiring devices for incorporation into manual specified in Section 01 33 00.

**PART 2 - PRODUCTS**

**2.1 SWITCHES**

- .1 Design S1:
  - .1 20 A, 120 V, specification grade single pole, two way switches.
  - .2 Manually-operated general purpose ac switches with following features:
    - .1 Terminal holes approved for No. 10 AWG wire.
    - .2 Silver alloy contacts.
    - .3 Urea or melamine molding for parts subject to carbon tracking.
    - .4 Suitable for back and side wiring.
    - .5 White nylon, heavy duty toggle.
    - .6 Integral ground terminal.
  - .3 Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.
  - .4 Switches of one manufacturer throughout project.
  - .5 Standard of Acceptance: Hubbell 1200 Series.
  - .6 Approved Manufacturers:
    - .1 Hubbell
    - .2 Pass & Seymour
    - .3 Arrow Hart
    - .4 Leviton
    - .5 Bryant

**2.2 RECEPTACLES**

- .1 Design R1:
  - .1 General purpose duplex receptacles, specification grade CSA type 5- 15 R, 125 V, 15 A, U ground, with following features:
    - .1 Ivory urea molded housing for all power receptacles.
    - .2 Suitable for No. 10 AWG for back and side wiring.
    - .3 Break-off links for use as split receptacles.
    - .4 Eight back wired entrances, four side wiring screws.
    - .5 Triple wipe contacts and riveted grounding contacts.
    - .6 Standard of Acceptance: Hubbell 5262-I Series.

- .7 Approved Manufacturers:
  - .1 Hubbell
  - .2 Pass & Seymour
  - .3 Arrow Hart
  - .4 Leviton
  - .5 Bryant
  
- .2 Design R2:
  - .1 Duplex receptacles, specification grade CSA type 5-20 R(T-Slot), 125 V, 15/20A, U ground, with following features:
    - .1 Ivory urea molded housing.
    - .2 Suitable for No. 10 AWG for back and side wiring.
    - .3 Break-off links for use as split receptacles.
    - .4 Eight back wired entrances, four side wiring screws.
    - .5 Triple wipe contacts and rivetted grounding contacts.
    - .6 Ivory nylon face.
    - .7 Standard of Acceptance: Hubbell 5362-N Series.
    - .8 Acceptable Manufacturers:
      - .1 Hubbell
      - .2 Pass & Seymour
      - .3 Arrow Hart Leviton
      - .4 Bryant
  
- .3 Design R3:
  - .1 GFCI duplex receptacles. Specification grade, CSA type 5-15R, 125V, 15A, U-Ground with the following features:
    - .1 Ivory urea moulded housing.
    - .2 Suitable for No. 10 AWG for back and side wiring.
    - .3 Eight back wired entrances, four side wiring screws.
    - .4 Triple wipe contacts and riveted grounding contacts.
    - .5 Ivory nylon face.
    - .6 GFI test and reset buttons.
    - .7 Standard of Acceptance:
      - .1 Hubbell GFR5252-I Series.
    - .8 Approved Manufacturers:
      - .1 Hubbell
      - .2 Pass & Seymour
      - .3 Arrow Hart
      - .4 Leviton
      - .5 Bryant
  
- .4 Other receptacles with ampacity and voltage as indicated.
  
- .5 Receptacles of one manufacturer throughout project.
  
- .6 Acceptable materials:
  - .1 Hubbell
  - .2 Pass & Seymour
  - .3 Arrow Hart
  - .4 Leviton
  - .5 Bryant
  
- 2.3 REVERSE ACTING THERMOSTAT**
  - .1 Line voltage, to start system on adjustable temperature
  - .2 Ivory color,

- . 3 Adjustable rotating dial
- . 4 Acceptable material: Honeywell, White Rogers.

## **2.4 COVER PLATES**

- . 1 Cover plates for wiring devices.
- . 2 Stainless steel, satin finish on flush mounted outlet boxes.
- . 3 Galvanized pressed steel surface covers on surface mounted outlet boxes.
- . 4 Heavy duty weatherproof while in use cover plates for devices designated as weatherproof.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- . 1 Switches:
  - . 1 Install single throw switches with handle in "UP" position when switch closed.
  - . 2 Install switches in gang type outlet box when more than one switch is required in one location.
  - . 3 Mount toggle switches at height specified in Section 26 05 00 - Electrical General Requirements or as indicated.
- . 2 Receptacles:
  - . 1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
  - . 2 Mount receptacles at height specified in Section 26 05 00 - Electrical General Requirements or as indicated.
  - . 3 Mount receptacles with "U" ground up for vertically mounted and neutral slot at top for horizontally mounted receptacle.
  - . 4 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.
  - . 5 All receptacles are to be polarity tested.
- . 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. Device leveler and retainer is an approved accessory for securing devices to flush installed device boxes.

END OF SECTION

**PART 1 - GENERAL**

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

- 1.2 SHOP DRAWINGS AND PRODUCT DATA**
- . 1 Submit shop drawings and product data in accordance with Section 01 33 00.

- 1.3 MAINTENANCE MATERIALS**
- . 1 Provide six (6) spare fuses of each type and size.

- 1.4 DELIVERY AND STORAGE**
- . 1 Ship fuses in original containers.
  - . 2 Do not ship fuses installed.
  - . 3 Store fuses in original containers in moisture free location.

**PART 2 - PRODUCTS**

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

- 2.2 FUSE TYPES**
- . 1 All fuses shall be high rupturing capacity (HRC) type, minimum 200kA interrupting rating (momentary RMS symmetrical).
  - . 2 Class J:
    - . 1 Fuses rated 1 to 600 amperes, 600 Vac, shall be CSA certified Class J in accordance with Standard C22.2 No. 248.
    - . 2 Where a time delay characteristic is required, fuses shall carry 500% of their ampere rating for not less than 10 seconds and shall be clearly labeled "time delay".
  - . 3 Class L:
    - . 1 Fuses rated 601 to 1200 amperes, 600 Vac, shall be CSA certified Class L in accordance with Standard C22.2 No. 248.10.
    - . 2 Where a time delay characteristic is required, fuses shall carry 500% of their ampere rating for not less than 10 seconds and shall be clearly labeled "time delay".
  - . 4 Class CC:
    - . 1 Fuses rated 1 to 30 amperes, 600 Vac, shall be CSA certified

- . 2 Class CC in accordance with Standard C22.2 No. 248.4.  
Where a time delay characteristic is required, fuses shall carry 200% of their ampere rating for not less than 12 seconds.
- . 5 Standard of acceptance:
  - . 1 Class J: Ferraz Shawmut type A4J (non-time delay) and AJT (time delay) and HSJ (time delay).
  - . 2 Class L: Ferraz Shawmut type A4BY (non-time delay) and A4BQ (time delay) and A4BT (time delay).
  - . 3 Class CC: Ferraz Shawmut type ATMR (non-time delay) and ATDR (time delay) and ATQR (time delay).
- . 6 Acceptable manufacturers:
  - . 1 Ferraz Shawmut.
  - . 2 Bussmann.
  - . 3 Littlefuse.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

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

END OF SECTION

**PART 1 - GENERAL**

**1.1 PRODUCT DATA**

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

**1.2 OPERATION AND MAINTENANCE DATA**

- .1 Provide operation and maintenance data for circuit breakers for incorporation into Manual specified in Section 01 77 00.

**PART 2 - PRODUCTS**

**2.1 BREAKERS GENERAL**

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

**2.2 MAGNETIC BREAKERS**

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

**2.3 OPTIONAL FEATURES**

- .1 Include:
- .2 On-off locking device for 10% of branch breakers and all breakers supplying exit signs and fire alarm devices.
- .3 Shunt trip breaker where indicated.

**2.4 GROUND FAULT CIRCUIT INTERRUPTER CIRCUIT BREAKERS**

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

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

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

END OF SECTION

## **PART 1 - GENERAL**

### **1.1 PRODUCT DATA**

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

### **1.2 OPERATION AND MAINTENANCE DATA**

- . 1 Provide operation and maintenance data for disconnect switches for incorporation into manual specified in Section 01 77 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 size as indicated).
- . 2 Provision for padlocking in off switch position by three locks.
- . 3 Mechanically interlocked door to prevent opening when handle in ON position.
- . 4 Fuses: size as indicated, to Section 26 28 14 - Fuses - Low Voltage.
- . 5 Fuseholders: suitable without adaptors, for type and size of fuse indicated.
- . 6 Quick-make, quick-break action.
- . 7 Double throw for manual transfer switch.
- . 8 ON-OFF switch position indication on switch enclosure cover.
- . 9 Acceptable manufacturers:
  - . 1 Siemens.
  - . 2 Cutler Hammer.
  - . 3 Schneider.
- . 10 Exterior mounted disconnect switches to be complete with NEMA 4X 316 grade stainless steel enclosure.

### **2.2 EQUIPMENT IDENTIFICATION**

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

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

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

END OF SECTION

## **PART 1 - GENERAL**

### **1.1 REFERENCES**

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

### **1.2 SHOP DRAWINGS AND PRODUCT DATA**

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

### **1.3 OPERATION AND MAINTENANCE DATA**

- .1 Provide operation and maintenance data for motor starters for incorporation into manual specified in Section 01 77 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.
  - .3 Mounted in NEMA 1 enclosure.
- .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 NEMA design 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 lockable operating lever on outside of enclosure to control disconnect, 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 labeled 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) current sensing relay for connection of BMS to indicate run status.
  - . 6 Factory installed interposing 24VAC relay for connection to BMS

## **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 consultant for each motor starter confirming operation and settings.

END OF SECTION

**PART 1 - GENERAL**

**1.1 REFERENCES**

- .1 ANSI C82.1-2004, Specifications for Fluorescent Lamp Ballasts.
- .2 ANSI C62.41-2008, IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
- .3 ANSI C62.45-2008, IEEE Guide on Surge Testing for Equipment Connected to Low- Voltage AC Power Circuits.
- .4 CAN/CSA C654-2010, Fluorescent Lamp Ballast Efficiency Measurements.
- .5 NECA/ESNA 500-1998, Recommended Practice for installing indoor commercial lighting systems.
- .6 ANSI/IESNA RP1-2004; American national Standard practice for office lighting.
- .7 ASTM F1137-2011e1, American Society for Testing and Materials Specification for 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.
- .9 IESNA LM-79, Electrical and photometric Measurements of Solid State Lighting.
- .10 IESNA LM-80, Measuring Lumen Maintenance of LED Light Sources.

**1.2 RELATED WORK**

- .1 Submittal Procedures: Section 01 33 00

**1.3 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings in accordance with Section 01 33 00.
- .2 Submit shop drawings for the following:
  - .1 Luminaire.
  - .2 Lamp/engine for each luminaire type.
  - .3 Ballast/driver for each luminaire type.
- .3 Shop Drawings:
  - .1 Shop drawings shall clearly indicate the following:
    - .1 Luminaire ID number as identified in contract documents.
    - .2 Fixture specification as identified in Part 2 and on the drawings.
    - .3 Lamp specification as identified in Part 2 and on the drawings.
    - .4 Ballast specification as identified in Part 2 and on the drawings.
    - .5 Photometric data for each luminaire type.
    - .6 Energy data for lamps and ballasts.
- .4 Catalogue cuts lacking sufficient detail to indicate compliance with Contract documents will not be acceptable.

.5 Submit complete photometric data prepared by independent testing laboratory for luminaires where specified, for review by Departmental Representative. Photometric data to include:

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

**1.4 OPERATION AND MAINTENANCE**

.1 Provide operation and maintenance data for inclusion in the manual specified in Section 01 77 00.

**1.5 WASTE AND DISPOSAL**

.1 Separate and recycle waste materials in accordance with Section 01 74 22.

.2 Place materials defined as hazardous or toxic waste in designated containers.

.3 Ensure emptied containers are sealed and stored safely for disposal away from children.

.4 Disposal of fluorescent lamps.

**PART 2 - PRODUCTS**

**2.1 LAMPS**

.1 Linear Fluorescent Lamps:

Lamp Type	Wattage	Base	Initial Lumens	Rated Life h	Colour Temp. (25C)	CRI	Additional Information
T8	32W	Med Bipin	2,900	36,000	4,100 K	85	

**2.2 BALLASTS**

- .1 Fluorescent Electronic Programmed Rapid Start Ballast:
  - .1 Performance requirements:
    - .1 Electronic programmed rapid start.
    - .2 Independent Lamp Operation (IOL) for rapid start ballasts allowing remaining lamps to maintain full light output when one or more lamps fail.
    - .3 Auto restart circuitry in order to restart lamps without resetting power.
    - .4 Operate from 50/60 Hz input source of 120V, 277V or 347V as applicable with sustained variations of +/- 10% voltage and frequency with no damage to the ballast.
    - .5 High frequency electronic type and operate lamps at a frequency above 42 kHz to avoid interference with infrared devices and eliminate visible flicker.
    - .6 Power Factor greater than 0.98 primary lamp.
    - .7 Minimum ballast factor of 1.0 for primary lamp.
    - .8 Lamp current crest factor of 1.7 or less in accordance with lamp manufacturer recommendations.
    - .9 Total harmonic distortion (THD) of less than 10% when operated at nominal line voltage with primary lamp.
    - .10 Class A sound rating.
    - .11 Minimum starting temperature of -18°C (0°F).
    - .12 End of live (EOL) protection circuit.
    - .13 Polychlorinated Biphenyl (PCB) free.
  - .2 Regulatory requirements:
    - .1 Underwriters Laboratories(UL) listed, Class P and Type 1 Outdoor; and Canadian Standards Association (CSA) certified.
    - .2 Meet or exceed ANSI C62.41 Category A for Transient protection.
    - .3 Meet or exceed ANSI/C82.11 where applicable.
    - .4 Meet or exceed the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).
    - .5 Ballast shall meet or exceed the requirements of CSA Standard 654 for ballast efficiency.
    - .6 Provide ballast with integral leads colour coded per ANSI C82.11
  - .3 Warranty:
    - .1 Ballast to carry a five (5) year warranty from date of manufacture against defects in material or workmanship for operation at a maximum case temperature of 75deg.

**2.3 SPARES**

- .1 Provide 10% spare lamps of each type to a minimum quantity of ten (10).
- .2 Provide 5% spare ballasts and LED drivers of each type to a minimum quantity of five (5).
- .3

- 2.4 Wall Mounted vacancy switch**
- .1 Dual technology PIR and microphonics detection
  - .2 Programmable to be manual "ON" or auto "ON"
  - .3 Ivory color, line voltage
  - .4 Non volatile memory
  - .5 Acceptable material: Sensorswitch WSD PDT-SA-IV or Lutron equivalent
- 2.5 CEILING MOUNTED OCCUPANCY SWITCH**
- .1 Dual technology PIR and microphonics detection
  - .2 Programmable time delay up to 20 minutes
  - .3 3 White color, line voltage
  - .4 Photocell control
  - .5 5 year warranty
  - .6 Acceptable material: Sensorswitch CMR 9P or Lutron equivalent
- 2.6 ASTRONOMICAL TIMER**
- .1 7-day programmable time clock
  - .2 Installed in a NEMA 1 enclosure
  - .3 Complete with on/off override
  - .4 Capable of powering two 120VAC 20A lighting circuits
  - .5 LCD display
  - .6 3 year backup battery
  - .7 Acceptable Material: Intermatic ET1700 or equivalent
- 2.7 PHOTOCELL**
- .1 120VAC rated
  - .2 Non metallic housing, weatherproof
  - .3 Sun shield
- PART 3 - INSTALLATION**
- .1 .Locate and install luminaires as indicated. Provide and install all necessary hangars, supports, fittings, etc. as necessary for a complete installation.
  - .2 Coordinate installation with all other services.
  - .3 Lights installed in drywall to all contain safety chain to structure.
- 3.2 WIRING**
- .1 Connect luminaires to lighting circuits as indicated.
  - .2 Each light fixture to have a separate "fixture drop" installed and connected to hard wired junction box or outlet box in ceiling space.

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

**3.3 LUMINAIRE  
SUPPORTS**

.1 Support luminaires independently of all other systems using an approved supporting method.

**3.4 LUMINAIRE  
ALIGNMENT**

.1 Align luminaires mounted in continuous rows to form straight uninterrupted line.

.2 Align luminaires mounted individually parallel or perpendicular to building grid lines.

END OF SECTION

**PART 1 - GENERAL**

**1.1 PRODUCT DATA**

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

**1.2 OPERATION AND MAINTENANCE DATA**

- .1 Submit operation and maintenance data for incorporation in the Manual specified in Section 01 77 00.

**PART 2 - PRODUCTS**

**2.1 BATTERY UNIT**

- .1 Refer to drawings for specifications.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

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

END OF SECTION

**PART 1 - GENERAL**

**1.1 PRODUCT DATA** .1 Submit product data in accordance with Section 01 33 00.

**1.2 OPERATION AND MAINTENANCE DATA** .1 Submit operation and maintenance data for incorporation in the Manual specified in Section 01 77 00.

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

**PART 2 - PRODUCTS**

**2.1 STANDARD UNITS** .1 Refer to drawings for specifications.

**PART 3 - EXECUTION**

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

END OF SECTION

**PART 1- GENERAL**

**1.1 PRODUCT DATA**

- .1 Submit product data in accordance with Section 01 33 00.
- .2 Submit product data sheets for radiant heating panels. Include:
  - .1 Product characteristics.
  - .2 Performance criteria.
  - .3 Mounting methods.
  - .4 Physical size.
  - .5 kW rating, voltage, phase.
  - .6 Material thicknesses.
  - .7 Colour and finish.
- .3 Submit product data sheets for unit heaters. Include product characteristics, performance criteria, physical size, limitations and finish.

**1.2 CLOSEOUT  
SUBMITTALS**

- .1 Provide operation and maintenance data for unit heaters for incorporation into manual specified in Section 01 33 00.

**PART 2 - PRODUCTS**

**2.1 ELECTRIC  
BASEBOARD**

- .1 Electrical ratings and their respective dimensions to be as indicated on the drawings.
- .2 Heating Element: tubular element, standard watt density
- .3 120V, 1000W, integral thermostat
- .4 Finish: epoxy/polyester powder paint White
- .5 Standard of Acceptance:
  - .1 Ouellet. OFM
  - .2 Cromalox equivalent
  - .3 Stelpro equivalent

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- .1 Install all electric heaters as indicated and in accordance with manufacturer's instructions.
- .2 For radiant panel heaters, ensure that manufacturer's mounting instructions for each fixture, including minimum distances from ceiling, walls or combustible materials, are followed.
- .3 Power and control connections are to be by Division 26 and Section 25 00 00.

**3.2 FIELD QUALITY  
CONTROL**

- . 1 Perform tests in accordance with Section 26 05 00.
- . 2 Test cut-out protection when air movement is obstructed.
- . 3 Ensure that heaters and controls operate correctly.

END OF SECTION